Gt. Brit. Fuel Research Board. Irish Peat Inquiry Committee

The winning, preparation, and use of peat in Ireland

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

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INTRODUCTORY NOTE

On March 9th, 1917, the Irish Department of Agriculture and Technical Instruction invited "the attention of the Advisory "Council of the Department of Scientific and Industrial "Research to the question of the utilisation of peat deposits "in Ireland." The matter was referred to the Fuel Research Board of the Department, and on April 20th a Conference took place between the Board and an Officer of the Irish Department with the late Professor McClelland, the Irish Member of the Advisory Council. As a result of this Conference it was decided to ask the Lord President to approve the appointment of a Committee of Inquiry. The Board, in putting forward this proposal, added the recommendation that the new Committee should be entirely Irish in constitution, and suggested that the terms of reference should run as follows:—

> "To inquire into and consider the experience already gained in Ireland in respect of the winning, preparation, and use of peat for fuel, and for other purposes, and to suggest what means shall be taken to ascertain the conditions under which in the most favourably situated localities it can be profitably won, prepared, and used, having regard to the economic conditions of Ireland; and to report to the Fuel Research Board."

They proposed that the Committee should consist of Sir John Purser Griffith, as Chairman, Professor Ryan of University College, Dublin, Professor Sidney Young, of Trinity College, Dublin, and Mr. George Fletcher, an Assistant Secretary of the Department of Agriculture and Technical Instruction for Ireland, nominated by that Department, with Professor Pierce Purcell, of University College, Dublin, as Secretary. In putting forward this recommendation, the Fuel Research Board expressed the view that it was important that existing knowledge should be collected and carefully sifted by a judicial body, and they explained that they had been guided by this consideration in selecting the names they proposed. The Board forwarded their proposals to the Lord President on 27th June, and the Lord President gave his concurrence on 29th June.

The Irish Peat Inquiry Committee was accordingly appointed on 2nd July, and it submitted its first report on 26th February 1918. The Fuel Research Board, after a careful consideration of the Report, held a Conference with the Committee on 11th June, as an outcome of which the Committee submitted a supplementary report dated 10th July 1918. On 23rd August

the Fuel Research Board submitted their considered findings on the Report to the Lord President, and he communicated these in the following September to the Chief Secretary for Ireland.

The Fuel Research Board recommended the erection and maintenance of an experimental peat station on a selected bog area, provided an agricultural colony could be established on the area under the control of the Irish Department of Agriculture and Technical Instruction. Only in this way could the necessary labour be found with any prospect of successful and continued work under economic conditions. The proposed formation of an agricultural colony necessitated a consideration of this aspect of the scheme by the Irish Department of Agriculture, and the report submitted on 26th April by the Committee appointed by that Department in March 1920 made it clear that the proposal was not feasible (*see* Section VII. below). In the final section of this paper, the work of the Fuel Research Board on the general peat problem since the report of the Irish Peat Inquiry Committee is given in outline.

Department of Scientific and Industrial Research,
16 and 18, Old Queen Street,
Westminster, S.W. 1.

23rd November 1920.

THE WINNING, PREPARATION, AND USE OF PEAT IN IRELAND—REPORTS AND OTHER DOCUMENTS

I

Irish Peat Inquiry Committee
Letter of Appointment

Department of Scientific and
Industrial Research,
2nd July 1917.

SIR,

I AM directed by the Committee of the Privy Council for Scientific and Industrial Research to inform you that the Director of Fuel Research (Sir George Beilby) and the Fuel Research Board have decided to set up a small committee of inquiry into the utilization of Irish Peat Deposits. It is proposed that the Committee shall consist of Professor Ryan, University College, Dublin; Professor Young, Trinity College, Dublin; Mr. George Fletcher, Irish Department of Agriculture and Technical Instruction; and yourself; with Professor Pierce Purcell, University College, Dublin, as Secretary.

I am directed to express the hope that you will be able to assist the Fuel Research Board by serving as the Chairman of the Committee. The terms of reference will be found at the foot of this letter. The meetings will take place in Dublin, and you will be consulted later by the Secretary as to the most convenient place and date for the first meeting.

I am, Sir,
Your obedient servant,
(Signed) LL. S. LLOYD.

Sir John P. Griffith,
Rathmines Castle, Dublin.

TERMS OF REFERENCE OF THE COMMITTEE.

To inquire into and to consider the experience already gained in Ireland in respect of the winning, preparation, and use of peat for fuel and for other purposes, and to suggest what means shall be taken to ascertain the conditions under which in the most favourably situated localities it can be profitably won, prepared, and used, having regard to the economic conditions of Ireland; and to report to the Fuel Research Board.

II

Letter from the Director of Fuel Research to the Chairman of the Irish Peat Inquiry Committee

FUEL RESEARCH BOARD,
7th July 1917.

PEAT IN IRELAND.

DEAR SIR JOHN GRIFFITH,

With reference to the work of your Committee, it may be well that I should put in writing the views of the Fuel Research Board on what they regard *as the first stage of the inquiry.* I think the leading points were considered with you in a preliminary way at our recent interview, but for the sake of clearness it may be well that the whole case should be re-stated.

The direction taken by the later stages of the inquiry may be a good deal affected by the results of the other activities of the Fuel Research Board, as some of the inquiries on which they are engaged may be expected to throw important light on the processes and economics of peat carbonisation. There appears, therefore, to be every justification at this stage for the concentration on those fundamental questions which lie at the root of any and every scheme for the development of the peat bogs in Ireland. These fundamental matters may be summarised in a single question; can partially dried peat (containing say 20, 30, or 40 per cent. of water) be delivered in large and regular quantities at certain points within a moderate (specified) distance from centres of population and industry at a cost which will compare with that of coal at the same points, due allowance being made for the difference in calorific value?

At our interview I understood you to agree with our view that the first step in the proposed inquiry ought to be to provide an answer to this question by making a careful study of the possibilities of peat winning in the case of one or more favourably situated bogs. The survey of the bogs of Ireland made early in the last century, to which you referred, would no doubt enable your Committee to make a preliminary selection of a certain number of bogs which show sufficient promise to justify a closer survey. I think we agreed that the chief points to be considered in the selection of a typical bog would be:—

(*a*) The extent, depth, and quality of the peat deposit and its capacity to yield a steady output of partially dried peat. This output might be specified in units of 100 to 1,000 tons per day.

(*b*) The facilities for easy and quick drainage of the water from the bog itself and from the cut peat in the course of its preparation.

(*c*) Proximity to centres of population and industry.

(*d*) Means of transport by rail, coasting ships, or by canal or river barges.

(*e*) Supplies of suitable labour and facilities for the housing of the workers.

(*f*) The value of the land underlying the bog for the purposes of reclamation.

(*g*) The existence of cheap water power for the generation of power required for the winning and preparation of the peat. (This may be regarded as a counsel of perfection, but it is an advantage well worth securing where it could be obtained.)

We believe that the policy of deliberately selecting the most favourable cases for first consideration is sound. If the results of your inquiries go to show that a good case can be made out for the development of the industry in these favoured cases the selection will insure that any development scheme which may be based on your recommendation will have the best possible start as the natural advantages would all be on the side of success. On the other hand, if it is not possible to make out a case for this development, the fact that every natural advantage has been taken into consideration by this method of selection would go far to meet any adverse criticism should the conclusion based on the results of your inquiry be of a negative character.

The conditions which are likely to prevail in industry after the war will be so new that it does not appear that any useful purposes would be served by the compilation of a history of the many attempts which have been made in the past to establish a peat industry of national importance. Nor does it seem desirable that your inquiry should be seriously concerned with the schemes of inventors and cranks who propose by one magical stroke to bridge over all the tedious and uncertain steps which we know must be taken if a permanent industry is to be built up. If the door is once opened for the admission of the proposals of the many inventors, financiers, or philanthropists, each of whom would have us believe that the peat bogs in Ireland are a veritable treasure house, the key to which they alone possess, the really useful work of the Committee would be most seriously hampered and the inquiry would be unduly prolonged.

To sum up the situation: The proposed scheme of inquiry and experiment of the Fuel Research Board on the economical use of fuel of all kinds for the production of heat and power on a very large scale will, at the outset at any rate, cover the applications of peat in the same directions. It therefore appears that your attention may be most profitably engaged in a serious endeavour to lay the ultimate foundations of a national development by an inquiry into means whereby peat, at or near its sources, may be given a definite rating in comparison with coal.

Yours faithfully,

(Sgd.) GEORGE T. BEILBY.

III

Report of the Irish Peat Inquiry Committee on the Winning, Preparation, and Utilization of Peat for Fuel and other purposes

To the Fuel Research Board.

Gentlemen,

The Irish Peat Inquiry Committee beg to present to the Fuel Research Board the following report on the *first stage* of the Inquiry, carried out in accordance with the following terms of reference, submitted to them in July 1917 :— Terms of reference.

> "To inquire into and to consider the experience already gained in Ireland in respect of the winning, preparation, and use of peat for fuel and for other purposes, and to suggest what means shall be taken to ascertain the conditions under which in the most favourably situated localities it can be profitably won, prepared, and used, having regard to the economic conditions of Ireland ; and to report to the Fuel Research Board."

In a letter dated 7th July 1917, addressed by the Director of your Board to the Chairman of our Committee, he set forth at length the views of your Board, and asked the Committee during the first stage of the inquiry to concentrate their attention on the problem of winning the fuel, and to defer to a later date the consideration of the various processes which exist for the utilisation of the peat for the production of heat and power on a very large scale. This direction has facilitated the work of the Committee and has allowed them to proceed unhampered to the full consideration of the main problem set before them, that of winning peat.

The Director of your Board addressed a number of questions to the Committee, which will be found with the answers of the Committee at the end of this report.

(1) Reports of Bog Commission, 1809–1814.

The Committee have been saved much labour and expense by having been able to utilise the valuable information obtained and published by the Commission appointed by Parliament in 1809 " to inquire into the nature and extent of the several bogs " in Ireland, and the possibility of draining and cultivating " them." Reports and maps of Bogs Commission.

The reports and maps of the Commission embrace all the principal bogs in the country, and give their areas, depths, and characteristics.

The Commission was constituted by Act of Parliament, and the members were appointed by warrant signed by the Duke of Richmond, the Lord Lieutenant of Ireland at that date.

The Commission consisted of some of the most distinguished men of the day, and the engineers employed to survey and report on the bogs of Ireland were amongst the foremost professional men of their time. They entered fully into the nature, character, and physical conditions of the Irish bogs, and were firmly convinced of the comparative ease with which the bogs could be reclaimed and made into a valuable financial asset of the country. Although objections were freely raised against their proposals on the ground that such reclamations would interfere with the use of the bogs for fuel purposes, yet they successfully criticised these objections and proved, in the words of their report—

> "That if the bogs of Ireland were reclaimed, we should
> " derive not merely the advantage of cultivating their
> " surface, but that at the same time the power of applying
> " them whenever necessary for fuel would be augmented
> " some hundred or rather some thousand fold" . . . .
> " Fuel can at present be obtained only from the edges of
> " these bogs, the excessive wetness of the interior
> " rendering it in its present state wholly unavailable for
> " that purpose, but if once drained fuel might be
> " obtained from every part of them."

Drainage of bogs.

The evidence in the reports of the Bogs Commission prove that practically all the large bogs of the country can be naturally drained without the aid of mechanical pumping and without any great works of river improvement, and that the effect of systematic draining would be to make the bog lands available for tillage and peat winning, followed by cultivation of the cut-away bogs.

It may naturally be urged that if the benefits are so great, it is difficult to understand why the work of draining the bogs has not been carried out long ago, and that there must be some fallacy underlying the proposal. The Bogs Commissioners in their Fourth and Final Report entered fully into this difficulty and pointed out that it was not to physical obstacles that the condition of these wastes was principally to be ascribed, but to the indeterminate nature of the boundaries between adjoining properties and the rights of turbary and grazing claimed by the tenantry. Without special legislation the problem bristled with difficulties.

It may be asked why the British Government did not take action on receiving such strong reports from the Bogs Commission, and bring forward legislation to carry out their recommendations. It might have got powers to carry out the work itself or it might have promoted legislation in the interests of the owners of property and have removed the difficulties already referred to.

The majority of the Bogs Commissioners were adverse to advising the Government to form a special Board to carry out a

large experiment of the kind, and favoured legislation to remove obstacles and assist in the work being carried out by individual or private enterprise.

To understand the position it is necessary to remember that at the time the Bogs Commissioners made their Final Report, British finances were exhausted as the result of the long Napoleonic war; Irish interests in Parliament were not sufficiently strong to carry such measures through, and the interest of the British Government in Ireland was not sufficient to induce it to make such a sacrifice in her favour.

The principal Irish landowners had come to Westminster under the Act of Union to sit in the British Parliament. They were too poor to live on a par with the English aristocracy, and too proud to do otherwise. The drain on their finances put an end to expenditure on their estates, led to absentee landlordism, the mortgaging of their properties, substitution of land agents in the place of the paternal landlord, the severance of friendly relations between landlord and tenant, and the increase of rents whenever the tenant improved his holding. This was followed by the Land League agitation and subsequent land legislation.

Meanwhile the effect of the Corn Laws agitation and so called free trade discouraged home agriculture and the tillage of the land. No further steps were taken to reclaim the bogs of Ireland, and the valuable work of the Bogs Commission has been shelved for more than 100 years. Fortunately its reports and maps have been carefully preserved in the archives of the Royal Dublin Society and the National Library of Ireland, and they have been placed in a most generous manner at the disposal of the Irish Peat Inquiry Committee.

From these reports the Committee have obtained most of their data with regard to the extent of the bog areas and their depth, from which an estimate has been made of the quantity of peat available.

(2) The Royal Dublin Society and Bog Reclamation.

We cannot omit reference to the interest taken by the Royal Dublin Society in the problems connected with the drainage and reclamation of bogs. As far back as the middle of the 18th century prizes were offered and awarded for the reclamation of bog areas. The minutes of the Society abound in references to the work done and the premiums awarded. When Parliament appointed the Commission already referred to, the Society supplied the necessary office accommodation and at the close of the Commission's labours took charge of and preserved their reports, surveys, maps, and sections.

In the year 1820 the Society nominated a permanent Committee of 21 members to inquire into the expense and

practicability of reclaiming the bogs and waste lands of Ireland. This Committee reported that every description of bog was capable of reclamation, and of being converted into profitable land which would repay outlay. British indifference to the importance of agriculture as a national asset, fostered by the import of cheap foreign foodstuffs, resulted in good land going out of cultivation, and as a natural result any idea of reclaiming waste lands or bogs was abandoned. For the past 100 years the bogs of Ireland have been used as a source of fuel only for the inhabitants of villages, towns, and districts where coal was not available.

(3) Attempts which have been made to utilize the Irish Peat Deposits.

Attempts, many of which were successful, have been made during the past 300 years to utilize the bog land, before and after the removal of the peat, for agricultural purposes. Such attempts have been described in 1645 by Dr. Boate in the "Natural History of Ireland." In 1660 it was proposed that "an Act of Parliament should be made that they who did not "at such a time make some progress in draining their bogs "should part with them to others that would," and in 1725 a Bill was passed by the Irish Parliament for the Encouragement of Tillage, the Drainage of Bogs, and for Inland Navigation. The absence from the Bill of compulsory powers is no doubt the reason why further legislation is now required after an interval of nearly 200 years.

Many unsuccessful attempts have been made during the past 100 years to make use of Irish peat for various purposes. Thus a peat charcoal factory was established at Derrymullen in the Bog of Allen* by Rogers and a factory for the gasification of peat in a pressure producer gas furnace at Kilberry, near

---

* The name Bog of Allen is applied to an indefinite area of bog situated in the central plain. The eastern boundary embraces the bogs lying nearest to Dublin, but the western and northern boundaries are not fixed. The following extract from the first Report of the Bogs Commissioners (1810) shows that even then the name was applied to an indefinite area:—

> "Most of the bogs which lie eastward of the Shannon, and which occupy a considerable portion of the King's County and county of Kildare, are generally known by the name of the Bog of Allen; it must not, however, be supposed that this name is applied to any one great morass; on the contrary, the bogs to which it is applied are perfectly distinct from each other, often separated by high ridges of dry country and inclining towards different rivers, as their natural directions for drainage, so intersected by dry and cultivated land, that it may be affirmed generally there is no spot of these bogs (to the eastward of the Shannon) so much as two Irish miles distant from the upland aud cultivated districts."

In other parts of the reports (2nd report, p. 31 and p. 182) both Richard Griffith and R. L. Edgeworth include in the Bog of Allen bogs situated in Queen's County, and Sir Robert Kane in his Industrial Resources of Ireland (1844) includes Kilbeggan, Co. Westmeath.

Athy by Reece, about the middle of last century. An account of the latter operation is given in a Parliamentary Report on the Destructive Distillation of Peat, which was submitted to Parliament in 1851 by Sir Robert Kane.

At Derrylea, near Portarlington, in 1866 several thousand tons of press peat were manufactured by Hodgson, but his process, like similar Continental ones, was not successful. The oldest known method for converting wet peat by pressure into fuel was that employed in 1844 by C. W. Williams, at Cappoge in the Bog of Allen, and one of the oldest of the dry press processes, that of Gwynne, was tested on a small scale in 1855 at Kilberry. The manufacture of sieve peat was carried on near the town of Sligo in 1863. Ten years ago attempts were made at Kilberry to facilitate the dehydration of peat by acting on the latter with an alternating electric current. All these processes, as well as those for the manufacture of paper from peat and the production of ammonia by means of peat, which were worked at Celbridge, Co. Dublin, and Carnlough, Co. Antrim, respectively, were abandoned after short periods.

(4) Area and Fuel Content of Irish Peat Deposits.*

Area.

Very large areas of Ireland are covered by its bogs, estimated to amount to about 3,000,000 acres, more than one half of which are "red bog" as distinct from "mountain peat soil." More than 1,000,000 acres of these bogs represent the flat and deep bogs, three-quarters of which are concentrated within the central belt, bounded on the north by a line joining Howth with Sligo, and on the south by a line joining Wicklow with Galway. These bogs are estimated to average at least 17 feet in depth, and we estimate that this great tract of 1,000,000 acres of flat bogs contains upwards of 2,000 million tons of anhydrous peat. The data do not exist which would enable us to calculate the peat contained in the mountain bogs, but we consider that the total content of all the Irish bogs is between 3,000 and 3,500 million tons of anhydrous peat, or say, 4,000 million tons of air dried peat. At the present rate of peat consumption, say 6 million tons per annum, and allowing that all the imported coal 4,650,000 tons were replaced by peat fuel on the basis of two tons of air dried peat to one ton of coal, that is about 9 million tons of peat, the peat deposits would satisfy the fuel and power requirements of the country at the present rate of consumption for more than 250 years.

Average depth.

Fuel content.

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* The area of the bogs as given in the Bogs Commissioners' reports (1810–1814) is 2,831,000 English acres. Professor H. Ryan has pointed out (Economic Proceedings, Royal Dublin Society, 1907, part 10, page 384) a rather curious error whereby 320,000 Irish acres are brought into the summary instead of English acres. The total area as corrected by Professor Ryan is given as 3,038,000 English acres. (*See* Appendix IV., pp. 53–55.)

The distribution of the bogs over Ireland is clearly shown on the map of Ireland (one-quarter inch to the mile) accompanying this report.*†

Depth of foreign bogs.

In many of the flat bogs in the central belt of Ireland, the depth for large areas varies from 20 to 45 feet with an average depth of 25 feet, and it is of interest to contrast the depths of these deposits with those of other countries. Out of 132,000 acres of Canadian bog, which have been carefully surveyed and reported on, almost 100,000 acres are under 10 feet in depth. The State of Wisconsin, U.S.A., contains 2,500,000 acres of bog, and for those surveyed the average depth is only 6 feet. The part of the Bog of Allen which lies nearest to Dublin has an area of 77,500 acres and a mean depth of over 22 feet. We believe the Continental bogs, with some exceptions, to be of lesser depths than those of Ireland.

(5) Work of the Irish Peat Inquiry Committee, Visits paid and Evidence taken.

Meetings held.

The Committee since their formation have held 32 meetings, some of which were held in Dublin for hearing and discussing evidence submitted by persons interested in the peat industries, while others were held in the bog areas in which the principal Irish peat moss litter factories are situated.

Visits to bog areas.

We visited the following bogs and peat moss litter factories :—

United Kingdom Peat Moss Litter Co., Portglenone, Co., Londonderry.

Irish Peat Development Co., Peat Moss Litter Works, Maghery, Co. Armagh.

Mr. Hamilton Robb's bog in Co. Tyrone, and his bog and Moss Litter Works at Umeras, Co. Kildare.

