

THE PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA



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REPORT

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3rd Mar. 1926

FROM THE

JOINT COMMITTEE OF PUBLIC ACCOUNTS

UPON THE

EXPENDITURE ON OIL EXPLORATION, DEVELOPMENT,
REFINING, ETC., IN THE COMMONWEALTH AND PAPUA.

PART II.—COMPRISING—

SHALE OIL,
POWER ALCOHOL,
LIQUID FUELS, ETC.

NOTE.—PART I.—DEALING WITH:—

OIL EXPLORATION WORK IN PAPUA,
OIL EXPLORATION WORK IN AUSTRALIA.

was presented to Parliament on the 21st August, 1925, and printed as Parliamentary Paper No. 34 of 1925.

JOINT COMMITTEE OF PUBLIC ACCOUNTS.

REPORT ON THE EXPENDITURE ON OIL EXPLORATION, DEVELOPMENT, REFINING, ETC., IN THE COMMONWEALTH AND PAPUA.

PART II.

EXPLANATORY.

The Joint Committee of Public Accounts in presenting this Report desires to intimate that upon its appointment it was made acquainted with the work in hand by the preceding Committee when that Committee's deliberations were interrupted by the dissolution of the ninth Parliament, viz., the preparation of Part II. of the Report on "The Expenditure on Oil Exploration, Development, Refining, &c., in the Commonwealth and Papua". Recognizing the importance of the subject-matter of the investigation, the present Committee resolved to continue and complete the inquiry, and in accordance with the provisions of Section 4 of the *Committee of Public Accounts Act 1913*, the evidence taken before the last Committee has been considered by the present Committee in the preparation of this Report.

INTRODUCTORY.

In Part I. of this Report, presented to Parliament on 21st August, 1925 (Parliamentary Paper No. 34 of 1925), it was indicated that Part II. would comprise the following subjects.

Shale Oil,
Liquid Fuels, Power Alcohol, &c.,
Commonwealth Oil Refineries Ltd.

In view, however, of the debates in the House of Representatives on the Power Alcohol Bounty Bill, and the promise given by the Minister for Trade and Customs (the Honorable H. E. Pratt) that further consideration of the measure would be postponed until the Report of the Joint Committee of Public Accounts on this subject had been received, the Committee deemed it advisable to confine Part II. of its Report to the question of Shale Oil, Liquid Fuels, Power Alcohol, &c., these matters being correlated, and to present a further Report concerning the remaining heading of its inquiry, viz., The Commonwealth Oil Refineries Limited.

COMMITTEE'S PROCEEDINGS.

Since Part. I. of this Report was presented, the following additional witnesses have been examined:—

Noël Kenric Stevens Brodribb, O.B.E., Chief Chemical Engineer, Munitions Supply Board, and Manager of the Cordite Factory, Department of Defence.

August Josef Francois de Bavay, Consulting Chemist, Melbourne.

Willis Gould, Assistant General Manager of the British Imperial Oil Company Limited, Melbourne.

Hugh Hamilton, Director of the Vacuum Oil Company Proprietary Limited, Melbourne.
Melbourne Taubert, Chief Chemist of the Vacuum Oil Company Proprietary Limited, Melbourne;

whilst Archibald Vyvyan Board, Director of the Plane Creek Power Alcohol Co. Ltd., Queensland, and representative of the International Sugar and Alcohol Co. of London; and

William Malcolm Sinclair, M.B., B.S., Director of Power Alcohol Ltd., gave further evidence concerning their respective propositions for the production of power alcohol in Australia.

Further information has also been elicited by the Committee concerning the possibilities of the development of the oil shale deposits of the Commonwealth, and of the production within Australia of liquid fuels and power alcohol from local materials, with a view to determining the best means whereby Australia can be made less dependent upon overseas sources for its oil requirements.

MEMBERS OF THE COMMONWEALTH PARLIAMENTARY JOINT COMMITTEE OF PUBLIC ACCOUNTS.

(Fifth Committee.)

THOMAS PATERSON, Esquire, M.P., Chairman.