Mulgeeth Peat Moss Litter Co., near Enfield, Co. Meath.

Irish Peat Industry Works, near Edenderry, King's Co.

Mr. David Sherlock's Moss Litter Works, Rahan, King's Co.

The Turraun Peat Co., Turraun, near Ferbane, King's Co.

We also visited the bog of the Leinster Carbonising Co. at Ticknevin, Co. Kildare, and examined the methods of winning farmers' peat fuel and so-called "commercial" peat fuel employed at Timahoe and Ticknevin respectively. A visit was paid to Mr. Hamilton Robb's weaving factory and producer gas plant at Portadown, Co. Armagh.

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* This map is a copy of the bog maps prepared in 1907 by the Geological Survey of Ireland from the published maps (one inch to the mile) of the survey. The mountain bogs of the southern areas have been inserted from such indications as were available on the 6-inch MS. maps. The original maps are of various dates, and while some of the smaller bogs shown on this map may have been cut away, it may be generally stated that the area of the larger bogs in the central belt shows no appreciable reduction since the time the Bogs Commission reports were made.

† The map reproduced has been reduced from the original large scale map accompanying the report.

During the visits paid to these various undertakings the Committee were received in the most kindly way and all possible information was afforded, both as regards methods employed, costs of working, output and results obtained. They cannot fail to take this opportunity of testifying to the very cordial way in which the owners of these works have met them and afforded every information, and would like to express their indebtedness to the following gentlemen :—Mr. Hamilton Robb, Mr. James Stott, Mr. F. A. Evans, Mr. Henry J. Staff, Mr. David Sherlock, Mr. F. P. Griffith, and Mr. James Lindsay, who gave valuable information on the winning of peat fuel and peat moss litter.

Evidence.

Evidence with regard to the composition of Irish peat was submitted by Professor Cronshaw of University College, Galway, and Professor Werner of Trinity College, Dublin, and, with regard to the methods employed in Ireland for winning peat, by Mr. E. St. John Lyburn, Economic Geologist to the Department of Agriculture and Technical Instruction for Ireland. With regard to the value of reclaimed bog land for agriculture and forestry, evidence was given by Mr. A. C. Forbes, Chief Forestry Inspector, and Mr. James Duncan, late agricultural Inspector of the Department of Agriculture and Technical Instruction. Mr. T. P Gill, the Secretary of the Department, gave evidence on the general policy of the Department towards the development of the peat industry in Ireland.

A report of the Engineering Joint Committee on Irish peat was submitted, and evidence was given on the subject matter of this report by Mr. Thomas Tomlinson, M.I.E.E., one of the members of the Committee.

Mr. Tissington Tatlow described experiments which had been carried out in Ireland for the Department on the manufacture of machine formed peat fuel and the more recent methods of preparing peat fuel employed on the Continent of Europe. Evidence bearing on the latter point was also submitted by Lt.-Col. Warburton, R.E.

Sir Henry Doran, Commissioner of the Congested Districts Board, gave us much valuable information with regard to the utilization of the bogs owned by the Board, to the cost of bogs in Ireland, and to several other matters to which attention must be directed in the purchase of bogs.

We have collected and tabulated statistics relating to the distribution of coal in Ireland and illustrated these on a map which accompanies this report. For the information contained in these returns we wish to express our thanks to the managers of the Irish railways and canals and to the Statistics Branch of the Department.

Statements as to the methods of winning, and the cost of peat fuel, have been obtained from almost all the County Surveyors in Ireland, together with the cost of coal, now and before the war, in the various counties. Similar statements

were submitted to us by the clerks of the Irish Unions and the Resident Medical Officers of the Irish Asylums regarding the amount and the cost of the fuel used annually in their Institutions.

Reports consulted.

During the course of our inquiry we have consulted the valuable publications of the Canadian Department of Mines on peat, and of the Canadian Peat Society, the articles on peat in the reports of the State Geologists for the States of Florida, Ohio, Indiana, Wisconsin, New Jersey, and Alaska. We have also made extensive use of the matter in Hausding's "Handbuch der Torfgewinnung und Torfverwertung," which contains much valuable matter in reference to the most recent German practice, and we have referred to various reports on the peat industry in Germany and Sweden.

(6) The Department of Agriculture and Technical Instruction for Ireland.

Department's experiments.

For many years the Department of Agriculture for Ireland have taken an interest in the development of the peat fuel and peat moss litter industry in Ireland, and from time to time articles on peat production and the agricultural use of bogs have appeared in the Journal of the Department.

In 1903 and 1905 Dolberg peat machines were imported by the Department from Germany and experiments were undertaken on bogs in Co. Cavan, at Inny Junction, Co. Westmeath, and at Castleconnell in Co. Limerick. Unfortunately their legal advisers came to the conclusion that the Department could not acquire bogs for these experiments. They were consequently driven into making arrangements with bog owners for permission to carry out these experiments on private bogs. This led to unsatisfactory results; some bogs turned out to be unsuitable, and difficulties with the proprietors in other cases led to the withdrawal of the machinery and the abandonment of the experiments. This has produced an impression in the country that the application of machinery to manufacturing peat fuel has proved a failure in Ireland, and the Committee regret to find the opinion very generally entertained. They do not share in this opinion, and have not discovered any reason why results which have proved satisfactory in Germany should not be equally so in Ireland. They are fully convinced that an experiment should be made to settle the question.

(7) Annual Consumption of Coal and Peat in Ireland.

Coal consumption.

We find from the returns issued by the Board of Customs and Excise of London* that the average annual import of coal into Ireland during the period of three years 1912 to 1914 inclusive was 4,650,000 tons per annum. In addition to this an average of 88,000 tons of native coal was mined and

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* (1) Cd. 6550, 7197, and 7741.

used in Ireland during each year of the same period. By the kind assistance of the managers of the railways, we have been able to trace the distribution of the coal by the railways and to determine the amount of coal remaining at the ports of import for local use and use in districts served from them by means of transit other than the railways. The following statement shows the approximate position of the coal distribution :—

	Tons.	Tons.
*Imported coal - - -		4,650,000
Native coal - - -		88,000
Total - -		4,738,000
Used by railways for locomotive and other purposes		475,000
†Balance left for domestic, gas-producing and manufacturing purposes - -		4,263,000
Of this transported by rail -	1,210,000	
Transported by barges on inland navigations - -	165,000	
Native coal not railed -	74,000	
,, ,, railed - -	14,000	
Total coal used in the inland districts of Ireland -	1,463,000	
Balance remaining at ports of import for local use and use in adjoining districts not requiring to be railed -	2,800,000	4,263,000

The total coal consumed in Ireland for all purposes only amounts to 1·08 tons per head per annum, in addition to which a considerable quantity of peat is used. This must be taken into account when making a comparison with the coresponding figure for the United Kingdom, which was 3·97 tons per head during the period 1912 to 1914. The greater industrial development of Great Britain must be taken into account in comparing these two figures.

In an endeavour to estimate the annual consumption of peat fuel in the country, we have plotted graphically on the accompanying map of Ireland, drawn to a scale of four miles to the

* Detailed figures showing coal imported at 73 Irish ports for the period 1912–1914 were obtained from the Statistics branch of the Department of Agriculture and Technical Instruction for Ireland. The figures used above are from the Board of Customs returns. (*See* Appendix IV., p. 56.)

† Of this, during the period 1912–1914 inclusive, an average of 376,000 tons per annum were used for the manufacture of gas and 178,000 tons of coke were produced.

inch, the distribution of the imported and native coal over the country. The areas of the circles represent the average annual tonnage of coal received at each point during the period 1912–1914, on a scale of 50,000 tons to 1 square inch.*

Peat fuel consumption

This map shows the local provincial centres of distribution and the small amount of coal distributed and used over a large portion of the western and north-western parts of the country, and clearly indicates the area which is dependent on peat fuel. From this map the quantity of coal coming into each county has been determined, and a fairly approximate estimate made of the quantity of peat which must be consumed per annum to satisfy the fuel requirements of the people in those areas. The estimate indicates that a quantity of about six million tons of air dried peat is won and used annually in Ireland. The greater portion of this is used by the peasant proprietors in the western and north-western districts of Ireland, the people over large areas of the country being almost entirely dependent on peat for their fuel supply.

From the information at our disposal it is not possible to make an exact estimate of the peat fuel consumption in Ireland, but the estimate is sufficiently correct to prove what an important part peat at present plays in the economic life of the Irish people. It is necessary constantly to bear in mind this feature of the peat problem, for the need of cheap domestic fuel is now one of the most important to be met, no matter how desirable it may be to look forward to the use of peat fuel for industrial purposes. Sir Henry Doran, in his evidence, emphasised the fact that large areas of bog under the control of the Congested Districts Board must be reserved for the supply of fuel to the small owners of land in the districts under their jurisdiction. He also expressed the opinion that with the exhaustion of the local peat deposits in certain densely populated districts, mainly occupied by small land holders, many families may have to leave unless provision be made for the supply of fuel.

In any scheme brought forward to use the bogs of Ireland for industrial purposes, the fuel requirements of the inhabitants of the adjoining country must be carefully safeguarded. In some of those districts where bog areas are limited they should be wholly reserved for the domestic fuel supply of the inhabitants. *On the other hand, over a great part of the country, after making ample provision for the supply of domestic fuel, vast quantities of peat remain for other purposes.*

Consumption of peat fuel per family.

In the purely peat-burning districts the fuel is used liberally, large fires being maintained throughout the year, the quantity consumed varying from 8 to 40 tons per family per annum, the amount depending upon the size and requirements of the different households. Naturally in those districts where the

* The map reproduced has been reduced from the original large scale map accompanying the report.

bogs are nearest at hand, the most liberal use is made of the fuel.

Estimate of peat fuel consumption.

A comparison between the coal distribution and the population of the corresponding districts seems to indicate that about 1,500,000 of the inhabitants of Ireland are wholly dependent on peat for fuel. If we take 4 tons of peat as a fair average consumption per head per annum, the total consumption of peat fuel in Ireland would be about 6,000,000 tons per annum. Another estimate in which the distribution of the bogs was taken into account gave an almost identical result. Arrangements are being made by the Department of Agriculture for the collection of statistics which will enable a more accurate estimate to be made in the future.

A return of the English Coal Commission for 1869 showed that 26 per cent. of the total consumption of coal in the United Kingdom was used for gas and domestic purposes. As already stated, the total home consumption per head per annum of coal in the United Kingdom is 3·97 tons, and 26 per cent. of this would be approximately 1 ton per head for domestic purposes. The Coal Conservation Sub-Committee in their report (Cd. 8880) estimate the consumption of coal in gas works at 18 million tons, and for domestic purposes at 35 million tons for the United Kingdom in the year 1913. Taking the population as 46 millions and the total consumption at 53 million tons, this gives an annual consumption of 1·15 tons of coal per head for gas and domestic purposes, and is approximately in agreement with the figure of 1 ton per head arrived at above. The calorific equivalent of 1 ton of coal would be approximately 2 tons of air dried peat, and it may be urged that the consumption of 4 tons of peat per head assumed above is too high an average. When it is realized that in many cases in the west of Ireland the peat has only to be brought a distance of half a mile to a mile and that it can be won in the farmer's spare time with only the expenditure of his labour, no payments having to be made, it will be seen that this high consumption of peat is akin to the consumption of coal in the villages of England and Wales near the coal pits.

We find that the increasing prosperity of the peasant proprietors throughout the country has led to a reduction in the use of peat fuel by them. Kitchen ranges for coal consumption have to some extent replaced the open peat fires. A possible explanation of this may be that the farmer has found his time more profitably employed in the cultivation of the land which has now become his own property than in the cutting of peat. Further, the increase in cost and scarcity of labour due to the extension of tillage in the country has contributed to this result. In some districts, owing to the cutting away of small bogs, the haulage of peat from distances has become a serious matter, and has materially increased the cost. No progress has been

made in the production of a denser and more portable peat fuel.

All over the country we find a tendency to commence cutting the fuel too late in the season, and therefore the fuel when cut and saved is not transported until late in the year, when in many cases the bog roads have become well nigh impassable and the fuel is seriously damaged by the wet weather. We find that considerable improvement might be made in the production of peat fuel, and this would be followed by its more general use, a result much to be desired. Another factor restricting the use of the peat fuel, is the lack of co-operation amongst the owners of adjoining turbary banks in keeping their cutting faces clear of water. We believe that some statutory regulation should be made which would compel all persons enjoying turbary rights to attend efficiently to the drainage of their banks. The Congested Districts Board insert clauses to this effect in all transfers of turbary rights which they make to their land holders, but the machinery for enforcing them might be improved.

It is necessary now to consider the methods adopted for the winning of this large quantity of peat fuel. Until we have a clear understanding of these methods and the reasons which have led to their adoption and continued use, it would be useless to discuss new methods by which the output can be increased.

(8) Season for Cutting, Saving, and Harvesting Peat Fuel in Ireland.

It must be borne in mind that the peat industry in Ireland is at present almost entirely in the hands of the farmers, and hence the time for the various operations involved in winning the peat is so arranged as to cause the minimum of interference with the usual seasonal agricultural operations. Frost having such detrimental effects on peat fuel, it is essential that no cutting for peat fuel should take place until after the heavy frosts are over. Generally speaking, Ireland is free from the occurrence of late frosts, but none the less a kind of belief, almost amounting to a superstition, exists that no peat should be cut before the 17th March, and even in some districts fuel is not cut until June or July, with the result that it cannot be properly saved before the advent of the autumn rains. The usual practice is to cut the peat when the spring tillage is completed, from the last week in April or the first week in May up to July, and to draw home the fuel during August and September.

The maximum length of season for cutting peat fuel in Ireland which has come under our notice is from the 14th January to the end of July or, say, 160 working days, but allowing for an ordinary proportion of bad weather, not more than 120 to 130 days can be relied upon. We believe that this

does not compare badly with the length of season enjoyed in other peat fuel producing countries.

(9) Methods of Winning Peat Fuel in Ireland.

The methods used fall under two heads (A) cutting with (*a*) the wing slane, (*b*) the breast slane, and (B) forming "mud turf" or "hand turf." These methods are described in some detail in Appendix (I.), but may be briefly summarised here.

(A) Cut Peat.

Wing slane cutting.

(*a*) *Wing slane.*—The greater portion of the six million tons per annum of air dried peat fuel, estimated (Section 7) as being used in Ireland, is cut with a wing slane by the peasant proprietors for their own use. It is cut on bogs contained on their own holdings or a few miles away on turbary on which they have a right to cut peat either by virtue of their land tenure or by rental from year to year. The peat is cut and spread by men when the spring tillage is finished, and nearly always saved and clamped by the women and children of the family, and carted home after the harvest work is completed. The conditions under which the farmers' peat fuel is won are so variable that it is difficult to give a reliable estimate of the cost. The operations involved are generally carried out when there is little other farm work to attend to, and the cost varies with the rates of wages in the different districts, with the quality of the peat, the rent of the bog and its distance from the farm. A cost of from 5*s.* to 10*s.* per ton of air-dried peat fuel, delivered at the farmstead, would cover all but extreme cases.

Breast slane cutting.

(*b*) *Breast slane.*—While the *wing slane* fuel is cut from the bog with the long axis of the sod in a vertical direction, the *breast slane* sod has its long axis horizontal. The breast slane sods are larger and more regular in shape and are chiefly cut for sale as, for example, at Cashla, Co. Galway and Tickneven, Co. Kildare. The breast slane sods stand transport with less damage than those cut with the wing slane on account of the direction in which the fibres lie. The costs vary within wide limits, as is usual in all matters connected with the peat industry. At Ticknevin, Co. Kildare, previous to 1914, it cost about 6*s.* per ton to win the peat fuel by this method and stack it on the canal bank at a distance of about 1½ miles from the bog.

(B) "Hand Turf" or "Mud Turf."

"Hand" or "mud turf."

This form of peat is not made to any large extent in Ireland, but its manufacture has been reported in Co. Limerick, Co. Cavan and Co. Louth. Well humified peat is raised from a bog hole, mixed with water and spread on the surface of the bog, where it is mixed and puddled by the feet of men or horses. It is then levelled and partings are made by hand, so that the

layer on drying and shrinking becomes divided into a number of sods. The fuel thus made is superior in density to the average "cut" peat described, and somewhat resembles machine peat, but owing to the great increase in labour involved, it costs much more than the slane cut fuel. Its use is very limited.

The methods of hand winning peat fuel just described have been developed in most places to such a degree that little, if any improvement can be made without a radical change in the methods employed, or without the introduction of machinery. Neither of these alternatives is possible in the case of the small peasant proprietor working for himself.

(10) The Hand Winning of Peat Moss Litter in Ireland.

The moss litter industry in Ireland is relatively unimportant compared with that of peat fuel, yet it represents practically the only case in which economic and systematic methods have been adopted for hand winning the peat on a fairly large scale. The methods of winning used are those introduced by the Dutch peat experts brought over by the Department of Agriculture and Technical Instructions for the firms engaged in the moss litter industry. In some details the lay-out has been improved as the result of the experience gained in working.

Lay-out of bog.

In order to avoid the heavy cost of spreading the peat, necessary with the usual system of hand winning peat fuel, a narrow slice, 2 feet wide and 2 feet deep, is cut from the face of the cutting bank. This is cut out in the form of sods 18 inches by 6 inches by 6 inches, and produces, when air dried, about one cwt. of moss litter per lineal yard of face. The cutter can place this amount of raw peat on the surface of the bog without moving from his position and without other help. An output of 3 tons per day of cut peat moss is secured from *one* cutter, whereas three men (a "cutter," a "catcher," and a "wheeler") are usually employed in the hand winning of peat fuel for the same output.

Ramparts.

To allow peat to be economically collected, the bog is divided by a main road through its centre, and at right angles to it "ramparts" or collecting banks, about 12 yards wide, are run on both sides at intervals of 112 yards. The bog between the ramparts is divided up by drains, 2 feet wide and 3 feet deep, 11 yards from centre to centre, forming cutting banks 100 yards long by 10 yards wide from the faces of which the above-mentioned strip is cut.

Cutting season.

The peat when spread is "footed" after a week, and later on clamped, collected, and stacked on the "ramparts," from which it may be removed to the factory as required. (*See* Appendix II.) The season for cutting moss litter peat extends through the winter from October until June, and the saving and collecting are completed by September.

While this method of hand winning the peat is economical, as stated elsewhere it would be difficult to find in any single

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FIG. 1.—ANREP-SVEDALA. ELEVATOR AND MACERATING MACHINE.

area sufficient labour for the hand winning of more than 30,000 or 40,000 tons per season, the total output per operative employed, including men, women, and children, not exceeding 100 to 120 tons per season. At the four bogs where the methods of winning described above are in practice, the combined amount of moss litter and peat fuel won per annum does not exceed 40,000 tons, and the bogs are widely separated.

(11) The Mechanical Winning of Peat.

Excavation.

The earliest attempts in Sweden and Germany to apply mechanical power to the winning of peat took the shape of a mechanically-driven elevator on which the peat when dug by hand was shovelled. The elevator conveyed the peat to a hopper over a macerating machine in which the peat pulp was thoroughly kneaded and mixed by means of a rotating screw, which eventually forced the peat pulp through a mouth-piece from which it issued in one or more streams. These streams were received on boards and cut into suitable lengths, either by a knife worked by hand or by the machine. The boards were then placed upon shelves on waggons, which were pushed to the drying ground, where the boards containing the sods were lifted by hand and laid on the bog, the sods being either immediately transferred to the surface of the bog or left on the boards or trays for a couple of days to dry. The latter procedure necessitates a large capital expenditure for boards and is not the usual practice. The Fig. 1 shows a machine of this type at work in Sweden. Its objectionable feature, the great number of men employed at the elevator and mixing machine, will be evident from the illustration. When the cost of spreading the sods on the drying ground is added to the high cost of excavation, the resulting cost per ton is very high. Such a machine during a recent test in Friesland in Germany, with a maximum output of 24 tons of air-dried peat per day, required 15 men and boys. The output of such a machine for the whole season of 100 days would not exceed 2,400 tons of air-dried peat. It should be stated that in many of the shallow bogs on the Continent where these machines are used, roots and trunks of trees are met with. These would render difficult the working of a dredger, and probably account for the extensive use of hand-fed elevators in place of dredgers.

Elevation.

Maceration.

Spreading.

High cost due to number of labourers required.

We next come to the more recent development in the design and working of peat-winning machines, and for the purpose of clearness we will separate the various operations as follows :—

Operations involved in mechanical winning of peat.

(*a*) The excavation and elevation of the raw peat from the bog.

(*b*) The maceration and mixing of the raw peat by means of rotating and fixed knives and a single or double screw conveyor which forces the peat through a nozzle or nozzles in a stream which is cut into lengths for sods.

(*c*) The transport of the formed sods and their deposition on the bog.

(*d*) The collection and stacking of the air-dried peat.

Recent German practice.

The most recent development in peat-winning machinery in Germany has been to combine in one unit, close to the face of the bog, a machine driven electrically and capable of performing operations (*a*), (*b*), and (*c*). We shall apply the term "automatic peat machines" to such as are capable of performing operations (*a*), (*b*), and (*c*) without any handling of the sods by men. In Canada and elsewhere a machine of the Anrep type which performs (*a*) and part of (*b*) has been developed, but the spreading and sod forming is carried out at another point.

Automatic peat machines. Canada.

In Germany and Austria the chief types at present in use are known by the names of the inventors or firms who make them and are called the Wielandt, the Strenge, the Dolberg, and the Baumann machines. The excavators in all these machines are of the ladder dredger type, and, with the exception of the Strenge, work on an inclined face, which has the advantage that the face when cut at a proper slope is in equilibrium. The working of the Strenge dredger appears to us to be open to several objections and need not here be considered.

Dredgers.

The chief point aimed at in the design of the dredgers employed is lightness of construction, every means being taken to reduce weight so that the load on the bog may be kept as low as possible. There are certain differences in the method of excavating, but all include the principle of the ladder dredger with continuously rotating excavating buckets fixed on a chain. After the excavated peat has dropped into the hopper of the macerating machine, and passed through the mouthpiece as a stream of about 10 × 10 cm. section, it is automatically cut into lengths of 40 cms. and laid on a conveyor which, as a rule, consists of a number of plates resting on rollers, each plate receiving one sod. The conveyor or transporter extends at right angles to the cutting face for a distance of 60 to 120 metres on the bog surface. The conveyor band in the Baumann machine is supported on a light lattice girder which rests on supports 15 to 30 metres apart. The supports take the form of small carriages which run on a single rail laid parallel to the face, the whole conveyor being capable of moving with the dredger parallel to the cutting face. The transporter consists of a conveyor band carried by a shallow girder which is capable of considerable deflection and adapts itself to slight undulations in the bog surface. When the conveyor band is completely loaded with sods it automatically tips and deposits the sods on to the bog surface. A certain amount of damage is done to the freshly-moulded sod, but recent improvements are said to have been made with a view of reducing this. Having deposited its charge of sods, the transporter moves forward the length of a sod, and the conveyor belt is again loaded. The upper conveyor band of

Transporter.

Baumann Machines.

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FIG. 2 (*a*).—BAUMANN MACHINE.

FIG. 2 (*b*).—BAUMANN MACHINE.

FIG. 2 (*c*).—BAUMANN MACHINE.

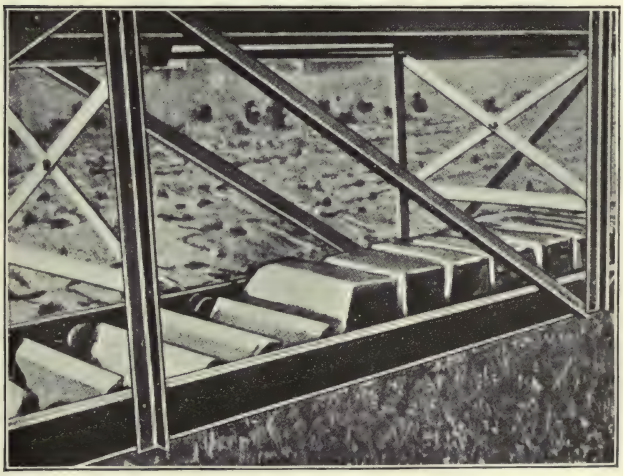

FIG. 3.—BAUMANN CONVEYOR. ARRANGEMENT FOR TIPPING SODS.

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FIG. 4.—WIELANDT AUTOMATIC PEAT MACHINE, DREDGER, &C.

FIG. 5.—WIELANDT TRANSPORTER.

FIG. 6 (*a*).—PERSSON TRANSPORTER.

FIG. 6 (*b*).—PERSSON TRANSPORTER.

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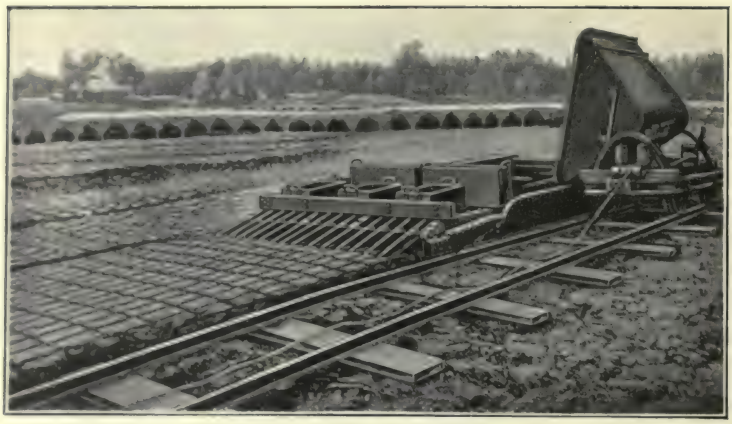

FIG. 7.—JACOBSON'S FIELD PRESS.

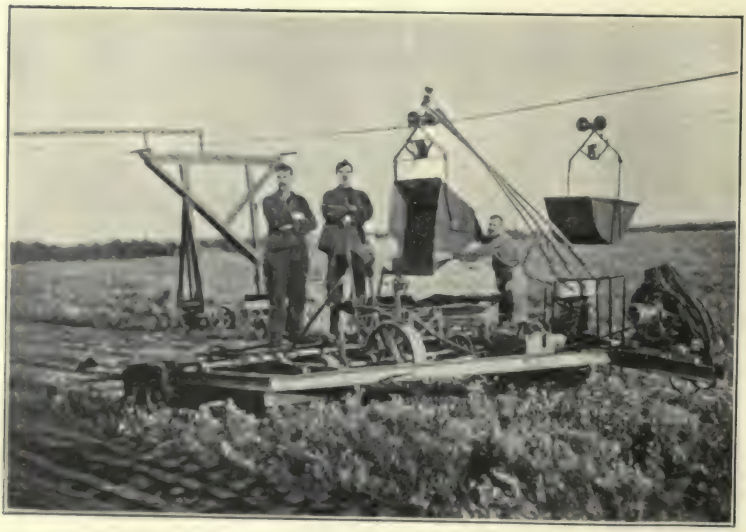

FIG. 8.—MOORE'S SPREADER (CANADA).

the Baumann transporter stands some 3 feet over the surface of the bog, and the sods are deposited by the plates of the lower conveyor band tilting around their long axes and dropping the sods on the bog. Figs. 2 (*a*), 2 (*b*), 2 (*c*) and 3 show a general view of the transporter and the arrangements for tipping. The lower or laden part of the conveyor lies close to the ground, and the empty plates return to the machine over the upper roller path. The transporter is said to have worked up to a length of 120 metres. The Wielandt sod transporter lies close to the bog and consists of a number of plates which tip round their short axes and pitch the sods on to the surface of the bog. Figs. 4 and 5 give views of the Wielandt machine.

Wielandt machine.

Another type of conveyor, which is not automatic, called the Persson conveyor, is used in Sweden. It is shown in Figs. 6 (*a*) and 6 (*b*), and consists of two endless parallel cables running on drums. The boards, loaded with sods, are placed on the cables and transported to the point required, where men lift the loaded boards off and empty the sods on the drying ground, the empty boards being returned on the lower cables. This conveyor, although not automatic, possesses certain advantages and appears to us to be worthy of further study. It has the merit of working up to lengths of 150 to 200 metres, and the transporter need only be moved once for each 25 to 30 feet of drying ground covered, whereas to cover the same area of drying ground in the automatic transporters the conveyor would have to move about 20 times.

Persson conveyor.

In many places in Sweden and at the Canadian Government Peat Bog at Alfred, Ontario, a somewhat different system has been adopted. In the Jacobson's field press used in Sweden, shown in Fig. 7, the excavated and macerated peat pulp is transported in cars to the drying ground, where it is spread, levelled, and rolled into a layer 5 to 6 inches deep by 10 feet wide. This layer is cut longitudinally into strips 4 inches or 5 inches wide by teeth or knives attached to the back of the levelling device. In Moore's spreader, which has been used on the Canadian Government bog at Alfred, Ontario, the peat excavated by dredgers is first passed through a macerator of the Anrep type and then transferred to buckets on an overhead telpher suspended on moveable supports. The skips or buckets are carried by the telpher so that they can be tipped over the hopper of the spreading machine shown in Fig. 8. The spreader is propelled by caterpillar tractors electrically driven by a motor taking current through a trolley running on an overhead wire. The peat from the hopper is distributed through a trough by a screw conveyor, and is fed into 32 rectangular mouthpieces, from which it issues as shown in Fig. 8, in 32 streams of 5 inches by 4 inches cross-section. The facility with which the peat sods may be transferred to the surface of the drying ground and the increased width (300 yards) of drying ground possible with this plant may be

Jacobson's field press.

Moore's Spreader, Canada.

urged as advantages which may be placed against the number of persons employed and the capital cost of the plant. It is said, however, that the design of the plant has been improved so as to allow of an increased output and of a reduction in capital cost and in the number of operatives employed. Nevertheless, any system in which the peat pulp has to be transported to the sod forming and spreading machine by telpher or other means is almost certain to involve the employment of considerable plant and of a large number of operatives. In both these systems the strips are cut into sods by circular discs which are drawn across the strips, the distance apart of the discs corresponding to the length of the sods. When shrinkage takes place on drying, the layer of peat will be divided into sods along the partings made as described above.

In forming an opinion on the relative merits of the various systems of mechanical excavation and spreading described above, we have had access to the excellent publications of the Canadian Department of Mines on this subject and to the more recent data contained in Hausding's "Handbuch der Torfgewinnung und Torfverwertung," published in Berlin, in January 1917, which gives the results of many tests carried out since the war began.

From an examination of the published costs and of the operations involved in the various systems it would appear that, for a large output, economy would lie with the automatic peat machines.

Merits of peat machines compared.

The automatic machines of the Wielandt type are said to be capable of excavating and spreading 76 tons of air-dried peat per day, and only to require the attendance of three to five men, whereas the plant used on the Canadian bog entailed, for excavating and spreading, the employment of some 14 persons for an average daily output of 50 to 60 tons of air-dried peat. The only drawback that we can see to the use of the automatic sod spreaders, other than the repair and maintenance of the conveyor, is the limitation placed on the width of the drying ground by the length of the conveyor or transporter, which in the Baumann and Wielandt type is from 60 to 120 metres. The objection to a narrow width of drying ground lies in the greater length of cutting face which has to be developed for a given output per season, with the consequent large area of bog which must be laid out for working. Further, a narrow drying ground limits the amount which can be cut off per lineal foot of the working face per annum. This results in high capital charges on the light narrow gauge railway which must be laid down for the collection of the air-dried peat. The increased length of the Persson transporter, Fig. 6, is the advantage which this system seems to possess over the machines of the Wielandt type, but, on the other hand, such a system is not automatic and requires more labour.

Owing to the fact that it has not been found possible for the Committee, or any of its members, to see in operation the plants which have been briefly described, it is only possible to draw general conclusions from the published matter on record. We have indicated however that the Wielandt, Baumann, Persson, and Moore machines are worthy of further study.

Another labour-aiding feature which may be availed of in connection with such plants is the use of a belt conveyor and stacking machine for collecting the air-dried peat into stacks adjoining the drying ground.

Reasons for advocating the use of Automatic Peat Machines.

The operations for which mechanical plant may be employed in the winning of peat are its excavation, maceration, and formation into sods, the spreading of the sods on the surface to dry and the collection and stacking of the sods when air dried. Labour is not eliminated from any of these operations, but it is considerably reduced. Machines cannot assist in the various turning and footing operations required to air dry the peat fuel, but may be used for loading the fuel for transport.

The following are the reasons which lead us to recommend the use of automatic machines:—

(1) It would be difficult to obtain in any one bog area the necessary labour for hand winning peat on a scale of 300 to 500 tons of air-dried peat per day, and the cost of transport becomes heavy if the peat has to be won in different districts and brought to a central station. Moreover, dependence on casual or migrant labour should be avoided where possible. By using "automatic" machines instead of hand winning the number of men required would be reduced to one-fourth although the number of women and children would be slightly increased.

(2) It is possible that a longer season can be worked with peat machines than without, as the men working the machines may be protected from the weather. There should therefore be less lost time due to climatic conditions than with hand methods.

(3) With automatic machines, work may proceed by night as well as day, cheap electric light being available.

(4) Machine peat dries more regularly than slane cut peat, is less affected by rain and recovers more rapidly from its effects. This results in quicker drying and a possibility of drying more peat per unit area of drying ground than with hand methods, and this would result in greater economy in collection.

(5) Machine peat shrinks more than slane cut peat, with a resulting increase in density, and hence less volume is required for equal calorific value. This is of great importance in connection with transport and grate area provided in steam boilers or producers. The volume for equal calorific value may be reduced from $5\frac{1}{2}$ to 4 or even to $3\frac{1}{2}$ times that of coal. Machine peat, owing to the breaking down of the original structure, has a more uniform distribution of the fibres, is less brittle, and is better able to stand handling in transport.

(6) Peat machines can cut for the whole depth of a deep bog and hence a more uniform material is obtained, which is very important for gas producing or steam raising.

OBJECTIONS WHICH HAVE BEEN URGED AGAINST THE USE OF AUTOMATIC PEAT MACHINES.

1. The difficulty of supporting the weight of heavy machines on the surface of the bog.
2. Heavy capital cost.
3. Difficulty of dealing with stumps and roots of trees.

As regards—

(1) Drainage, when properly carried out, consolidates the bog and renders it quite possible to transport the machines over the surface, either by distributing the weight on rails or by caterpillar tractors.

(2) The cost due to capital charges is neutralised by the saving in labour.

(3) It is generally recognised that roots and trunks of trees only occur near the margins of the flat bogs in Ireland, and that the interiors of the deep bogs are remarkably free from such obstructions.

(12) Area of Bog required for the winning of 100,000 tons of Air-Dried Peat per Annum.

The letter addressed by the Director of your Board to the Committee suggested that the outputs might be stated in units of 100 to 1,000 tons per day. If we assume a supply of 100 and 1,000 tons per day for 300 days in the year this would amount to 30,000 and 300,000 tons respectively, which would have to be won in a season of 100 to 150 days. For the sake of a round figure we will consider the area and other quantities involved for the winning of 100,000 tons of air-dried peat per season, a figure which is intermediate between those given. It is interesting to note that this figure has a close relation to the amount of peat which would be required to displace the coal used in Dublin or Belfast for the production of electric power. The combined coal consumption of the

Output of 100,000 tons.

Dublin Corporation and Dublin United Tramway Company, for the generation of electric power, is about 47,000 tons per annum, equivalent to 94,000 tons of air-dried peat. The Belfast Corporation Electricity Department use for tramway, lighting, and power purposes about 41,000 tons of coal per annum, equivalent to 82,000 tons of air-dried peat.

Area of bog required.

To determine the area of bog which must be cut away each season to yield an output of 100,000 tons of air-dried peat, the following assumptions may be made:—That the density of the peat in the undrained bog is 1·00, the percentage of water 92, and the depth of the bog 20 feet, figures which may be safely applied to the central belt of bogs in Ireland. One acre of such bog will yield 2,600 tons of air-dried peat (25 per cent. water), and hence the output of 100,000 tons would involve cutting away about 38 acres per annum. To make provision for 100 years' life for such a scheme would require some 3,800 acres of bog, and if the output is to increase to 300,000 tons, then about 12,000 acres would be required.

Area cut away.

Area of drying ground.

There are, however, other factors to be taken into consideration such as room for working peat machines and area of drying ground. On the assumption that two spreadings of peat may be made and dried on the one area in the same season, it will be possible to air-dry 100 to 110 tons of machine peat per acre of drying ground, and for an output of 100,000 tons, a total area of drying ground of 1,000 acres will be required. Room for working peat machines, stacking, and transport will absorb about 200 acres. The total area required for an output of 100,000 tons of air-dried peat per annum will then be—

	Acres.
Drying ground at 100 tons per acre - -	1,000
Room for working peat machines, transport, and stacking - - - - - - -	200
Area cut away in 100 years at 38 acres per annum - - - - - - - -	3,800
Total area for 100,000 tons output -	5,000

From this it will be seen that an area of 5,000 acres of bog, 20 feet deep, may be taken as the area required for the needs of a large scale central power scheme, but if provision is made for extension, 10,000 acres will be required.

Using automatic peat machines, each of which must have its drying ground adjacent, it is essential that large areas of the bog must be laid out and drained from the beginning, and that, once the drains and working faces are fixed, work will proceed systematically. When it is realised that this output of 100,000 tons will be spread over an area of some 5,000 acres, or say 8 square miles, it will be seen that the question of collection and transport requires very careful investigation. The lay out

of the working faces adopted must be the result of an exhaustive study of the most economical methods.

Output of automatic machines.

An "automatic" peat machine capable of excavating and spreading sufficient raw peat to produce 7·6 tons of air-dried peat per hour will, in 100 days of 10 hours each, have an output of 7,600 tons. If it is found possible to work double shifts, or night and day, or a longer season, this output will be correspondingly increased. The raw peat required to produce 7,600 tons of air-dried peat, when spread on the surface of the bog, allowing 10 per cent. free space between sods, would require a drying ground 6,325 yards long by 100 yards wide, or 130 acres. If two spreadings can be made on the same ground, that is, if the peat cut and spread in the early part of the season (say February) can be sufficiently dried to be collected and stacked clear of the drying ground by the 1st May, it will be possible to have a second spreading, in which case only half the area, or 3,163 yards by 100 yards, will be required. We consider that two spreadings will be possible, and that hence the length of the drying ground and the length of the cutting face (they are both equal) will be 3,163 yards or 1·8 miles. Since 13 or 14 automatic machines will be required for the output of 100,000 tons, the total length of face being excavated will be almost 25 miles. The finished stack of peat from one automatic machine will be 3,163 yards long and contain 7,600 tons, or 2·4 tons per lineal yard, and with this system this will be the maximum amount which can be collected per yard of track laid on the collecting banks. To furnish this output a strip 13 feet wide will be excavated from the face of the bog 20 feet deep. The average haul of the air-dried peat on the track on the collecting bank will be ·9 mile before it reaches the main track leading to the power station. Should it be found possible to make three spreadings per season on the same area, reductions in length of face will result in corresponding economies being effected.

Drying ground.

Width of drying ground with various machines.

Since the length of the working face and the length of the drying ground are equal, it will be seen that the amount cut per lineal yard of face is limited by the width of the drying ground. In the case of "automatic" machines the present practice limits the width of the spreading ground to 100 or 120 yards. On the other hand with Persson's transporter 200 yards is said to be possible, but this machine is not automatic. In the case of Moore's spreader and the Jacobson field press the width of the drying ground extends to 300 yards. In the last two cases the machines are not automatic, and the field railway or moveable telpher which conveys the raw peat from the dredger to the spreader requires a number of attendants. Nothing short of a careful study of these machines under the same working conditions can show with which of them the advantage lies, but it will be obvious that many

disadvantages must arise from the separation of the dredger from the spreader.

A safe conclusion as to the type of machine best adapted for use in the large scale operations contemplated in this report can only be arrived at when the individual merits of the machines have been investigated and tested in connection with the problems of winning, collection, and transport.

Purchase price of bogs.

The price at which large areas of bogs have been purchased in Ireland varies from one pound per acre upwards. When small areas are bought in a district where bog is scarce, high prices may be paid, but in the case of a large power scheme, requiring a large area, the price paid per acre, and hence the total price paid for the necessary bog area, will be small compared with the total outlay. If the total amount of bog area required is not purchased at the beginning, and should further area be required at a later date, owing to the success of the power scheme, then a prohibitive price will have to be paid if bog within an economic distance of the station is to be acquired.

Drainage.

The problem of draining the bog area also renders it essential that the whole area of the bog should be under the control of the one authority, so that it may be dealt with as a whole and on the most efficient lines.

Transport.

The advantage of freedom of transport by the most convenient route would also indicate the advisability of having a large area under control.

Agricultural use

As will be seen from section 15, any excess area purchased over present requirements can be improved by drainage and used for agricultural purposes. To win mechanically 100,000 tons of air-dried peat and deliver it at a distance not exceeding, say, three miles from the bog, would require approximately 130 men and 400 women and children for a season extending from February to the end of September. For the remainder of the year only about 35 men would be required on transport.

(13) The effect of Drainage on Bogs.