Senate.

Senator HATTEL SPENCER FOLL, Vice-
Chairman.
Senator WALTER KINGSMILL.
Senator EDWARD NEEDHAM.

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SYDNEY LANE GARDNER, Esquire, M.P.
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PARKER JOHN MOLONEY, Esquire, M.P.
JOHN HENRY PROWSE, Esquire, M.P.
EDWARD CHARLES RILEY, Esquire, M.P.
The Honorable Sir GRANVILLE DE LAUNE RYRIE,
K.C.M.G., C.B., V.D., M.P.

SHALE OIL.

Recognizing in the oil shale deposits of Australia a potential source for oil supplies, the Committee endeavoured to ascertain the extent and probable oil contents of the shale deposits in the Commonwealth. The figures submitted by various witnesses and derived from official publications vary considerably, but the estimates relating to those areas where more or less development has taken place have been based on detailed examination.

In New South Wales it is estimated that there are 40 million tons of shale, representing 3,500 million gallons of oil, of which 20 million tons or 2,000 million gallons are in the Newnes district.

The Newnes deposit, extending from the Capertee Valley to the Wolgan Valley, is the most extensive yet developed, being proved over an area of 5,000 acres, the thickness of the seam varying from 14 inches to 50 inches. The New South Wales shale is stated to be one of the richest shales in the world, containing from 60 to 150 gallons of oil to the ton, and averaging in actual distillation about 101 gallons. Large quantities have in the past been exported for use by gas manufacturers. The quantity of shale mined in that State from 1865 to 1924 has totalled 1,919,685 tons, the annual amount varying considerably.

In Tasmania the reserves, and probable reserves of shale, are set down at 42 million tons, or 1,700 million gallons of oil; the Mersey Valley representing 10 million tons of actual reserves, and 27 million tons of probable reserves, or 1,000 million gallons of oil. The occurrence of shale in Tasmania has been known for about 50 years, and development work has been proceeding, but in a desultory manner, for the past twenty years. Although the oil content of the Tasmanian shale, generally called Tasmanite, is not so high as that of the New South Wales shale, averaging only about 40 gallons to the ton, the deposits are more accessible and more easily mined, and it is considered that from a commercial stand-point their development should be more favorable on account of the probable lower working costs.

Although deposits of shale are known to exist in Queensland, South Australia, and Western Australia, little or no attention has been paid to their development, and their extent and probable oil contents are as yet unestimated.

In Victoria there are said to be no oil shale deposits.

Evidence heard by the Committee showed that efforts made from time to time to establish the shale oil industry in Australia had not been a commercial success, the failure in most instances being attributed to lack of capital, the high cost of working, and the difficulty of obtaining retorts suitable for the different nature of the shale in the various localities. This experience of the industry has not been confined to Australia, for although many countries possess rich oil shale deposits, oil from that source has only been produced in any quantity in Scotland, where, as a matter of fact, the industry depends largely for its revenue on the sale of sulphate of ammonia.

In New South Wales numerous companies dating back to 1895 have undertaken the production of oil from shale, but at present the only concerns more or less active in this State are the Newnes Shale Oil Works (to which further reference is made later in this Report) and the Crown Ridge mine at Capertee, where a small retort has recently been working.

In Tasmania, some years ago, one company produced about 100,000 gallons of oil, which was stated to have given favorable results as a motor fuel; whilst another company retorted 11,000 gallons.

Owing to the prominence which has lately been given to the question of oil supplies in Australia, attention is however again being directed to the local shale oil industry. At the time of the visit of the Public Accounts Committee to the Mersey Valley, Tasmania, in March, 1925, extensive works were in course of erection for the Tasmanian Cement Company, which proposed to combine the manufacture of cement with the retorting of shale and the production of oil, primarily to supply fuel for the works, but subsequently for marketing. Since that time, however, it has been decided by the Company not to proceed, for the present, with the shale oil project. Preliminary work was at that time also being conducted by the Australian Shale Oil Corporation Limited, which, under an agreement with the Tasmanian Government, had to complete before 30th June, 1926, the installation of plant capable of treating 180 tons of shale per 24 hours, and to have working before 30th June, 1930, plants capable of treating 1,000 tons each day. The Southern Cross Motor Fuel Company, at whose works the Committee witnessed the retorting of a small parcel of shale in an experimental plant, has recently been reconstructed with a view to increased activity.