From the evidence collected it would appear that the percentage of water contained in the undrained flat bogs of Ireland varies from 92 to 95 per cent., leaving out of account abnormal cases. In the well drained bog 88 to 91 per cent. of water would appear to be the corresponding limits. While we feel that the evidence on which these figures are based is reliable, we are none the less of opinion that there is room for further work on determinations of the percentage of moisture in relation to the different kinds of peat and bog and on the effects secured by drainage in its different stages. Recommendations for experimental work bearing on this will be found on page 46 of this report.

The problem of the efficient drainage of bogs is a complex one and the physical factors which are operative are rather obscure, and being one of the most important problems con-

cerning the utilization of peat, it should be thoroughly understood.

The solution of the drainage problem, as we at present conceive it, consists in making a number of shallow drains or cuts on the surface which will quickly lead the surface water to the minor and main drains, encourage run-off, and prevent, as far as may be, the water-logging of the upper layers after the period of drying and evaporation is past. We feel, as before stated, the need of further inquiry in order to elucidate this problem. All the evidence received during the progress of our inquiries and found in the literature on the subject points to the desirability of not attempting to hasten the drainage too much, but of sinking the drains slowly so that the surface "mattress" may gradually deepen. The drains should be sunk a little deeper each year, any attempt to sink too quickly will only result in failure, as the sides and bottom of the drains, not being consolidated, will close in and fill up. It is desirable to keep the extension of the drainage well ahead of cutting the peat. Instances are on record of the drainage producing such a shrinkage in a 20-foot bog that the reduced depth was only 15 feet. The consolidation of the surface or the production of a surface mattress is an absolutely essential condition preceding the use of peat-winning machinery on the bog.

The drier the surface of the bog the less saturated will be the layer of air in contact with it, and the more favourable the conditions for air drying. So far as we know no successful process exists for eliminating the excess water contained in peat other than natural air-drying. The only economic way of air-drying at present known is to spread the sods, whether slane cut or machine formed, on the surface of the bog or on a prepared drying ground on the cut-away bog until they are sufficiently dry and firm to stand handling and raising into small piles or footings slightly elevated over the bog surface.

For the better understanding of the effects of drainage we think it advisable to explain, for the guidance of those who have not had previous experience of this subject, the vast difference in the yield of anhydrous peat per ton of a raw peat containing, say, 93 per cent. of water, compared with one containing 90 per cent. of water. At first sight it may appear that the peat containing 90 per cent. of water is only a little drier than that with 93 per cent. Consideration will, however, show that in the second case we have 10 per cent. of dry peat substance as compared with 7 per cent. in the first, an increase in yield per ton of the raw peat dealt with of 43 per cent. By draining a bog so that the moisture content is reduced from 93 per cent. to 91 per cent., the removal of almost 24 per cent. of the original water content is effected; if the reduction is carried to 90 per cent., over 32 per cent. of the original water content is eliminated. To cite another instance, a reduction from 95 per cent. to 90 per cent. involves the elimination of

52½ per cent. of the original moisture content. From these remarks it will be seen that the drainage plays a very important part in economy of production. The cost of excavating and spreading the sods of air-dried peat depends largely on the amount of dry peat substance contained in each ton of raw peat handled, and therefore the drainage problem is worthy of careful study so that the best results may be attained. It is also stated and generally accepted that with drainage an increased amount of humification is produced in the upper layers of peat, with consequent reduction in bulk and increase in calorific value.

Yield of Drained Bog per Foot Acre.

Assuming 90 per cent. water in a drained bog, and a density of 1·00 the yield will be about 120 tons of anhydrous peat per foot acre of the bog, or about 160 tons of air-dried peat containing 25 per cent. of water.

(14) Calorific Value of Air-Dried Peat and the Rating of Peat and Coal.*

Peat, air-dried under varying conditions of climate, is found with such differences in moisture content that many writers object to the term "air-dried peat" on account of its indefiniteness, and prefer to base all calculations on anhydrous peat or dry peat substance. Peat, however, only remains in the anyhdrous condition for a short time after it leaves the drying chamber, the substance being so hygroscopic that it quickly takes up from six to eight per cent. of moisture, so that from a practical point of view anhydrous peat has no existence. It is preferable, therefore, to define the meaning attached to the term "air-dried peat" in this report. Peat in a good dry season may be saved with as low a moisture content as 17 to 18 per cent., while under moderate conditions it may be saved with 25 to 30 per cent. moisture. We have adopted as a standard 25 per cent. moisture content for "air-dried peat," and it is to such peat that all our calculations and values relate.

A ton of average slane-cut air-dried peat fuel, filled in loosely, occupies approximately 140 cubic feet. whereas the corresponding figure for bituminous coal in bulk would be about 45 cubic feet. Again, air-dried peat containing 25 per cent. moisture has a calorific value of between 6,000 and 7,000 B. Th. U. per lb., whereas coal as supplied in Dublin averages 11,000 to 12,000 B. Th. U. per lb. "as received." Taking the mean of these figures, 6,500 B. Th. U. for the air-dried peat and 11,500 B. Th. U. for the coal, it follows that 1·77 tons of air-dried peat fuel is required to give the calorific equivalent of a ton of

* The above rating of peat and coal is based on a consideration of thermal properties alone. If we take into account the value of the by-products obtained, when peat or coal is gasified in a producer (*see* Appendix III., page 52) it will be found that for power production peat is in a much more favourable position to compete with coal than would appear from the above statement.

coal. The 1·77 tons of average slane-cut air-dried peat will occupy 5½ times the volume of one ton of coal, and hence may be said to be approximately 5½ times as bulky as its calorific equivalent in coal.

Machine peat fuel will, when filled in loosely, give an average volume of 100 cubic feet per ton, but the calorific value per pound is the same as if the peat were slane-cut. The 1·77 tons of machine peat will occupy 3·93 times the volume of one ton of coal, and hence may be taken as four times as bulky as its calorific equivalent in coal. The advantages of dealing with machine peat, in which the volume required for a given calorific effect has been reduced by roughly 30 per cent., will be obvious when we consider the increased load in the waggons used for transport and the reduced area of grate required when it is burned in either gas producers or steam boilers. Although we believe the factor 1·77 to be quite safe, for the purpose of this report we shall assume two tons of "air-dried" peat as the calorific equivalent of a ton of coal.

(15) Reclamation and Agricultural Use of Bogs.

While it may appear that a lengthy discussion on the agricultural use of bogs is foreign to this part of the report, we have come to the conclusion that, looking at the problem of the utilization of the peat deposits as an economic whole, it is impossible to ignore their agricultural value; firstly, because of the enormous importance of their reclamation for agriculture to the country at large, and secondly, because their agricultural use will reduce the cost of winning the fuel.

The area of Ireland is 20,850,000 acres and, excluding the area under water, there are 20¼ million acres of land, of which, as stated on page 13 of the report, approximately three million acres consist of bog in one form or another and, as stated by the Bogs Commissioners, amount roughly to one-seventh of the whole country. Should it be possible, while utilizing the fuel contained in those bogs, to bring any considerable portion of this bog area into cultivation, such a result could not but have an important bearing on the economic life of the people of the country, and the matter is of special interest at the present moment when efforts are being made to extend tillage and bring additional areas of the country under cultivation.

We have already pointed out that the Bogs Commission of 1809 to 1814 was appointed to determine chiefly the possibility of draining and cultivating the bogs of Ireland, and that after the closest investigation the Commissioners were firmly convinced of the comparative ease with which the bogs could be reclaimed and made into a valuable financial asset to the country, not only for agriculture but also as a source of peat fuel.

We have come to the conclusion that the economic future of these waste areas of Ireland depends on this combination of drainage, tillage, peat cutting, and subsequent tillage of the

cut-away bogs. The consumption of the peat deposits for fuel need no longer be considered as a drain on the country's natural resources, but as a means of extending and developing agriculture, Ireland's greatest and most important industry.

The reports of the engineers of the Bogs Commission contain estimates of the cost, and details of the methods recommended for the reclamation of the bogs, and agree as to the practicability of converting these immense waste areas of Ireland into remunerative agricultural land at a comparatively small cost, without taking into account the value of the peat fuel at the same time made available.

Ample evidence in support of the importance of combining the agricultural and fuel industries in bog areas is found in the reports which we have perused from Canada, the United States, Germany, Austria, Holland, and Sweden.

Drainage is the first essential both for agriculture and for fuel-cutting, and even if the agricultural value of the land when reclaimed were only sufficient to defray the cost of the purchase and drainage of the bog area, it would then have effected a marked reduction in the cost of the fuel. In the large undertaking of the German Government at Wiesmoor, although the power generated from the peat fuel is used both at Wilhelmshaven and Emden, yet the German Government would have been satisfied if the working of the power station enabled them to reclaim the land for agricultural purposes without cost, the power production being looked upon as the by-product. Without going into detail on the question of the preparation and use of bog lands for agriculture, it may be generally stated that bog, like all other land, requires manuring for the production of crops. In the case of bog land the first necessity is lime, and without lime nothing can be produced. Ireland is fortunate in having lime in one form or another available close to the principal bogs. Nitrogen, phosphate, and potash are also necessary, but not to the same extent.

The agricultural use of bogs falls under two headings:—

(*a*) Agricultural use before cutting the fuel.

(*b*) Agricultural use after the fuel is cut.

All over the country large areas of cut-away bog may be seen reclaimed for agriculture, mostly laid down in grass, but also thousands of acres yielding good crops of potatoes, barley, and various other root crops such as mangolds, parsnips, and carrots. The use, however, of the bog previous to the cutting away of the fuel is more restricted, very largely because no proper drainage scheme has been undertaken. During the visit of the Committee to the bog areas in different parts of Ireland, they have seen excellent crops grown both on the virgin bog and also on the cut-away bog. The Department of Agriculture and Technical Instruction have carried out some instructive experiments both in pots and on small plots of ground, and also large scale field experiments, with the object of discovering the best system of manuring. They have also investigated the use of

bogs for afforestation, but apparently afforestation is only feasible on the cut-away deep bog or the shallow mountain bogs.

In the bulletin published by the State Geologist of Ohio reference is made to the successful use of the Ohio peat deposits for the production of celery and onions on a very large scale, and experimental work has been undertaken by the State with the object of securing the best results.

In Germany and Austria the subject of the reclamation and agricultural use of their peat deposits has for many years received careful attention, and large subsidies have been given to various societies formed for the utilization of their bogs. It is only in comparatively recent times that these societies directed their attention to the utilization of the peat for fuel purposes, and even now the agricultural use of the bogs is given at least equal importance to their use for power purposes. In Norway, Sweden, and the Netherlands large sums are annually voted for experimental work on the utilization of the peat deposits, the agricultural use of the bogs being kept prominently in view.

In order to prevent the wasteful use of the peat deposits and to ensure that the cut-away bog should be left in such a condition as to be suitable for agricultural use, the Bog Preservation Law of April 1st, 1913, was passed in Germany. This prohibits the cutting of the peat without permission and proper supervision, unless it is cut for the use of one household and not for sale. The successful cultivation of the cut-away bog has existed in all countries for years, and it is now claimed, in the most recent literature obtained from Germany, that the problem of cultivating uncut "high bog" has been successfully solved.* The best procedure to adopt, and the proper proportions of lime, kainite, phosphate, and ammonium sulphate to add, have been determined and published.

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* "High bogs," generally called *moss peat* or *moss bogs*, have been formed mainly from peat mosses (sphagnum), heathers (Erica) and wool-grasses (Eriophorum).

"Low" or flat bogs have been formed on a more fertile base from grasses, marsh grass, sedge, reeds and rushes. They occur mostly in areas subject to inundation by rivers and lakes, and form as a rule swamps and marshes.

In consequence of their situation the high bogs contain less admixed earthy substances and have therefore, formed as they are mainly from mosses, a very low ash and high carbon percentage; they are poor in plant food. The low bogs, subject to frequent inundations and to the deposition of dust carried by the wind, contain much earthy matter and have a more or less high percentage of ash. The peat-forming plants of the low bogs are poor in potash and phosphoric acid but are, on the other hand, rich in lime and easily soluble nitrogen.

The percentage of lime in the peat-forming plants is often utilized for the characterization and distinction of the various peat bogs. Thus, according to Professor Fleischer, *high bogs* are those in which the percentage of lime in the dry substance, supposed free from casual constituents, does not exceed 0·5, and *low bogs* are those in which the percentage of lime does not all below 2·5. Transition, mixed or intermediate bogs have percentages of lime lying between these limits.

(Hausding, "Handbuch der Torfgewinnung und Torfverwertung." 1917.)

(16) Possibilities of Increased Use of Peat Fuel for Industrial and Domestic Purposes.

(a) *Industrial use of Peat.*—As already stated, the work of the Committee in this the first stage of the inquiry has been largely confined to investigating the conditions under which peat fuel can be most economically won, yet it was impossible to disregard the consideration even in a preliminary manner of the possible ways in which the fuel might be used when won.

Difficulty of transporting peat fuel.

We explained the difficulties of transporting hand-won peat fuel, which are due (*a*) to its friable character, and (*b*) to its great bulk in relation to its fuel value. The use of macerating machines considerably reduces these difficulties. The cost of transport suggests the advantage of utilizing peat, if possible, in the immediate neighbourhood of the bog, and this suggests the establishment of a power station, where the fuel could be used either for steam raising or in producer plant. In order to justify such a proposal for utilizing large peat deposits, it would be necessary to show that the scheme would be likely to prove a commercial success. In a highly industrial district the problem would be relatively simple, but industries are sparse in the neighbourhood of our large peat bogs. It must be remembered, however, that the backwardness of the industrial conditions of these districts is largely due to the absence of cheap power, and it is reasonable to assume that, if cheap power were made available, industries would be developed. In any case, however, the growth of industrial concerns is a slow process and, whatever the nature of the ultimate load, it would be desirable that a "process" load should be arranged for from the beginning, and this suggests some electro-chemical undertaking, such as the manufacture of calcium cyanamide, for which cheap electric power is necessary. Such a load might be modified as the demand for power for industrial purposes grew, and would at all times include the power required for mechanical winning of peat.

Electro-chemical industry.

It may be noted here that, among the disabilities under which such districts have hitherto laboured, one advantage stands to the credit of an enterprise of this character, namely, that there are few vested interests to be interfered with or installations to be modified or scrapped.

Demand for cheap electric power.

We anticipate that with a supply of cheap electric power a demand would rapidly be created for it for municipal undertakings, for the electrification of railways and canals and also for agricultural purposes.

The recent increase in the area under tillage in Ireland, amounting in 1917 to about 700,000 acres, its probable further increase and the shortage of agricultural labour, will render necessary the use of labour-aiding appliances and the increasing employment of mechanically-propelled implements on a large scale. The extent to which cheap electric power has been availed of for agricultural purposes in Germany previous to the

war is abundantly indicated in the Report to the Board of Agriculture on "Agricultural credit and Agricultural co-operation in Germany" (Cd. 6626). In this connection the example in England of the city of Hereford, where the electricity supply department has found a ready and increasing sale for its current to farmers in the immediate vicinity, is most encouraging.

While this demand for distributed current is growing, the surplus power generated would be absorbed in an electro-chemical undertaking, in the mechanical winning and haulage of the peat, and, perhaps, in the production of moss litter. During this period the methods used in winning the peat, the design and operation of the producers or steam plant could be improved and perfected, so that when a larger demand arose the new plant required to meet it could be provided on the most efficient lines as the result of the experience already gained. Such a general and varied use of electric power as that indicated above would result in a high-load factor and consequent reduction in charges on capital.

Price of coal.

The price of coal for industrial purposes is subject to considerable variation even under pre-war conditions. From the Home Office returns (Cd. 7741) it will be seen that between 1910 and 1913 the price of exported coal at Cardiff varied from 14*s.* to 15*s.* 10*d.* per ton, Scotch coal ex Glasgow varying from 9*s.* 11*d.* to 13*s.* 6*d.*, and English coal ex Liverpool from 12*s.* to 14*s.* 11*d.* The coal used for industrial purposes in Dublin may be taken as costing on a fair average 15*s.* per ton during the pre-war period 1912–14. The trend of coal prices has been steadily upwards, and they are now extremely high. It does not seem likely that prices will undergo any material reduction for many years. But even assuming coal at 15*s.* per ton, and accepting the conservative calorific equivalent of 2 tons of peat to 1 ton of coal, the competing price of peat fuel is fixed at 7*s.* 6*d.* per ton at the same place, no account being taken of the value of the by-products. (*See* Appendix III.) From the results of our investigations we are of opinion that peat fuel can be won in Ireland in large quantities and delivered at a central power station within, say, 3 miles of the bog site at a price per ton, including all charges, below that figure.

Present industrial use of peat is limited.

The amount of peat fuel used for industrial purposes is very limited. In different parts of the country it is used for lime burning, kiln drying of corn, kelp burning, and for driving saw-mills, stone crushers, and threshing machines, and for the power required in peat moss litter works, Owing to the present shortage of coal one or two provincial gas undertakings are endeavouring to use it for lighting purposes. The largest user for power purposes is the Marconi Wireless Station, Clifden, Co. Galway, where over 6,500 tons per annum of air-dried peat fuel is burnt in steam boilers for the production of the necessary power and heat for running the station.

Mr. Hamilton Robb, of Portadown, who has taken a great interest in increasing the use of peat fuel, obtains annually 2,500 to 3,000 tons of air-dried peat fuel from his bogs at Maghery, near the south-west corner of Lough Neagh. The peat is carried in his own barges down the Blackwater River, across the foot of Lough Neagh, and up the River Bann to his weaving factory at Portadown, a total distance of 12 miles, where it is used in two 240-b.h.p. producers, which supply three gas engines for running the factory. It is also used in a steam boiler for the production of the heat and humidity required in the factory. The peat fuel is charged to the factory at 10*s.* per ton air-dried. **Portadown producer plant.**

(*b*) *Domestic use of Peat Fuel.*—We have already explained the extent to which peat fuel is used by the farmers and rural population of Ireland, and indicated the need for peat fuel in a more portable form than at present used for domestic purposes. We will now consider the extent to which fuel, won by mechanical power on a large scale, might take the place of imported coal for domestic purposes. About 6,500 tons of peat fuel is brought per annum to Dublin by the Grand Canal Company's system, this fuel being principally obtained from the Ticknevin and Allenwood districts in County Kildare, the eastern extremity of the Bog of Allen, the distance being about 28 miles. In addition to this, 2,500 tons of peat is transported by the canal from other points to various districts through which the canal passes. A fairly large traffic in peat fuel is carried on from the western portion of Connemara, the peat fuel being brought in small sailing boats, known as "hookers," from Cashla, across Galway Bay, to Galway and Kinvarra, and to Ballyvaughan in County Clare. There is also a small amount of peat, amounting to 1,200 tons per annum, carried in boats from Kilrush, County Clare, to Limerick and various places along the Shannon. **Peat fuel used in Dublin.** **Galway.** **Clare.**

The only transport of peat fuel on the railway systems which has come to our knowledge is about 5,000 tons per annum, carried on the West Clare Railway, and a small amount carried over the Great Southern and Western Railway system in County Kerry.

With regard to peat which is brought to Dublin from County Kildare, we find that, owing to the conditions under which the peat is generally sold in Dublin, only the poorest quality of peat is sent in, the denser and better varieties being retained for local consumption. This arises from the fact that the peat fuel is chiefly used in Dublin by the poorer classes largely because, for such a small sum as a penny, a definite amount of fuel—2, 3, or 4 sods—as the case may be, can be obtained. With this amount of peat a fire may be lighted which will last a sufficient time to cook a meal. The peat won in County Kildare is brought to Dublin in boats usually owned by the wholesale dealer in peat at Dublin. These boats bring loads

ranging from 58 to 32 tons of peat, the quantity depending on the quality of the peat, the size of the boat, the depth of water, the condition of the canal, and the headroom under the bridges. Since the sale is ultimately by the sod it is to the advantage of the turf dealer to bring as many sods as possible per boat load without regard to the quality, and this has resulted in an inferior type of peat fuel of low density and calorific value being brought to Dublin.

As stated in Appendix I., previous to 1915 the labour costs of winning peat fuel under the heads of cutting, saving, and clamping on the bog and removal to canal bank in the Ticknevin district, where the peat is cut by the breast slane method, amounted to 5·96 shillings per ton air-dried.

The following are the costs of peat delivered on the canal bank in Dublin :—

Cost of peat clamped on canal bank at	Per ton.
Ticknevin - - - - - -	5·96 shillings.
Loading boat - - - - -	0·80 „
Freight to Dublin, about - - -	2·40 „
Tolls on canal - - - - -	1·50 „
Unloading (about) - - - - -	0·80 „

making in all 11*s.* 6*d.* per ton air-dried peat on canal bank in Dublin. The usual course, however, is for the wholesale dealer from Dublin to purchase from the bog cutter a barge load of 50 tons of peat loaded at Ticknevin for a price which before the war worked out at about 7*s.* 6*d.* per ton. This shows but a slight gain to the cutter over what he would have received for his labour in the ordinary course. During 1916 as much as 18*s.* per ton was paid at Ticknevin for the air-dried peat on barge under the same conditions. In Dublin the peat was retailed at four sods a penny, but during war conditions we believe two sods have been sold (although three is the usual number) for one penny. We have tested the price by actual purchases, and these work out at a price of about 42*s.* per ton delivered to the consumer in one case and 36*s.* 8*d.* in another, the current price of coal (December 1917) being 47*s.* per ton.

We believe that peat won by mechanical power on the large scale could be placed in depôts in Dublin at the cost quoted above and that this improved fuel could be retailed, with a reasonable margin of profit, at a price which would ensure a steady demand by a section of the community to whom peat has for many years been a necessity. In many of the asylums and workhouses throughout the country slane cut peat fuel has been delivered at a price varying from 8*s.* to 12*s.* per ton, and at this price it could easily compete with imported coal, the pre-war price of which in the inland towns of Ireland varied from 25*s.* to 30*s.* per ton in different districts. We find that at present peat is sold in Tullamore at 16*s.* per ton, the price of coal on the same date being approximately 50*s.* per ton.

Difficulties of transporting Peat Fuel.

Slane-cut peat fuel, in comparison with coal, suffers from the great bulk and weight necessary to yield an equivalent calorific value. As stated, twice the weight, and five to six times the bulk are required, and, further, slane-cut peat fuel is of a friable and brittle nature. These inherent defects enter so largely into the difficulty of transporting peat, as at present prepared, to any distance that, unless special arrangements can be made for its transport, such peat will always find difficulty in competing with coal at any considerable distance from the point where it is won. Machine peat fuel is, however, denser and tougher and suffers less damage in transport, and since the volume required for equal calorific effect is only three to four times that of coal as against five times for slane-cut peat, it is in a much more favourable position.

To meet the above-mentioned difficulties of bulk and brittleness Mr. F. P. Griffith has suggested that under certain conditions the peat should be placed in large containers on the bog site and not removed from these containers until delivered at the point where it is to be used. The bulkiness of the peat is naturally of less importance if the fuel be used in a central power plant close to the bog from which it is won. In that case the peat, hauled in specially designed trucks by electric locomotives from the bog site to the works, could be dealt with economically by mechanical elevators.

Elsewhere in this report we have alluded to certain causes which tend to restrict the use of peat fuel in the provincial towns and country districts of Ireland, namely, the exhaustion of small bogs, the scarcity of labour, the bulkiness and friability of the material, and the lack of a reliable supply at a reasonable cost.

(17) Ownership of Bogs and Difficulties of Purchase.

In discussing the improvement of the bogs of Ireland, the Bog Commissioners stated it to be their conviction that the undeveloped condition of these wastes could not be solely ascribed to physical obstacles, but that the main hindrance to improvement was due to questions connected with the ownership of the bogs, and the rights usually vested in the occupiers of the adjoining farms. They recommended legislation for the removal of these obstacles. They also reported that such legislation should secure a free passage under proper regulations through the adjacent estates, so far as requisite for carrying on and completing the main lines of drainage and communication, as otherwise the interested opposition of a neighbouring proprietor might impede and render of no effect the efforts of the improver.

The same difficulties exist at the present day. We are of opinion that they cannot be overcome without conferring com-

pulsory powers of purchase on the authority into whose hands the reclamation and utilization of the Irish bogs may be placed. Such authority should be endowed with powers to obtain access to the bog lands for pedestrian and vehicular traffic, telegraph, telephone, and power lines, and for the construction of drains. We have the striking example of the Department of Agriculture and Technical Instruction being defeated in their endeavours to carry out certain experiments in the winning of peat fuel, owing to the fact that they were not endowed with powers to acquire bog areas for the purpose.

(18) Answers to Sir George Beilby's Questions.

Sir George Beilby in his letter to Sir John P. Griffith, dated the 7th of July 1917, made certain suggestions as to dealing with the problem of winning peat, which had been referred to the Irish Peat Inquiry Committee. The principal suggestion was that the first step of the inquiry ought to be to provide an answer to the question, "can partially dried peat (containing 20, "30, or 40 per cent. of water) be delivered in large and regular "quantities at certain points, within a moderate (specified) "distance from centres of population and industry, at a cost "which will compare with that of coal at the same points, due "allowance being made for the differences in calorific values?"

He further suggests that "the first step in the proposed "inquiry ought to be to provide an answer to this question by "making a careful study of the possibilities of peat winning "in the case of one or more favourably situated bogs."

In accordance with these suggestions we have made a careful study of the possibilities of peat winning on a large scale, and we have come to the conclusion that with a suitably situated bog, well drained, and with the aid of modern excavating, macerating, sod-forming, and spreading machinery, air-dried peat can be won and delivered in certain districts at a cost that will compare favourably with coal, due allowance being made for the difference in calorific values.

We have come to the conclusion that portions of the Bog of Allen, situated in the County of Kildare, may be considered to fulfil the required conditions, and propose therefore, in special reference to this bog, to give answers to the chief points laid down for consideration by Sir George Beilby.

For facility of reference, the questions and answers are tabulated under the heads (*a*), (*b*), (*c*), (*d*), (*e*), (*f*), (*g*), given in Sir George Beilby's letter.

Question (*a*).—The extent, depth, and quality of the peat deposit and its capacity to yield a steady output of partially dried peat. This output might be specified in units of 100 to 1,000 tons per day?

Answer (*a*).—The extent of this portion of the Bog of Allen, including the bogs of Lullymore, 16,247 acres; Timahoe, 12,878 acres; Clane, 2,235 acres; and Mouds, 5,070 acres; is

36,430 English acres. Its average depth is abont 24 feet, as ascertained by the surveys made for the Bogs Commission, 1810. It is estimated to contain 105 million tons of anhydrous peat, or 140 million tons of air-dried peat containing 25 per cent. of moisture. The character of the peat in these bogs is given in Mr. Griffith junior's reports to the Commission. Generically the flat bogs of the central plain, which are the most important from the point of view of operations on a large scale, may be classed as "low bogs," resting as they do on calcareous subsoil. They are, however, in reality "mixed bogs," since in nearly all cases, owing to their great depths, the upper layers of the bogs have been formed from the "sphagnum" mosses characteristic of "high bogs."

It thus happens that we find normally on these bogs an upper, fibrous, mossy layer of sphagnum peat, suitable for the manufacture of peat moss litter, and a lower layer of dense, humified peat, well adapted to the preparation of a compact fuel of relatively high calorific power (about 10,000 B.Th.U. in the anhydrous state).

The average percentage of ash in the peat is low, and that of the nitrogen, especially in the peat in the lower layers, is high, when compared in both cases with peat from American and Canadian bogs.

As regards the capacity to yield a steady output of partially dried peat, these bogs have been cut for fuel only along the outside margin, and not even there for the full depth of the bogs, since no systematic drainage has been carried out.

Question (*b*).—The facilities for easy and quick drainage of the water from the bog itself, and from the cut peat in the course of its preparation?

Answer (*b*).—There is every facility for the drainage of these bogs, but no general or systematic drainage, such as was recommended by the Bogs Commission, has ever been carried out on any large and comprehensive scale.

Question (*c*).—Proximity to centres of population and industry?

Answer (*c*).—These bogs are the nearest to Dublin, ranging from 25 to 40 miles from the city. There are several important towns in their neighbourhood, such as Naas, Newbridge, Edenderry, Portarlington, Monasterevan, Mountmellick, Tullamore, Maryborough, and Kildare.

Question (*d*).—Means of transport by rail, coasting ships, or by canal, or river barges?

Answer (*d*).—Means of transport are at present limited to carriage by road and by boats on the Grand Canal. No peat is carried in this district by rail.

Question (*e*).—Supplies of suitable labour and facilities for the housing of the workers?

Answer (*e*).—The supply of labour is very restricted, being almost limited to the small farmers and their families, when not engaged in agricultural work.

Question (*f*).—The value of the land underlying the bog for the purpose of reclamation?

Answer (*f*).—There is no doubt that the drainage of the bog areas would make this land available for tillage, allow the peat to be won, and permit of the cultivation of the land after the peat had been cut away. (See the reports of the Commission on the bogs of Ireland, 1810 to 1814.)

Question (*g*).—The existence of cheap water power for the generation of power required for the winning and preparation of the peat?

Answer (*g*).—No water power exists in the neighbourhood of the Bog of Allen to generate power for winning and preparing the peat. The most promising source of such power would appear to be gas engines for generating electric energy; the gas being provided from producers in which peat would be used as the fuel.

(19) Suggested Lines of Research on Peat.

We regret that little experimental research has been carried out in Ireland in connection with the peat industries, and we have had to fall back for guidance on work done in Austria, Germany, Sweden, Holland, Canada, and the United States.

Although we are of opinion that much of the data thus obtained is applicable to Ireland, yet we are convinced that the importance of the peat industry in Ireland warrants very careful research and investigation of many problems connected with the drainage of the bogs, the winning and drying of peat, the utilization of peat in gas producers and the recovery of its by-products.

We are therefore of opinion that systematic experiments should be carried out as indicated below:—

I.—Drainage.

(*a*) To investigate the properties of peat which have a bearing on the problem of the drainage of bogs.

(*b*) To determine the effect of drainage on the moisture content of the peat, and the rate at which the reduction of moisture takes place.

(*c*) To determine how the rainfall over bog areas finds its way to the drainage channels. In what proportions do the factors soakage, run-off, and evaporation, operate?

II.—Drying.

(*a*) To investigate the relative importance of the various factors involved in the air-drying of peat fuel.

These factors are—

(1) Humidity and temperature of the air, wind action, sunshine and rain.

(2) Frost.

(3) The size of the sod of peat and the effect of the maceration.

(4) The character and chemical constituents of the peat.

(*b*) To determine whether the waste heat from exhaust gases or heat from gas specially burned can be economically employed to reduce the percentage of moisture in peat already partially air dried.

(*c*) To investigate the electro-osmotic process of separating water from peat.

III.—Economic uses of Peat.

(*a*) To determine the most economic percentage of water in peat for producer work with recovery of by-products.

(*b*) To determine the most economical way of utilizing the energy obtainable from peat.

(*c*) To determine the best mode of preparing peat for domestic use.

(*d*) To find whether peat charcoal can be economically utilized for the preparation of calcium carbide.

IV.—Other Experiments.

(*a*) To examine the effect of moisture, ash content, and humification on the calorific value of peat.

(*b*) Such other experiments as may be suggested during the course of the work.

(20) Conclusions and Recommendations.

We have come to the conclusion that peat fuel may be won in Ireland on a scale which would warrant the establishment of electric power stations at one or more of the most favourably situated bogs. We have also come to the conclusion that such a scheme for peat winning should be associated with the reclamation of the bog for agricultural purposes. We are satisfied that the economic winning of peat, on such a scale, is dependent on the use of machinery. Such machinery should be electrically driven, and electricity would also be available for agricultural purposes. By the application of the best labour-aiding appliances, the difficulty due to shortage of labour would be greatly reduced. The peat winning industry being a seasonal occupation would, if dealt with alone, necessitate casual and migrant labour of an expensive type. Such casual labour is recognised as a perpetual source of restlessness and discontent, and should be avoided wherever practicable. If, however, the peat winning industry be coupled with an agricultural colony, there appears every hope that the two may be worked so as to supplement each other, and thus result in the establishment of a thriving and contented community.

We are of opinion that sufficient peat to provide a steady output of 100,000 tons of air-dried peat fuel per annum can be

won mechanically on a selected bog area, and can be air-dried to 25 per cent. or 30 per cent. moisture content in an ordinary season, taking into account the climatic conditions of Ireland and the length of the working season. While an exact estimate of the cost cannot be made, we are of opinion that air-dried peat (25 per cent. moisture) can be delivered, at a cost of between five and six shillings per ton, at a factory not more than three miles from the bog site. We believe that this output may be obtained from the one bog area, and that the supply may be maintained in all seasons if well-organised methods are employed. To provide for a possible loss of part of the season's output in a bad year, reserve stocks must be kept, and these may be stacked in the open with little protection, expensive shedding being unnecessary.

We have come to the conclusion that such an enterprise should be initiated by the State. Wide powers such as are required to carry out our recommendations for the development of the peat deposits can best be exercised by the State. A further weighty reason is found in the fact that many attempts have been made in Ireland by private enterprise to develop the peat industry, but they have been generally associated with certain patented processes aiming at the elimination of the moisture contained in the peat, all of which have proved financial failures. The public have therefore lost confidence in any scheme for the utilization of the bogs, and we think it would be difficult to attract private capital for such work. We are convinced that an undertaking for the utilization of peat on a large scale, near to the bog, for the production of power with by-product recovery is financially sound, especially if the power be used in the manner suggested on page 37 of this report. We feel, however, constrained to remark that, apart from the question of immediate financial return, a serious and well-considered scheme for utilizing our huge peat resources should be put into operation with the least possible delay. Not only is the question of fuel conservation of vital national importance, but the supply of electrical power for industrial purposes to districts which have hitherto lacked such a supply would greatly stimulate industrial development and conduce to the prosperity and well-being of our people.

Recommendations.

We beg to make the following recommendations:—

(1) That the State purchase a large bog, so that full control may be obtained over the whole area for drainage, transport, and transmission purposes, the aim being to allow of the winning of at least 100,000 tons of air-dried peat per season.

(2) That an authority, endowed with necessary powers, be set up to take charge of and administer the scheme, together with the experimental investigations involved.

(3) That systematic drainage of the bog be carried out, so as to render it fit for peat winning and agriculture.

(4) That different types of electrically driven peat-winning machines and labour-aiding appliances, for loading and conveying, be obtained and employed under working conditions to determine which is the best for work on a large scale in Ireland.

(5) That the portion of the bog where the peat has been cut away, in addition to that not immediately required for peat winning, be prepared and utilized for agricultural purposes.

(6) That an electric power station be erected with all necessary buildings and plant, the peat fuel being used in gas producers with recovery of the by-products, and the gas utilized for the production of electrical energy by the most economical methods.

(7) That powers be granted for the distribution of electrical energy, provided that, in the case of any area where there is an existing electrical authority, these powers shall only apply to the supply of electrical energy in bulk to the existing authority.

(8) That a "process" load be arranged for by the installation of an electro-chemical industry, which would have the effect of improving the load factor in the power station.

(9) That experiments be carried out on the physical and chemical properties of peat in relation to the drainage of bogs, and on improvements in the method of drying and utilizing peat as suggested in Section 19 of this report.

(10) That hamlets or small villages of labourers' houses be provided on suitable sites.

To carry out these recommendations special legislation will be necessary for the compulsory purchase of bogs, for obtaining rights of way, for access to the bogs, for drainage, for electrical transmission, and for the distribution and sale of current.

We should recommend that the agricultural side of this scheme be placed under the care of the Department of Agriculture and Technical Instruction, who possess a staff of officers thoroughly acquainted with the subject.

The winning of the peat, the erection and working of the electric station, the utilisation of the electric energy developed for peat winning, chemical industries, distribution for power and lighting purposes, and the experimental investigations should be in charge of a special committee, as this side of the undertaking will need vigilant attention in every detail.

As the object of our recommendation is to determine the best way of winning peat and the most efficient methods of using it, it is obvious that the whole installation must be considered as a great research or experimental station, which must at every stage of the work be controlled by a scientifically trained staff.

Your obedient servants,

JOHN P. GRIFFITH, *Chairman.*
SYDNEY YOUNG.
HUGH RYAN.
GEORGE FLETCHER.
26th Feb. 1918. PIERCE F. PURCELL, *Secretary.*

APPENDIX I

(9) Methods of Hand Winning Peat Fuel.

A. (*a*) *Wing Slane Cutting.*

The so-called farmers' fuel is cut almost entirely with a "wing" slane the latter being a spade with a blade 12 inches long by 5 inches to 6 inches wide, having a "wing" or cutting lug projecting at right angles from the right-hand edge, the wing measuring about 6 inches long. In a soft bog the "cutter" has timber floats or boards 13 inches by 6 inches strapped to his feet to distribute his weight and to prevent his feet from cutting up the bog on which he stands. In soft bog the blade of the "slane" is driven down with little effort, the blade lying back at an angle of about 20° with the vertical, and the blade and wing cutting two surfaces of the sod. If the two other vertical surfaces are free, the lower face of the sod is formed by breaking off the sod with the slane on which the sod rests and by which it is pitched on to the bank. The wing slane is again driven into the bog and another sod wrenched free and transferred to the surface, the operation for each sod taking about two to three seconds. If the bog is a hard one with small twigs or branches, pressure of the foot may be used to drive in the slane. The freshly cut sod usually measures 12 inches by 6 inches by 6 inches to 12 inches by 5 inches by 5 inches.

When the sod is placed on the cut-away bog, or on top of the cutting bank, it is generally taken up by a three-pronged pike or fork, by means of which it is transferred three or four yards for spreading purposes. Sometimes a second man is employed forking when it is desired to cut off more than the usual amount of peat in the same season. Occasionally the raw peat sods are passed from hand to hand until spread on the cut-away ground or on the upper surface of the bog. The men cutting and forking interchange with each other at intervals. The practice in many parts of the country is for three neighbouring farmers to co-operate in the cutting of their peat fuel, and these three men can cut in 9 to 12 days sufficient fuel for their families for the whole year. They cut and spread 4½ to 5½ tons of air-dried fuel per day, but to do this they work very long hours. The rate of pay for agricultural labourers was 2*s.* 6*d.* to 3*s.* 6*d.* per day previous to 1914, and at this rate the cutting and spreading works out at 1*s.* 4*d.* to 2*s.* 3*d.* per ton of air-dried peat.

The peat is cut as a rule during April and May, and after 14 days in good weather the sods are placed in small piles or "footings" of five sods, placed on end and leaning towards each other. After another 14 days these sods are turned in the footings, and then, if the weather is good, after a further 14 days they may be put into small clamps on the bog and after-

wards removed to stacks on the roadside so as to be accessible in bad weather. The time which must elapse between each operation depends on the weather, and in a bad season the sods may have to be placed in "rickles" or small conical piles containing about 20 to 30 cubic feet before they are fit to be placed in the stacks. All the operations of footing and saving are usually carried out by women and children.

Peat fuel cut with the wing slane is very friable and suffers considerable loss in handling, often 10 to 15 per cent. being lost, depending on the character of the peat and weather conditions.

It is difficult to estimate the cost of fuel won by the farmers under such varying conditions, but we consider that, if the bog from which peat fuel is drawn is not at too great a distance, the air-dried peat will cost from 5*s.* to 10*s.* per ton when stacked in the farmyard. At such a cost it easily competes with coal.

A. (b) Breast Slane Cutting.

When peat is cut for sale it is called "commercial peat" and is generally cut with the breast slane. A breast slane usually consists of a spade with an iron blade 14 inches long by 5 inches wide, with sharp cutting edges, mounted on a short handle, the length over all being 3 feet 6 inches. With the breast slane the peat sod is cut with its long axis horizontal, the cutter as a rule standing so that the sod when cut is on a level with his breast. The sods are cut from a levelled bench by marking off a line parallel to the face, and 13 inches to 16 inches back from it. The breast slane, with its blade vertical, makes a vertical cut 5 inches deep at right angles to the face, and another cut horizontal, so as to detach a sod, say, 14 inches by 6 inches by 5 inches. The dimensions vary, but 13½ inches by 5 inches by 5 inches would be the average. These sods, being cut parallel with the fibres, are less friable and will stand more handling than the wing slane sods. The sod when detached is pitched to a "catcher" who places it on a flat bottomed barrow with one end and without sides. When 20 sods are placed on this barrow it is wheeled back on to the drying ground by a "wheeler" and carefully tipped so that the sods fall gently on to the bog surface, standing on end and in long "drills" containing five rows each. Considerable skill is shown in the methods employed, which have been developed as the result of long experience. The turf cutters at Ticknevin, Co. Kildare, where the peat fuel sent to Dublin is cut, rent a turf bank or face, 16 Irish perches (112 yards) long, at 35*s.* to 40*s.* per annum. From this the turf is cut, wheeled out and spread either on the cut-away bog or on the top of the cutting bank. The more feet cut per linear foot of face the further back must it be wheeled to make room for its spreading and saving. The usual practice is to employ a "cutter," a "catcher," and a "wheeler." The catcher places the sod on the barrow and when it is loaded with 20 sods wheels it some 20 yards. The wheeler then takes the loaded barrow 50 yards further and tips the peat on the bog. Meanwhile the catcher returns and loads another barrow. The strip of bog, 70 yards wide by 112 yards long, is about 1⅘ acres (1 Irish acre) and gives spreading ground for about 60 tons of air-dried peat, or a little more than a large barge load. If the cutter wishes to cut more than ½ ton per lineal yard of face, he must spread the peat over a strip wider than 70 yards from the face, and this will require an extra wheeler. This involves an extra cost of about 60*s.* on the barge load, and hence he finds it cheaper to rent a new face and not economical to cut more than ½ ton air-dried peat per lineal yard of cutting face. In 1862, C. Hodgson, in a paper before the Institution of Civil Engineers (Ireland), emphasised this and stated that if 500 tons were cut and saved per mile of cutting face for 2*s.* 6*d.* per ton—the cost would be 5*s.* per ton if 1,000 tons were won, and 8*s.* per ton if 2,500 tons were won per mile. Without accepting his figures as strictly accurate, a rise in cost per ton with increasing yield per foot of face is as true to-day as in 1862. With mechanical winning there will be an economic limit, but a much higher one than for hand winning.