Having regard to the quantity of oil actually produced, the most important effort to establish the shale oil industry in Australia has been that of the Commonwealth Oil Corporation Limited, which was formed in London in 1905 with a capital of £800,000, for the purpose of working certain shale deposits in New South Wales. In the following year the Company acquired the properties and plant of the New South Wales Shale and Oil Company at Hardley Vale and

Genowlan. Several tunnels were driven into the shale seam at Newnes and in the Capertee Valley, and a treatment plant was installed in the Wolgan Valley, a deep narrow gorge in the Blue Mountains, to which the Company had to construct a narrow-gauge railway of 32 miles with severe gradients. A bench of Scotch retorts capable of treating about 100 tons of shale a day was erected, but owing to the entirely different characteristics of the Australian shale as compared to the Scotch shale, the retort had to be remodelled before the material could be successfully treated. Owing to the isolated locality in which the works had been erected, much extra expense was incurred, with the result that the total expenditure ultimately amounted to £1,796,800. The works operated for a time, and when the first destroyers arrived in Australia in 1911, about 50,000 gallons of fuel oil were supplied to the Navy by the Commonwealth Oil Corporation Limited. This oil, it was stated by the Naval Secretary, was an excellent article, and was supplied at a very moderate price. In February, 1912, however, the works were closed down for about three years. Subsequently the Commonwealth Oil Corporation Limited went into liquidation. Mr. David Fell was appointed Receiver in New South Wales, and Mr. John Fell was called in to give assistance as an oil refinery expert. In 1914 Mr. John Fell took over the concern, and became Managing Director of the Commonwealth Oil Corporation Limited: he now holds a first mortgage over the whole of the assets of the Company, the capital of which has been written down to £433,338. The plant at Newnes is the largest of its kind in the southern hemisphere, and has a capacity of 30 million gallons of oils per annum.

In giving evidence before the Public Accounts Committee, Mr. Fell pointed out that as a result of economic and labour conditions, together with unfair competition through large quantities of mineral oils being allowed in free of duty owing to the wording of the Tariff, and the effect of the agreement between the Commonwealth Government and the Anglo-Persian Oil Company for the establishment of the Commonwealth Oil Refineries Ltd., the works and mines at Newnes were closed down again in January, 1923, and, with the exception of the refinery, which treated imported crude oil from March, 1923, to September, 1924, they have not since operated.

During the periods of their activity, viz., from 1909 to 1912, and from 1915 to January, 1923, these works have produced 25,260,015 gallons of crude oil and crude naphtha, from which were derived the following products:—

Refined Products—					Gallons.
Gas Oil	..	..	..	..	13,915,065
Kerosene	..	..	..	..	3,136,670
Lubricating Oil	..	..	..	..	2,316,126
Motor Spirit	..	..	..	..	1,689,279
Power Kerosene	..	..	..	..	743,380
Total Refined Oils	..	..	..	..	21,800,520

By-Products—					Tons.	Cwt.	Qrs.
Paraffin Wax	..	..	..	..	230	15	0
Oil Coke	..	..	..	..	307	6	3
Oil Pitch	..	..	..	..	528	18	0
Sulphate of Ammonia	..	..	..	..	718	7	0

The disastrous effect of the closing of such works consisting of shale and coal mines, power plant, retorts and complete distillation plant for the preparation of refined products from the crude oil, as well as the railway, the locomotives and rolling stock, can only be properly appreciated by a personal inspection. At the time of the Accounts Committee's visit, December, 1924, the shale mine was falling into decay, the drives were gradually closing in, and the works generally, including the railway, were rapidly deteriorating for want of use and through absence of proper maintenance. As a result of its inspection the Committee was impressed by the urgent necessity for early action being taken to prevent further loss, as it was apparent that the longer such a state of affairs continued the more expensive it would be to remedy it.