The usual output per cutter using the breast slane in Co. Kildare is 3 tons of air-dried peat per day of 12 hours. When, however, the Dutch system of cutting with the breast slane can be used and larger sods cut, the output will be raised to between 4 and 4½ tons per day of 10 hours, and with the system employed the catcher and wheeler are dispensed with. This system is described in Section 9 and Appendix II when dealing with moss litter, to which the Dutch method is almost wholly confined in Ireland. With one spreading per season 50 to 60 tons of air-dried peat is the maximum which it is possible to save per acre of drying ground, working on the above system.

The following is the cost of hand-winning peat fuel at Ticknevin, Co. Kildare, based on a wage of 12*s.* (pre-war) and 20*s.* (1917) per week of 72 hours :—

	Pre-war.	1917.	
Cutting, catching, and spreading -	2·16	3·60	shillings per ton air-dried.
Footing - - - - - -	·36	·60	„ „
Clamping on bog - - -	·24	·40	„ „
Total labour cost of winning peat on bog.	2·76	4·60	„ „
Filling and transport in carts a distance of 1½ miles and stacking on canal bank.	2·40	2·80	„ „
	5·16	7·40	
Rent of bog face - - -	·80	·80	
Total cost at canal bank -	5·96	8·20	

As will be seen, the cost of tranport of the fuel 1½ miles to the canal is more than 40 per cent. of the total pre-war cost, even including rent, and this is the result of the uneconomic conditions under which it is hauled, only 5 to 7 cwts. being taken in each load over the rough bog roads.

B. Hand or Mud Turf.

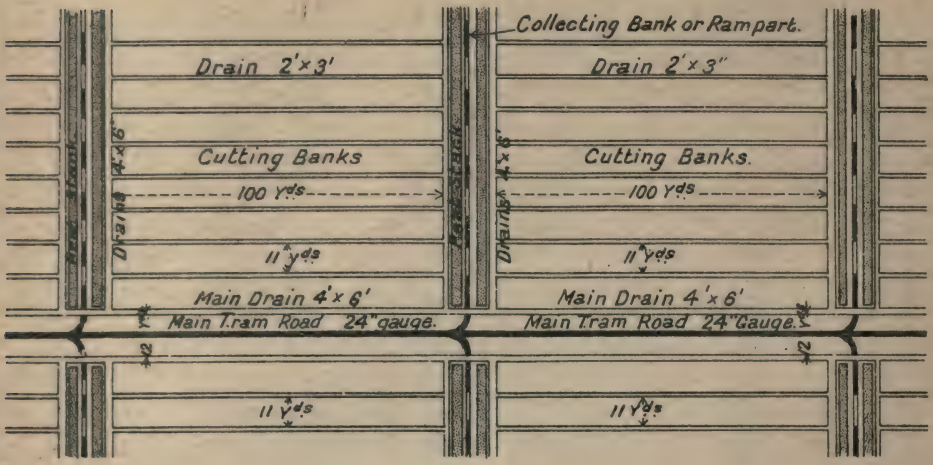
This has already been described in detail at page 21 of report.

APPENDIX II

(9) The Hand Winning of Peat Moss Litter in Ireland.

The first procedure is to open up the bog by driving two main drains 4 feet wide at the top, 2 feet wide at the bottom, and 5 feet deep, at a distance of 12 yards apart, and running parallel to each other right through the centre of the bog. The drains are sunk gradually, and are cut in such a direction as will divide the bog up into suitable areas for working, and also allow proper falls for the drainage. The strip of bog contained between these two main drains forms the main roadway along which a narrow gauge railway is run for the transport of the peat from the bog to the factory. At distances of 112 to 115 yards, a pair of minor drains, 3 feet wide at the top and 4 feet deep, are dug at right angles to the direction of the main road. These two minor drains run parallel to each other, are 12 yards apart, and the strip between them forms the stacking ground, generally called the "rampart," on which the peat, when won on the adjoining portion

SCHEME OF PEAT WINNING AT MAGHERY CO. ARMAGH



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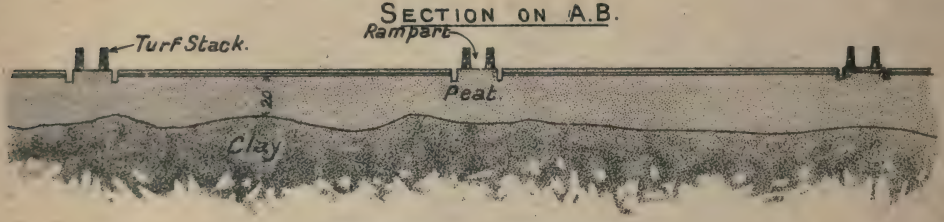

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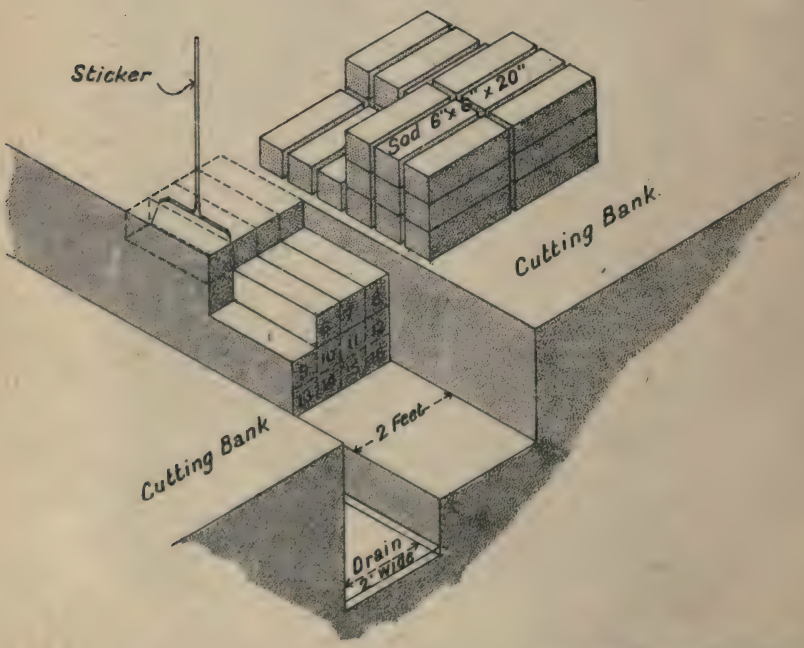

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of the bog, is collected and left ready for removal to the factory. The length of these ramparts varies from 600 to 800 yards, depending on the size of the bog, and the whole bog is now laid out in working fields 800 yards long by 100 yards wide on either side of the main road. A reference to the accompanying plan showing the lay-out and method of working at Maghery, Co. Armagh, will make this clear. The working fields are again divided by running a series of small surface drains, 2 feet wide at the top and 3 feet deep, at distances of 11 yards from centre to centre, the drains running parallel to the axis of the main road. All the peat excavated from the main drains, minor drain, and surface drains is cut out in the form of sods and is made use of for the production of moss litter. The fundamental idea underlying this system of lay-out is to develop as many lineal yards of cutting face per acre as is found economically possible. The cutting of this drainage system will naturally take time, and it is desirable that at least two to three years should elapse before cutting is seriously undertaken. The peat moss is cut from the faces of the minor drains (3 feet by 2 feet) which form the sides of the cutting banks, 100 yards long by 10 yards wide, and a strip 2 feet wide and 2 feet deep is cut from each face of the drain. The excavated peat is placed on top of the cutting bank in the form of sods as shown in the sketch, without either handling or wheeling, and it is important to note the great economy which results, in this, the first operation of winning the peat, by dispensing with the wheeling and spreading. An average day's work for a cutter is to cut this strip 2 feet wide by 2 feet deep by 100 yards long (called a "chain"), that is 44·4 cubic yards of raw peat, which on drying should produce about 3 tons of peat moss litter if the bog is well drained. If the bog is imperfectly drained, the yield may be only 2 tons per chain. A specially skilled cutter is capable of raising and placing on the cutting bank to dry 60 cubic yards of raw peat, sufficient to produce 4 to 5 tons of air-dried peat, in the day. At Maghery, Co. Armagh, this strip, 2 feet wide by 2 feet deep, is cut into 16 sods of 6 inches by 6 inches cross section, the length of the freshly cut sod being about 18 to 20 inches. All the vertical cuts, longitudinal and transverse, shown on the sketch are made with a tool called a "sticker," which consists of a steel blade $\frac{3}{16}$ths of an inch thick, 9 inches deep, and 18 inches long, with a vertical handle mounted in the middle. A breast slane or spade, with a blade 18 inches long by 6 inches wide, is then driven horizontally so as to detach the sod, which is then placed on the surface of the cutting bank, as shown in sketch. The section of 2 feet by 2 feet cut from the bench is regulated so that it may be placed on the bank directly from the breast slane without further handling. There are slight variations in the methods employed on different bogs, in some cases the vertical longitudinal cuts being made with a large hay knife, the breast slane as before being used to make the horizontal cuts necessary to detach the sods. The season for cutting moss litter usually begins on the 1st of October and continues until the following June. The frost during the winter facilitates the manufacture of peat moss litter, but is injurious to fuel peat.

When the peat moss litter is cut and placed on the surface of the bog to dry, a week of good weather will usually get it into such a condition that footing of the sods may be commenced. A "footing" consists of seven sods built up so as to allow free passage of air through the pile, and when the sods are sufficiently dried they are either refooted (*i.e.*, the bottom sods are raised to the top) or else placed in long "walls" loosely built so as to give free access of air, at the same time affording some protection from rain. When further drying has taken place the sods may be either transferred into small clamps or removed direct to the permanent stacks on the ramparts. Practice varies; on some bogs three turning operations are found necessary, on others only two are necessary. As a rule all the "footing" and "walling" work is carried out by women and children.

The peat is collected from "the footings" or "wallings" during August and September, and carried in baskets or hand-barrows by two men and placed in large stacks, 10 feet wide at the base and tapering to 4 feet wide

at the top, the height being 8 feet. As will be seen from the accompanying sketch, the average distance which the peat has to be carried to the stacks is about 25 yards, and as the work is heavy and arduous it is usually undertaken by men only. The peat remains in stacks on the ramparts until it is brought to the factory in specially constructed trucks which contain 25 to 30 cwt. of the air-dried litter, and for this purpose a temporary narrow-gauge railway is laid along the rampart as required. On most bogs the trucks are pushed by hand or drawn by donkeys, but on the Irish Peat Development Company's bog at Maghery, Co. Armagh, a small electric locomotive, taking its current from an overhead wire supported on wooden poles, is used to haul the peat a distance of from 2 to 2½ miles. All the labour involved in cutting, footing, and stacking the peat is paid for on a piece-work basis, and, at the rates paid, the cutters' earnings compare favourably with those current in the same districts for agricultural work. Without giving exact figures it may be stated that, excluding rent, capital and sinking fund charges, the moss litter will cost about 5*s*. per ton delivered at the factory.

APPENDIX III

(14) Rating of Peat and Coal.

(a) *Note on the Recovery of Ammonia from Peat.*

In Section 14, page 33, of Report an approximate rating of peat and coal was given from a consideration of thermal properties alone. When, however, the peat or coal is first gasified, with by-product recovery, we must take into account the value of the sulphate of ammonia obtained as a by-product, and it will then be seen that when the fuel is used in this way, peat for power purposes is in a much stronger position to compete with coal than would appear from thermal considerations alone. Since one per cent of nitrogen

= 22·4 pounds of nitrogen per ton of anhydrous peat.
= 16·8 „ „ „ air-dried peat (25 per cent. water),

and also one pound of nitrogen yields theoretically 4·714 pounds of sulphate of ammonia, it follows that one ton of air-dried peat (25 per cent. water) containing 1 per cent. nitrogen on anhydrous value would give theoretically 79·2 pounds of sulphate of ammonia. If the recovery of the maximum amount of ammonia per ton of peat is the aim rather than the production of the maximum amount of power, an efficiency of 70 per cent. is stated to be regularly attained in practice, and adopting this value we get the following result.

One ton of air-dried peat (25 per cent. water) contains ¾ ton of anhydrous peat, and if the anhydrous peat contains 1 per cent. of nitrogen the yield with 70 per cent. recovery will be 55·44 pounds of sulphate of ammonia.

The average of 58 determinations of nitrogen, mostly made by Professor Emil Werner of Dublin University on samples of peat taken at depths of 3 feet to 30 feet below the surface in the Bog of Allen, gave 1·77 per cent. The individual values varied from ·60 near the surface to 1·86 at 12 feet deep. At depths from 16 to 30 feet the percentage of nitrogen varied from 1·78 to 2·41. If we adopt 1·8 per cent. of nitrogen as the average, then one ton of air-dried peat should actually yield 99·8 pounds or, say, 100 pounds of sulphate of ammonia. The nitrogen in coal generally varies from about ·8 per cent. to 2 per cent., but 1·2 per cent. may be taken as an average value. With 70 per cent. recovery one ton of coal with 1·2 per cent. nitrogen will yield 88·7 pounds of sulphate of ammonia.

If we assume the pit-head price of coal to be 10*s.* per ton and the cost of air-dried peat near to the bog to be 6*s.* per ton, then, if two tons of air-dried peat be taken as the thermal equivalent of one ton of coal in producer plant, the gross cost of an equivalent amount of energy from coal and peat will be 10*s.* and 12*s.*, but, as shown in the following table, the two tons of peat yield about one cwt. of sulphate of ammonia in excess of that from the one ton of coal. Even when a small margin of 3*l.* per ton is taken between the value of the sulphate of ammonia and its cost of recovery, it is sufficient to change the position in favour of peat when compared with coal for the production of power on the basis of the prices assumed.

	Per cent. of Nitrogen.	Ammonium Sulphate recovered.	Gross Cost of Fuel.
		Pounds.	
One ton coal - - -	1·2	88·7	10*s.*
Two tons air-dried peat -	1·8	199·6	12*s.*

The price of 10*s.* per ton is in favour of coal, whereas the price of 6*s.* taken for peat should be a maximum figure. The point is often overlooked, when comparing peat and coal, that even if you require two tons of peat to one ton of coal you have the by-products from two tons of peat as against those derived from one ton of coal. To put it otherwise, the fuel for a given amount of energy in the case of peat yields 2¼ times as much sulphate of ammonia as when using coal.

APPENDIX IV

Memorandum by Professor Pierce Purcell, M.Inst.C.E., on the Area and Fuel Content of the Irish Peat Deposits, and on the Consumption of Coal and estimated Consumption of Peat Fuel in Ireland.

The following memorandum has been prepared by Professor Pierce F. Purcell, M.Inst.C.E., on the Area and Fuel Content of the Irish Peat Deposits and on the distribution and consumption of coal in Ireland, with an estimate of the annual consumption of peat fuel, these being the data from which the figures in Sections 4 and 7 of the Report of the Irish Peat Inquiry Committee were obtained.

Area and Fuel Content of the Irish Peat Deposits.

Note.—The areas are taken from the Reports of the Bogs Commissioners, 1810–1814. A number of errors in the summary to their Fourth Report have been pointed out by Professor Hugh Ryan, D.Sc., and these have been corrected. In many cases the figures given by the Bogs Commissioners for the unsurveyed bogs are only approximate. The peat in the bog has been assumed to weigh 62·4 pounds per cubic foot and to contain on the average 92 per cent. of moisture. This gives a yield of 97 tons of anhydrous peat per foot acre. One ton of anhydrous peat will produce 1·33 tons of air-dried peat with 25 per cent. moisture. The depths of the bogs are in most cases given on the maps of the Bogs Commissioners, but in other cases have been assumed or derived from other sources.

TABLE I.—AREA AND FUEL CONTENT OF FLAT BOGS IN IRELAND.

Flat Bogs of Central Ireland.

Bogs Commissioners, 1810–1814, Report No.	Name of District.	Area in Statute Acres.	Average Depth in Feet.	Anhydrous Peat contained Millions of Tons.
I. and II.	Bog of Allen	77,505	22	165·0
II.	River Boyne	42,370	23	94·4
II.	River Brosna	44,594	25	108·0
II.	River Shannon	34,500	28	93·5
II.	River Inny	34,569	25	83·8
III.	Lough Gara	49,277	20	95·6
III.	River Barrow	7,459	18	13·0
III.	Lough Corrib	83,724	17	138·0
III.	Co. Mayo	181,178	10	175·9
IV.	Lough Ree	26,630	25	64·7
IV.	River Suck	129,238	21	263·5
	Totals	711,044	18·75	1,295·4

Flat Bogs not situated in Central Ireland.

III.	Roscrea to Killenaule	36,025	17	59·4
III.	W. of Maryboro'	14,754	19	27·1
III.	W. Clare	22,340	17	36·8
III.	Lough Neagh	70,196	15	102·0
IV.	Iveragh	43,567	12	50·7
IV.	Kenmare River	14,605	16	22·7
IV.	Laune and Maine	26,556	11½	29·6
IV.	Slieve Luaghar	32,902	11¾	37·5
IV.	River Cashen	31,514	18	55·0
	Totals	292,459	14·85	420·8

Other Flat Bogs not accurately surveyed.

IV.	Small bogs under 500 Irish Acres.	193,600	—	—
IV.	Erris and Tyrawley (Co. Mayo).	170,090	—	—
IV.	Co. Wicklow bogs	97,000	—	—
IV.	Connemara	194,400	—	—
	Totals	655,090	10	635·4

TABLE I(*a*).—SUMMARY. AREA AND FUEL CONTENT OF IRISH BOGS.

Description.	Area in Statute Acres.		Average Depth in Feet.	Anhydrous Peat contained Millions of Tons.
Flat Bogs:—				
In central belt		711,044	18·75	1,295
Outside central belt		292,459	14·85	421
Other bogs not accurately surveyed		655,090	10·00*	635
Mountain Bogs:—				
Erris and Tyrawley, Co. Mayo	155,500			
Kerry and Cork	500,000†			
Connemara	324,000†			
Donegal, Tyrone, Fermanagh	400,000†			
		1,379,500	5·00*	668
Totals		3,038,093	—	3,019

* Depths assumed as no definite figures are available.
† These bogs were unsurveyed and the areas were only estimated.

Thus the area of bogs reported on by the Bogs Commissioners was over three million acres and contained 3,019 million tons of anhydrous peat, which would produce 4,025 million tons of peat fuel containing 25 per cent. of moisture. To arrive at the present reserves we must deduct at least 750 million tons to allow for the peat fuel consumed during the last 106 years since the Bog Commissioners reported, but we must also take into account the normal growth of the undrained bogs during the same period as this will have replaced, to some extent, the quantity cut away.

Coal Consumption and Estimate of Peat Fuel consumed.

In connection with the work of the "Irish Peat Enquiry Committee" an attempt was made to estimate the annual consumption of peat fuel in Ireland (*see* page 16). As there were no existing statistics of the consumption of peat, the estimate was a difficult one to make, and it was determined to approach the problem by first of all making a detailed study of the distribution of both native and imported coal in Ireland.

Statistics were furnished by the Department of Agriculture and Technical Instruction for Ireland giving the coal imported through 73 known ports, but in the case of some of these ports it was difficult for the Department to obtain reliable figures. From the various railway companies returns were received of the tonnage of coal railed from each port and delivered to the different stations on their systems. The coal used for locomotive and other purposes by the railway companies was returned, and the native coal mined in Ireland was also available. These figures were then abstracted for the years 1912, 1913, and 1914, and what was assumed to be a fair average for the pre-war consumption and distribution of coal was obtained for these three years. The coal distributed to individual railway stations was then collected and plotted on the 4 miles to an inch map of Ireland, the coal sent to each point being represented to scale on the map by the area of a circle. These figures were subsequently collected from the map by counties so as to show approximately the total amount of coal consumed in each county.

The whole question of the fuel problem in each county was then reviewed, keeping in mind the peat deposits available, the coal consumed and other data received in returns from county surveyors. An attempt was then made to estimate the peat fuel consumption on the basis of 20 to 25 tons of air-

dried peat fuel per annum to each household. Subsequent to this, at the suggestion of the Irish Peat Enquiry Committee, the Department of Agriculture and Technical Instruction for Ireland undertook in connection with their agricultural statistics to obtain returns of the number of farmsteads in the various provinces which consumed (*a*) coal only, (*b*) more coal than peat, (*c*) more peat than coal, and (*d*) peat only. This return is now available and gives a reasonably close check with the estimate prepared for the Peat Committee. From the Department's return it would appear that approximately 323,000 farmsteads or about 66 per cent. of the rural population are solely dependent on peat fuel, whereas the Peat Committee's estimate gave 290,000 families dependent on peat fuel. A very conservative estimate based on this gave the peat fuel consumption in Ireland as about 6,000,000 tons of air-dried peat per annum, but it is possible that it may be as high as 8,000,000 tons per annum. For this statement a consumption of 7,000,000 tons of air-dried peat fuel per annum will be assumed.

Taking as a basis of comparison that two tons of peat fuel are equal in calorific power to one ton of coal, the total coal equivalent of the 7,000,000 tons of peat consumed in Ireland is 3,500,000 tons of coal in addition to which the coal actually consumed is 4,630,000 tons. Hence, previous to 1914, peat fuel supplied $\frac{3,500,000}{8,130,000} \times 100$, or 43 per cent. of the total fuel requirements of the country.

Table II. gives the general statistics as to coal used in Ireland, average figure for the years 1912–13–14, and shows the way in which the coal is distributed.

Table III. gives an abstract of the coal and peat consumption in each Province (railway coal being excluded). It will be noticed that the average coal consumption in Connaught is only ·174 tons per head of the population as compared with an average of 1·07 tons in the other three Provinces.

Table IV. gives the detail of the coal consumption by Counties.

Table V.—Returns collected on 1st June, 1918, by Department of Agriculture giving numbers of farmsteads consuming peat fuel.

NOTE.—*All figures in tables are the average of the years* 1912, 1913, *and* 1914.

TABLE II.

	Tons per Annum	
Coal imported - - - - - -	4,542,500*	
Coal mined in Ireland - - - - -	88,000	
Total used in Ireland - - - -		4,630,500
Locomotive and Railway Co.s' coal - -	475,000	
Distributed by railways - - - -	1,213,000	
Distributed by barges on inland waterways -	165,000	
Coal remaining in port of import or distributed by lorries close to seaboard - -	2,777,500	
		4,630,500

* *H.M. Customs returns of the coal imported into Ireland for the years 1912, 1913, and 1914 give an average of 4,650,007 tons per annum, and this figure is used in the body of the Report. The distribution of this quantity to individual ports was not available and hence the imports into 73 known ports obtained by the Department of Agriculture, and amounting to 4,542,500 tons has been used in the preparation of the map accompanying the Report. The figures in Tables II., III., and IV. have been taken from this map.*

TABLE III.

Province.	Population (1911).	Coal Consumption.	Coal consumed per Head per Annum.	Estimated Peat Fuel Consumption.
		Tons.	Tons.	Tons.
Leinster - - - -	1,162,044	1,294,798	1·11	1,050,000
Munster - - - -	1,035,495	762,384	·74	1,625,000
Ulster - - - -	1,581,696	1,992,196	1·26	2,025,000
Connaught - -	610,984	106,122	·17	2,300,000
Totals - - -	4,390,219	4,155,500	·95	7,000,000

TABLE IV.—SHOWING POPULATION AND NUMBER OF FAMILIES (1911 CENSUS) WITH COAL USED IN EACH COUNTY IN IRELAND, AND AN ESTIMATE OF THE PEAT FUEL CONSUMED. (COAL USED FOR RAILWAY PURPOSES EXCLUDED.)

Average for 1912–13 *and* 1914.

County.	Population (1911).	Number of Families.	Total Coal used in each County and County Borough.	Coal per Head per Annum.	Estimated Annual Consumption of Air-dried Peat Fuel.
LEINSTER.			Tons.	Tons.	Tons.
Carlow County -	36,252	7,816	20,938	·58	
Dublin City or County Borough.	304,802	2,365	682,878	2·24	
Dublin County -	172,394	35,062	80,220	·47	
Kildare County -	66,627	13,023	54,864	·82	
Kilkenny County -	74,962	15,826	81,132	1·08	
King's County -	56,832	12,535	23,325	·41	
Longford County -	43,820	9,524	7,010	·16	
Louth County -	63,665	14,024	116,921	1·84	
Meath County -	65,091	14,876	30,390	47	
Queen's County -	54,629	12,026	31,872	·57	
Westmeath County	59,986	12,953	26,957	·45	
Wexford County -	102,273	21,853	80,956	·79	
Wicklow County -	60,711	12,960	57,845	·95	
Total - -	1,162,044	244,843	1,294,798	1·11	1,050,000

TABLE IV.—SHOWING POPULATION AND NUMBER OF FAMILIES (1911 CENSUS) WITH COAL USED IN EACH COUNTY IN IRELAND, AND AN ESTIMATE OF THE PEAT FUEL CONSUMED. (COAL USED FOR RAILWAY PURPOSES EXCLUDED)—*continued.*

County.	Population (1911).	Number of Families.	Total Coal used in each County and County Borough.	Coal per Head per Annum.	Estimated Annual Consumption of Air-dried Peat Fuel.
		Tons.	Tons.	Tons.	
MUNSTER.					
Clare County - -	104,232	20,535	19,680	·19	
Cork City or County Borough	76,673	15,469	201,202	2·63	
Cork County - -	315,431	61,149	149,807	·48	
Kerry County -	159,691	28,854	45,675	·29	
Limerick City or County Borough.	38,518	7,477	92,568	2·41	
Limerick County -	104,551	21,161	48,412	·46	
Tipperary County -	152,433	30,786	95,681	·63	
Waterford City or County Borough.	27,464	5,140	83,837	3·05	
Waterford County -	56,502	11,984	25,522	·45	
Total - -	1,035,495	202,555	762,384	·74	1,625,000
ULSTER.					
Antrim County -	193,864	41,872	360,473	1·86	
Armagh County -	120,291	27,309	123,653	1·03	
Belfast City or County Borough.	386,947	77,370	878,733	2·27	
Cavan County -	91,173	20,536	23,713	·26	
Donegal County -	168,537	34,425	32,337	·19	
Down County -	204,303	46,369	271,090	1·33	
Fermanagh County	61,836	13,973	13,654	·22	
Londonderry City or County Borough.	40,780	7,745	98,788	2·42	
Londonderry County	99,845	22,115	49,552	·50	
Monaghan County -	71,455	16,377	57,128	·80	
Tyrone County -	142,665	32,340	83,075	·58	
Total - -	1,581,696	340,431	1,992,196	1·26	2,025,000
CONNAUGHT.					
Galway County -	182,224	35,328	33,622	·19	
Leitrim County -	63,582	13,865	11,388	·18	
Mayo County - -	192,177	36,969	18,034	·09	
Roscommon County	93,956	20,097	12,665	·14	
Sligo County - -	79,045	16,600	30,413	·39	
Total - -	610,984	122,859	106,122	·17	2,300,000
GRAND TOTAL (IRELAND) -	4,390,219	910,688	4,155,495	·95	7,000,000

TABLE V.—RETURN SUPPLIED BY THE DEPARTMENT OF AGRICULTURE AND TECHNICAL INSTRUCTION FOR IRELAND, 14TH JANUARY 1919.

Fuel consumed on Farms in Ireland.

(Returns collected on 1st June 1918.)

Province.	Number of Farms using					Percentage of Farms using				
	Coal only.	More Coal than Peat.	More Peat than Coal.	Peat only.	Total.	Coal only.	More Coal than Peat.	More Peat than Coal.	Peat only.	Total.
Leinster - -	55,432	3,452	4,544	41,430	104,858	52·9	3·3	4·3	39·5	100·0
Munster -	45,218	4,253	4,641	65,335	119,447	37·8	3·6	3·9	54·7	100·0
Ulster - -	55,551	6,138	6,677	95,016	163,382	34·0	3·8	4·1	58·1	100·0
Connaught -	1,506	930	1,287	104,139	107,862	1·4	0·9	1·2	96·5	100·0
Ireland -	157,707	14,773	17,149	305,920	495,549	31·8	3·0	3·5	61·7	100·0

Note.—The above columns (other than those for coal only) contain figures for a small number of farms using wood.

IV

Irish Peat Inquiry Committee.—Supplemental Report and Estimates

GENTLEMEN, 10th July 1918.

SINCE our conference with your Board on the 11th of June, we have given careful consideration to the various points then discussed. We thank the Board for the kind reception given to us and for the friendly and sympathetic consideration of our report of the 26th of February, which we had the honour of submitting to you.

In that report we made proposals for a large scale experiment, to be carried out under State control on commercial lines, including the mechanical winning of peat, the provision of an electric power station, the supply of power for industrial purposes, the provision of continuous employment so as to avoid the introduction of casual or migrant labour, the reclamation of bog land for agriculture purposes, and the provision of homesteads for the workpeople. This would obviously form a complex experimental proposition, and we fully agree and sympathise with the desire of your Board that each stage should be examined and proved in detail.

The primary object is to find whether peat can be won on a large scale economically, so as to be able to compete with coal as a fuel.

The present shortage of fuel in Ireland appears to offer a specially favourable opportunity for devoting attention to the winning of peat mechanically, and for devoting our best efforts to perfecting the machinery for excavating, macerating, spreading, and saving the peat fuel.

If the winning of peat by mechanical means proves in practice economical, it will not be difficult to extend the investigation to the utilization of peat for industrial purposes.

The principal aim, as definitely stated in the last paragraph of our report, is the experimental investigation on a commercial scale of outstanding problems connected with the mechanical winning of peat. This investigation would naturally precede the inauguration of any large scheme of utilization, but we consider that experiments on utilization on a moderate scale should proceed concurrently with those on mechanical winning.

We are satisfied that even at this preliminary stage a large bog of some 10,000 to 15,000 acres should be purchased by the State and scientifically drained. A portion would be devoted to an agriculture experiment, while another section would be devoted to the winning and preparation of peat fuel. Sites would also be provided for the experimental station and for dwellings or homesteads for the workpeople. Although peat winning is a seasonal operation, yet, for the immediate future

there would be ample work to keep the workers constantly employed in the drainage of the bog and its preparation for agriculture.

Should the result of this preliminary investigation justify the estimates of peat winning made in our report, and go to show that the peat can be economically won, it would seem that the larger scheme outlined in the report should logically follow as a step in the development of this natural resource of the country.

To carry out this investigation we recommend that the following scheme be adopted :—

1. The purchase of a bog of at least 10,000 acres.

2.—(*a*) The provision of four electrically operated peat winning machines of the automatic dredger, macerator, and transporter type, with appliances for collecting, stacking, and loading.

(*b*) The provision of narrow-gauge tracks with electric locomotives and waggons.

3. The erection of an electric power station of at least 500 kw., using peat fuel, to supply the power required for operating the peat machines, transport on the bog, experiments on peat utilization, &c.

4. The preparation of the bog by—

(*a*) Main drainage.
(*b*) Local drainage for peat winning.
(*c*) Local drainage for agriculture.

5. The provision of the necessary housing for the employees and office and laboratory accommodation.

The winning of the peat should be carried out on strictly commercial lines, careful records of output, with labour, maintenance, and power costs being kept.

Peat could be sent up to Dublin by canal so that the actual cost of loading, transport, and handling might be ascertained. The cost of the organising and depôt expenses in Dublin could be determined and the market for such fuel explored. Machine peat might also be put on rail, to determine the loss in handling and the cost of transport and delivery of this class of fuel.

Research assistants should be appointed to investigate the problems indicated in Section 19 of the report.

Five hundred acres of bog should be drained and prepared for agricultural purposes. The agricultural treatment of this area should be under the care of the Department of Agriculture and Technical Instruction for Ireland.

Labour.—The problem of dealing with the labour not required during the winter season for peat winning demands consideration. In the peat-saving season a large amount of the necessary labour for footing, &c., may be got from children during their school holidays and outside school hours. During the experi-

mental period there would be considerable scope for employing labour in winter on drainage and other operations.

The Agricultural Experiment.—We consider the agricultural treatment of the bog lands as an essential part of the peat-winning scheme. The fact should not be overlooked that while in the case of a colliery the area of agricultural land is diminished, in the case of peat winning it is increased by the reclamation of the bog. The possibility of reclaiming bog land for agricultural purposes before the peat is won, and after the bog is cut away is not a problem which has to be investigated for the first time or which needs proof.

The Bogs Commission of 1809–1814 proved conclusively that bog can be reclaimed and utilized for agriculture with success, and the results can be seen in many of the bog areas of Ireland. Good corn and root crops can be seen on land of this character in numerous holdings throughout the country. The Department of Agriculture and Technical Instruction have recorded in their journals numerous experiments carried out under their direction, while the Proceedings of the Royal Dublin Society abound with references to the results of bog reclamation fostered under their patronage in the early part of the last century. The reasons why such agricultural reclamation of the bogs of Ireland has not extended are fully discussed by the Bogs Commission and referred to in detail in our report.

We would therefore press for the acquisition of the necessary bog by the State, and also that its utilization for agriculture should be carried out as part of the scheme for the development of peat fuel in Ireland.

We are of opinion that a grant of 100,000*l.* should be placed at the disposal of the Fuel Research Board for the purposes of carrying out this investigation on an adequate scale.

Your obedient Servants,

JOHN P. GRIFFITH, Chairman.
GEORGE FLETCHER.
HUGH RYAN.
SIDNEY YOUNG.
PIERCE F. PURCELL, Secretary.

To the Fuel Research Board,
15, Great George Street,
Westminster, S.W. 1.

Irish Peat Inquiry Committee.

University College,
Earlsfort Terrace,
Dublin.

DEAR SIR GEORGE BEILBY, 10th July, 1918.

I am directed by the Committee to send you the enclosed Supplemental Report in accordance with the agree-

ment reached at our conference with your Board on the 11th June.

The following is a rough estimate of the cost of the suggested scheme :—

	£	£
Purchase of bog—		
10,000 acres at 2*l.*		20,000
Drainage—		
Main drainage - - - - Labour,	5,000	
Minor drainage of 1,000 acres at 5*l.* for peat winning - - - - Labour,	5,000	
		10,000
Plant—		
Peat winning plant, and plant for collection and handing - - - -	10,000	
Repair shop and machinery - - -	2,000	
Locomotives and rails - - - -	5,000	
Power Station, 500 kw. producer plant, gas engines, generators and buildings -	12,000	
		29,000
Housing and Offices - - - - - -		5,000
Preparation of 500 acres for agriculture - -		5,000
		69,000
Running expenses for four years - - -		14,000
Contingencies, say - - - - - -		13,000
Total - - -		£96,000

As stated in the supplemental report, we are of opinion that 100,000*l.* should be provided. Should you require any further particulars we shall be happy to supply them.

Yours faithfully,

(Signed) PIERCE F. PURCELL,
Secretary.

Sir George Beilby, F.R.S.,
Fuel Research Board,
15, Great George Street,
Westminster.

V

Report and Recommendations of the Fuel Research Board on the Report of their Irish Peat Inquiry Committee on the Winning, Preparation, and Use of Peat for Fuel and other Purposes

1. Since its establishment in 1916 the Research Department has received many proposals for the investigation of schemes for the preparation and utilization of peat. Most of these proposals centre round specific inventions or processes which were believed by their authors to be of world-wide application and they were put forward, as a rule, without serious reference to the physical and economic conditions actually existing in the bog areas of any particular country or locality.

Early in the history of the Advisory Council on Scientific and Industrial Research the Irish representatives on that body pressed for the consideration of the subject of peat utilization from the Irish point of view.

When the Fuel Research Board was established early in 1917 the consideration of this subject was passed over to that body.

2. The whole subject was then carefully reviewed by the Director of Fuel Research. This review made it abundantly clear that a large proportion of the failures of the past were due to the fact that the attack on the problems involved had generally been made in the interests of some particular process or invention, instead of by the more business-like and logical plan of a study of the physical and economic conditions of definite bog areas and the careful consideration of the application of known and established methods of peat winning and utilization in these areas.

3. As there appeared to be scope and opportunity in Ireland for an inquiry on these broader and more fundamental lines, it was decided in July 1917 that a committee should be set up in Ireland for this purpose.

The Committee was composed of the following members:—

Sir John Purser Griffith, M.A.I., M. Inst. C.E., Chairman.
Professor Hugh Ryan, D.Sc.
Professor Sidney Young, D.Sc., F.R.S.
George Fletcher, Esq.
Professor Pierce F. Purcell, M.A.I., Secretary.

The following were the terms of reference to the Committee:—

"To inquire into and to consider the experience already gained in Ireland in respect of the winning, preparation,

and use of peat for fuel and for other purposes and to suggest what means shall be taken to ascertain the conditions under which in the most favourably situated localities it can be won, prepared, and used, having regard to the economic conditions of Ireland; and to report to the Fuel Research Board."

4. In a covering letter to the Chairman of the Committee the Director stated very clearly the point of view of the Fuel Research Board in regard to the immediate objects of the inquiry. A copy of this letter will be found on page 7.

5. On 26th February 1918 the report was signed in Dublin by all the members of Committee and transmitted to the Fuel Research Board in London. The report comprises an introduction, 20 sections, and three appendices, and it was accompanied by three large maps.

The more important features which emerge from the inquiries of the Committee are:—

(i) That large areas of peat bog of depth of sufficient and good quality exist in Ireland in situations where facilities for deep drainage and transport might be developed.

(ii) That the output of air-dried peat in Ireland is in the neighbourhood of 6,000,000 tons per annum, and therefore that ample experience already exists of all that appertains to the winning of air-dried peat by manual labour. This experience shows that natural air-drying, though necessarily a seasonal operation, still holds its own as the most economical means of reducing the water content of cut peat. Though the cutting and drying season is necessarily a short one, yet in average years it is possible to reduce the water content of the cut peat to 25 per cent.

(iii) That the present output of air-dried peat is mainly used for domestic firing, but that a sufficient quantity is regularly consumed for industrial purposes to enable a limited comparison to be made of the relative values of peat and coal in industries. The calorific value of air-dried peat containing 25 per cent. of water is from 6,000 to 7,000 B.T.U. per pound, as compared with 11,000 to 12,000 B.T.U. for coal as supplied in Dublin. It may be taken therefore that in calorific value $1\frac{3}{4}$ tons of air-dried peat are equivalent to 1 ton of coal.

If air-dried peat is to replace coal for industrial purposes much experimental and pioneering work has still to be done.

(iv) That though hand winning of peat is thoroughly understood in Ireland, there is no equivalent experience in the use of machine cutting or of mechanical transport on the bog.

(v) That there is no sufficient experience of the application of scientific drainage to bog areas or of the scientific lay out of these areas for cutting, drying, and transporting peat.

(vi) That there is no experience of the combination of agricultural development of bog areas carried out in association with the more highly developed methods of peat winning referred to in (iv) and (v).

(vii) That hand winning of air-dried peat requires during the season a supply of mixed labour consisting of men, women, and children, and it is suggested that this labour could best be furnished by the establishment of labour colonies in close proximity to the bog areas.

That to provide work and wages for the majority of the able-bodied men of the colony for the whole round of the year it would be necessary side by side with the peat scheme to carry on an agricultural land reclamation scheme.

(viii) That while the use of more scientific methods in peat winning would considerably increase the output per worker, yet the essential conditions affecting the provision of suitable labour would still be those laid down in paragraph (vii).

6. From the foregoing summary it will be seen that the Committee have dealt in a business-like way with the fundamental matters on which any successful development of the peat bogs of Ireland must be based. The information they have thus collected, sifted, and presented is invaluable, and the main body of the report is in all respects worthy to take its place as the natural successor of the Bogs Commission Report of 1809-1814. In their "Conclusions and Recommendations," however, the Committee carry the report far beyond the preliminary stage of the inquiry, and commit themselves to a very extensive scheme for the establishment of a large power station on a suitable bog area.

7. At the time the Committee was appointed, the Fuel Research Board were aware that proposals for the establishment in Ireland of central electric power stations based on peat as fuel were being freely advocated by writers in the technical press. It appeared to the Board, however, that these proposals were neither supported by well ascertained facts nor by first-hand experience of the technical and economic problems which still awaited solution before the proposals could be regarded as practical. The Board considered that the solution of these

particular problems would most naturally follow, not precede, the settlement of the broader foundations of any extensive development of peat winning in Ireland. They therefore, through the covering letter of the Director, strongly represented to the Committee that they should concentrate their attention on the more fundamental questions, leaving over the more complex questions for discussion after the fundamentals had been established. In advocating this method of attack, the Board were also influenced by the knowledge that the more specialised aspects of fuel preparation and power production which they are preparing to investigate at the Fuel Research Station at East Greenwich would bear very closely on the problems involved in the utilization of peat instead of coal in power stations. The replies to the questions put in the Director's letter are given in Section 18 of the report. The most far-reaching of these replies may be given in the words of the report :—

> " We have come to the conclusion that with a suitably situated bog, well drained, and with the aid of modern excavating, macerating, sod forming, and spreading machinery, air-dried peat can be won and delivered in certain districts at a cost which will compare favourably with coal, due allowance being made for the difference in calorific value."

8. Up to this stage the Committee seem to have made out a case for the establishment of a research station on a selected bog where the best methods of drainage, transport, and mechanical cutting and winning could be investigated, but their actual recommendations went beyond this point and the obvious conclusion which would have been drawn from the report had it been published would have been that they were prepared to recommend that the Government should finance an extensive electric power scheme on untried lines. In view of the discussions in the technical press, referred to above, it is practically certain that the general belief in Ireland would have been that the Committee had given its unconditional support to the imperfectly-thought-out schemes of certain electrical enthusiasts.

9. At informal meetings in London with the chairman, Sir John Griffith and with the Secretary, Professor Purcell, it was strongly urged by the Director that the committee should reconsider their report with a view to its modification on this point. The Fuel Research Board invited the whole Committee to come to London for a conference on the subject. This conference between the Board and the Committee took place on June 6th, 1918, and after a full discussion it was agreed that the Committee should submit a supplementary report in which it would be made clear that they concurred with the Board

in the view that the knowledge and experience available would not justify the proposal to proceed with an extensive scheme of peat winning having as its central feature the establishment of a large central power station on or near a bog area. As an alternative to the larger scheme the Committee undertook to make proposals for the establishment of a peat experimental station on a moderate but practical scale.

The Supplemental Report.

10. On July 10th, 1918, the Committee sent a supplementary report signed by all its members.

The following are the recommendations now made :—

(1) The purchase of a bog of at least 10,000 acres.

(2) (*a*) The provision of four electrically operated peat winning machines of the automatic dredger, macerator, and transporter type, with appliances for collecting, stacking, and loading.

(*b*) The provision of narrow-gauge tracks with electric locomotives and waggons.

(3) The erection of an electric power station of at least 500 kw. using peat fuel, to supply the power required under 2*a* and 2*b*.

(4) The preparation of the bog by—

(*a*) Main drainage.

(*b*) Local drainage for peat winning.

(*c*) Local drainage for agriculture.

(5) The provision of the necessary housing for the employees and of office and laboratory accommodation.

Conclusions of the Fuel Research Board.

11. After a careful study of the subject the Board agree that it is desirable that further investigation of the methods and economics of peat winning should be made on the lines proposed by the Committee in order that trustworthy data may once for all be obtained.

For the determination of these data an experimental station on a fairly large scale would have to be set up on a selected bog area.

At this station the best methods of drainage and lay-out of the bog, and of cutting, drying, and transporting peat would be investigated under thoroughly practical conditions. The station would thus be in a position to supply peat fuel in large quantities so that its use for domestic and industrial purposes could be tested on a practical scale and over sufficiently long periods to ensure that trustworthy results would be obtained.

12. From the industrial point of view the most important question for the future is whether in selected localities large central stations for the generation and distribution of electric

power can be permanently run on peat as fuel in competition with hydro-electric or coal-fired stations.

13. In arriving at an answer to this question the economical winning of air-dried peat is necessarily at the foundations of the whole matter, but even after the most favourable possibilities have been ascertained for this initial step, *an equally important step will be the determination of the best means of obtaining power by the use of peat as fuel.* This step will involve experimental inquiries which will need to be carried out on a gradually increasing scale till an economical and industrial unit has been developed and proved.

14. These experimental inquiries are closely related to the scheme of research on coal and other forms of fuel which is to be carried out at the Fuel Research Station at East Greenwich, and they ought therefore to be carried out under the direction of this Board, otherwise needless overlapping and waste of public funds will occur. The Fuel Research Board would therefore be prepared under suitable conditions to direct the work of an experimental peat station in Ireland. It is not possible at this stage to lay down these conditions with any approach to finality, but broadly they would involve—

(*a*) The purchase by the Government of a suitable bog area.

(*b*) The establishment on that area of an agricultural colony under the control and management of the Irish Department of Agriculture.

(*c*) The establishment of an experimental station on the bog area under the control of a deputy Director to be appointed by the Fuel Research Board.

(*d*) The appointment of an Irish Advisory Committee in connection with the station.

15. As regards the financial aspects of the scheme, the Committee say: "We are of opinion that a grant of 100,000*l.* "should be placed at the disposal of the Fuel Research Board "for the purpose of carrying out this investigation on an "adequate scale." In the covering letter which accompanied the supplemental report the Secretary gives an estimate showing how the Committee have arrived at the above sum. The estimate is here rearranged under three heads:—

I.—Capital:—

	£
Purchase of bog, 10,000 acres at 2*l.* - - - - -	20,000
Plant, buildings, and machinery	34,000
	54,000

II.—Development:—

	£
Drainage, main and minor, agricultural preparation of 500 acres - - - - - -	15,000
Running expenses for four years -	14,000
	29,000
III.—Contingencies - - - - -	13,000
	£96,000

16. The Board neither accept nor reject these figures. In particular they cannot judge whether the estimated cost of the land and the cost of agricultural development is reasonable. If, however, the figures are taken as a first approximation to the truth, the burden which would fall on this Department would be limited as regards capital to the expenditure on building and machinery plus a share of "Contingencies," and as regards running expenses to 14,000*l.* over a period of four years, thus:—

	£
Building and machinery 34,000*l.* plus 6,000*l.* for contingencies - - - - - -	40,000
Running expenses for four years, say - -	14,000
	£54,000

17. The Board are of opinion that if satisfactory arrangements can be made for the purchase and holding of a selected bog area, and for the management of an agricultural colony on that area, then the above expenditure on the establishment and running of an experimental station would be justified; for the results obtained ought once for all to clear away the uncertainty which has hitherto prevailed as to the economic possibilities of the bogs of Ireland.

GEORGE BEILBY.
CHARLES A. PARSONS.
R. A. S. REDMAYNE.
R. THRELFALL.

23rd August 1918.

VI

In the second half of September 1918 the report of the Fuel Research Board on the report of the Irish Peat Inquiry Committee was communicated to the Chief Secretary. Correspondence followed between the Irish Office and the Department, as the result of which the Chief Secretary, on March 9th, 1920, in agreement with the Research Department, requested the Vice-President of the Department of Agriculture and Technical

Instruction in Ireland to appoint a committee to examine the agricultural proposals of the Irish Peat Inquiry Committee, as accepted by the Fuel Research Board. The Committee met for the first time on 19th March 1920, and reported on 26th April 1920 as follows :—

Report of the Sub-Committee on Agricultural Matters appointed by the Department of Agriculture and Technical Instruction for Ireland.

SIR,

IN accordance with your request we have examined the various agricultural matters which arise out of the report of the Irish Peat Inquiry Committee and which you referred to us for consideration and report.

We held two meetings, at one of which, in the unavoidable absence of Sir John Griffith, chairman of the Irish Peat Inquiry Committee, Professor Pierce Purcell, M.A., M.A.I., M.Inst.C.E., and George Fletcher, Esq., F.G.S., members of that Committee, were in attendance. We desire to acknowledge the ready and valuable assistance they afforded us.

Our reference required us to examine the Committee's proposals relating to agriculture and the financial estimates in connection therewith. We therefore beg to submit our report under two heads :—

I.—General Observations and Conclusions, and

II.—Observations on the Financial Estimates submitted by the Irish Peat Inquiry Committee.

We would observe that as so much depends upon local conditions we did not find it possible to include in this report detailed financial estimates either for the reclamation, for agricultural purposes, of virgin and cut away bog, or for the establishment of an agricultural colony. We are of the opinion that no such estimates of a reliable nature could be furnished without actual inspection of the bog or bogs proposed to be bought and close investigation of the local conditions. Our report is therefore of general rather than specific application.

I.—General Observations and Conclusions.

These we summarise as follows :—

1. The Labour requirements for Mechanical Peat Winning Operations and their relation to an Agricultural Colony.

We are given to understand that the period during which the proposed peat winning operations call for the employment of the largest number of men extends from February to August. This period synchronises, however, with that during which male labour would be most required for farm work, and during the winter months when such labour might be spared from the farm

it is not required for fuel winning operations. The establishment of an agricultural colony as proposed would not, therefore, effect the main object which the Committee had in mind when making this proposal, namely, the securing of regular and steady employment for male labour throughout the year. We consequently conclude that an agricultural colony is not, and cannot be, complementary to a scheme for the mechanical winning of peat fuel.

2. The Reclamation of Virgin Bog.

We are unanimously of the opinion that in view of (*a*) the greatly increased cost of labour, lime, and manure, and (*b*) the yield and quality of the crops to be expected from reclaimed virgin bog, the reclamation of such bog even where local conditions are most favourable to reclamation, would not be remunerative, although due allowance were made for the increased value of arable land.

3. The Reclamation of Cut-away Bog.

As regards the reclamation of cut-away bog (*i.e.*, the surface left after most of the peat has been removed for fuel purposes), we are of the unanimous opinion that expenditure in connection therewith would, in all probability, be remunerative provided (i) that the cut away bog afforded adequate facilities for drainage, (ii) that a sufficient depth of peat were left by those in charge of the peat fuel winning operations, and (iii) that either the stratum underlying the peat residue consisted of suitable mineral matter, such as marl, limestone, gravel, or clay, with an admixture of sand, or that one or more of these materials were present in close proximity to the cut away bog.

II.—Observations on the Financial Estimates submitted by the Irish Peat Inquiry Committee.

These we summarise as follows:—

1. Purchase of Bog Area.

We fully appreciate and endorse the views of the Committee as to the advisability of acquiring at the outset a large area of bog for the winning of fuel. We understand that, for reasons connected with the peat fuel proposals, the bog area which they propose should be purchased must be portion of the Bog of Allen.

Although, apart from turbary, the main, and in many cases the only, source of revenue from bogs comprised in the Bog of Allen is sporting rights, we are of the opinion from actual experience and in view of information afforded us that even a large area of such bogs could not be purchased at 2*l.* per acre as estimated by the Committee, and that the purchase money would amount to 10*l.* per acre or even more.

We are given to understand that the Committee do not propose to interfere in any way with existing turf banks or turbary rights, and for that reason, and possibly others, the area of 10,000 acres which they propose should be purchased would not encroach on or interfere with the margin of the bog where such rights exist. None of us know of an area of 10,000 acres of bog in one unbroken stretch in the Bog of Allen, but if there be such an area it may be possible to secure it for less than 10*l*. per acre, *i.e.*, for less than the price which we consider the minimum in respect of bogs known to us, and which are typical of many comprised in the Bog of Allen.

2. Cost of Establishment of an Agricultural Colony.

Though we have already indicated that the establishment of an agricultural colony will not secure the purpose the Committee had in view and is, therefore, not complementary to the industry of peat winning by mechanical means, we think it advisable to record the following general observations on the financial aspect of this proposal of the Committee. The expenditure on the establishment of an agricultural colony may be grouped as follows:—(*a*) Dwelling-houses and out-buildings; (*b*) Lands; (*c*) Incidental expenditure on roads, fences, &c., and on live-stock, implements, &c. Under pre-war conditions it would doubtless have been feasible to charge the colonists such rents for their houses and land as would represent reasonable interest on the capital outlay involved or to have adopted the plan of enabling them to purchase their holdings on the instalment (annuity) principle, and thus to have secured repayment of such outlay. The greatly enhanced cost of building and of land renders it now much more difficult to secure in the form of rent a reasonable interest on the requisite capital expenditure or the ultimate recoupment in full of capital expended.

(*a*) *Farm-houses and Out-buildings.*—The only item of the estimate submitted by the Committee which has reference to the provision of houses and offices is one of 5,000*l*. The cost of labour and building materials has greatly increased since the Committee reported, and if, as we understand, the item of 5,000*l*. was to include the provision of houses and offices for the technical and administrative staffs engaged on the winning of peat fuel, it is obvious that this sum would not also provide for much building, if indeed any, required in connection with an agricultural colony.

In a locality situated within, say, 5 miles of supplies of sand and gravel, &c., and within reasonable carting distance of a railway station or canal, the present cost of a moderate and unpretentious farm-house and simple out-buildings (stable, byre, and shed) would, we are satisfied, amount at the very least to 500*l*. Houses and out-buildings alone would, therefore, on the basis of 38 families—which, we understand, is the minimum

size of the agricultural colony contemplated by the Committee —require an expenditure of at least 19,000*l.*

(*b*) *Land.*—Arable land would be required as sites for the dwelling-houses and farm buildings. The estimates make no provision for the purchase of arable land either as sites for houses, &c., or for the colonists' holdings. We are unanimously and strongly of the opinion that the holdings cannot in practice be restricted to bog land, that the main part of the holdings must be on arable land, and that each colonist should be provided with at least 20 acres of arable land. We are also of the opinion that, failing compulsory powers of purchase, it would, as a rule, be extremely difficult, if indeed not impossible, to secure beside, or in close proximity to, the bog the requisite arable land for the colonists, and that, assuming land so situate were available, at least 50*l.* per acre would have to be paid for it in fee simple. This item would, therefore, involve a minimum expenditure of 1,000*l.* per colonist and of 38,000*l.* for a colony of the size previously mentioned.

(*c*) *Other Incidental Capital Expenditure.*—The establishment of a colony such as we contemplate would also involve expenditure on the provision of roads, fences, and, probably, water-supply, and capital would also have to be provided for the requisite live-stock, implements, &c. For these items the estimate makes no provision.

Whilst desiring to see established in Ireland an industry such as that which the Irish Peat Inquiry Committee advocate, we regret that we cannot, for the reasons set out in this report, recommend, as a practical and profitable scheme in association therewith, the establishment of a farm colony for the purpose of reclaiming and cultivating the surface of virgin bog and as a source of labour requisite for the peat winning industry.

We are,
Sir,
Your obedient Servants,
JOSEPH H. HINCHCLIFF, Chairman.
ROBERT DOWNES.
H. FRANKS.
H. R. VEREKER.
SAMUEL WILSON.

To HUGH T. BARRIE, Esq., M.P.,
Vice-President,
Department of Agriculture and
Technical Instruction for Ireland.

26th April 1920.

Copy of Letter forwarding the Report of the Sub-Committee.

Irish Office,
Old Queen Street, S.W.1,
20th May 1920.

DEAR SIR FRANK HEATH,

REFERRING to previous correspondence regarding the proposed agricultural operations in connexion with the Peat Scheme suggested by the Irish Peat Inquiry Committee appointed by your Department, the report of the Committee appointed by the Vice-President of the Irish Department of Agriculture has been received, and Sir Hamar Greenwood, the Chief Secretary, now directs me to send you two copies of this report for your information.

He regrets that the findings of the Committee are not favourable to the suggested establishment of a farm colony in connexion with this scheme.

Sincerely yours,
(Signed) S. WATT.

Sir Frank Heath, K.C.B.

VII

Work undertaken by the Fuel Research Board since the Presentation of the Report of the Irish Peat Inquiry Committee

Since the Irish Peat Inquiry Committee concluded their inquiries in 1918, close touch has been maintained with Professor Pierce Purcell, who had acted as its Secretary, and the Fuel Research Board has continued to finance the experimental work on peat-cutting machines on which he has been engaged. In connexion with this work the Board in July 1919 sanctioned the appointment of Mr. E. J. Duffy, B.Sc., B.E., as Research Assistant to Professor Purcell, and they have now before them an interim report on the research work carried out by him during the period from July 15, 1918, to November 15th, 1919.

It was proposed that Mr. Duffy should undertake as one of the principal subjects of his investigations a research into the properties of machine-formed peat which might have a bearing on its economic winning and utilization. It was originally intended that trial runs with the Dolberg peat macerating and forming machine should be made before the end of the season 1918, but much trouble and delay took place in getting the machine into working order. By the middle of November some successful runs had been made with the machine, and everything appeared to be in good working order. Meantime, however, a hard frost had set in, and it was decided to wait till the end of January 1919 before resuming operations. A Swedish peat machine (Abjorn Anderson), which had been on order since July 7th, 1918, arrived in Ireland towards the end of September 1918. It had been hoped that trials with this machine would

have been carried out before the winter set in, but owing to the long delay, due to war conditions, which occurred in obtaining a special hopper and mouthpiece, which were indispensable, this was impossible.

Towards the end of January the machines and the necessary accessories were ready to start work at Turraun. No sooner was work begun, however, than a dispute between the Turraun Peat Company and their workers occurred, which led to the stoppage of work of all kinds. This labour difficulty lasted till August 1919, and only on the 26th of that month was it possible to make a beginning with the experimental work. Some little progress had been made, though the natural peat-cutting season was practically over by that time.

During the present season (1920) peat has been cut by the machines at Turraun, and air-dried on the bog. It is expected that by the end of the year 100 tons of the air-dried peat will be sent to H.M. Fuel Research Station at East Greenwich for experimental work on its use, directly as fuel, and indirectly as a source of gas, oils, and char.

This work on the winning and use of peat will be continued till data have been collected which will make it possible to come to a considered conclusion as to the technical and economic conditions on which any extensive development of this industry can take place in the United Kingdom.

With the concurrence of the Lord President, Professor Pierce Purcell has been appointed Peat Investigation Officer to this Department. During the summer he visited Canada in order to make himself fully acquainted with the most recent work of Mr. Moore for the Canadian Government on the winning of peat by machinery.

A lecture by Professor Purcell on "The Peat Resources of Ireland" has been printed by this Department as a special report.*

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* "The Peat Resources of Ireland": a Lecture given before the Royal Dublin Society by Prof. Pierce F. Purcell, Assoc. M. Inst. C.E., Fuel Research Board, Special Report No. 2. Price 9*d.* (by post 10½*d.*). Copies are obtainable from H.M. Stationery Office.

Printed under the authority of HIS MAJESTY'S STATIONERY OFFICE
By Eyre and Spottiswoode, Ltd., East Harding Street, E.C. 4,
Printers to the King's most Excellent Majesty.

No. 3. The Coal Fire (*an investigation into the efficiency of open fires*), by Margaret White Fishenden, D.Sc. 1920. Price 4*s*. (by post, 4*s*. 2½*d*.).

TECHNICAL PAPERS:—

No. 1. The Assay of Coal for Carbonisation Purposes. Price 6*d*. (by post, 7*d*.).

No. 2. Report on the Simmance Total Heat Recording Calorimeter. Price 9*d*. (by post, 10½*d*.).

REPORTS OF COMMITTEES OF THE DEPARTMENT

Mine Rescue Apparatus Research Committee. First Report of (*with diagrams and plates*). 1918. Price 2*s*. (by post, 2*s*. 2*d*.).

Mine Rescue Apparatus Research Committee. Second Report of (*with diagrams and plates*). 1920. Price 2*s*. (by post, 2*s*. 2*d*.).

Inquiry Committee on the Standardisation of the Elements of Optical Instruments. Report of. Price 1*s*. (by post, 1*s*. 1½*d*.).

Lubricants and Lubrication Inquiry Committee. Final Report of. Price 2*s*. 6*d*. (by post, 2*s*. 9½*d*.).

TECHNICAL RECORDS OF EXPLOSIVES SUPPLY

No. 1. Denitration of Spent Acids (*in the press*).

No. 2. Manufacture of Trinitrotoluene (T.N.T.) (*in the press*).

No. 3. Sulphuric Acid Concentration (*in the press*).

No. 4. Acid Mixing (*in the press*).

MISCELLANEOUS REPORTS, ETC

Report on the Sources and Production of Iron and other Metalliferous Ores used in the Iron and Steel Industry, by Mr. G. C. Lloyd, Secretary, Iron and Steel Institute. *Revised and enlarged edition*, 1918. Price 2*s*. (by post, 2*s*. 3*d*.).

Monograph on the Constitution of Coal, by Marie C. Stopes, D.Sc., Ph.D., and R. V. Wheeler, D.Sc. (*with plates*). 1918. Price 2*s*. (by post, 2*s*. 2*d*.).

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