As the losses during the recent years of inactivity had amounted to over £80,000, and were continuing at the rate of £1,000 per month, Mr. Fell intimated to the Committee that he was appealing to the Commonwealth Government for assistance on the grounds that the industry was of national importance and a vital necessity in time of war or other emergency.

Recognizing the need for early action, the Joint Committee of Public Accounts, on 5th January, 1925, addressed the Prime Minister as under:—

"Pending the discovery in Australia of mineral oil in commercial quantities, it appears to the Committee that the most potent source for the supply of Commonwealth requirements from within its own shores lies in the exploitation of its vast deposits of oil shale.

"As you are already aware, the shale oil industry has been established for some years at Newnes, New South Wales, where the Commonwealth Oil Corporation Limited (John Fell and Co. Ltd.) erected extensive works which, however, are not being operated at the present moment. The evidence heard by the Committee and its own observations during a recent visit to Newnes indicated that unless early action is taken to place this industry on a satisfactory basis, there is a possibility that these works will soon be rendered practically useless. The Committee recognizes in the works at Newnes a national asset which, in time of emergency, may become vital to the protection of the Commonwealth, and it therefore recommends that definite and immediate steps be taken to prevent such an asset from becoming worthless."

Meanwhile, Mr. Fell had approached the Prime Minister, and in December, 1924, made a proposition that the Government should take over 51 per cent. of the Company's capital and enter into a partnership agreement on the same lines as that existing between the Commonwealth Government and the Anglo-Persian Oil Company Limited for the constitution of the Commonwealth Oil Refineries Limited.

Mr. Fell was informed by the Prime Minister that the Government was averse to entering into a partnership as suggested, but recognizing the national importance of having an oil supply within the Commonwealth, it might see fit to help the industry if a concrete proposition could be evolved.

On the 20th January, 1925, Mr. Fell asked that the Commonwealth Government would guarantee an overdraft at the Commonwealth Bank, but on 6th March, 1925, the Prime Minister informed Mr. Fell by telegram as follows:—

"Referring your telegram fifth March Government to-day considered your request that it should either make a direct advance or guarantee an advance by the Commonwealth Bank for the purpose of assisting the carrying on of the shale oil industry at Newnes. It was decided that the making of an advance cannot be approved by the Government for the reason that advances to individual concerns is a matter for financial institutions not the Government. Recognizing however the importance of the provision of an adequate supply of oil for Australia Government is prepared to consider any proposals you may put forward which will ensure the continuance of the industry at Newnes provided the action required falls within the functions which can be legitimately carried out by the Government."

On the same date the Prime Minister, in replying to the letter of the Public Accounts Committee, communicated the Government's decision concerning Mr. Fell's offer, and concluded with the following request:—

"As, however, the Committee has been making extensive inquiries into oil, and have actually made an examination of these works, and are familiar with the problem which the question of the continuation of the works presents, the Government would greatly appreciate any suggestions which the Committee may be in a position to make with the object of ensuring the continuation of the industry in any way which does not involve the making of monetary advances by the Commonwealth Government to a private firm."

After further considering this matter, the Committee replied to the Prime Minister on 23rd April, 1925, as follows:—

"Referring to your communication of the 6th ultimo, and following on mine of the 11th idem, I have now the honour to convey to you the views of my Committee as to the means which might be adopted to ensure the continuation of the shale oil industry."

"A review of the history of the industry in Australia and elsewhere indicates that so long as ample supplies of mineral oil are available the production of oil from shale cannot be regarded seriously as a commercial undertaking, because the conditions of competition are too unequal. Even with the assistance already given by way of bounties and duties, the industry has not flourished, and it is not surprising that capital has been difficult to obtain, and that financial institutions are not favourably disposed to help it."

"Recognizing the limitations of this industry when regarded purely as a commercial proposition, the Committee approached the matter from the Defence aspect, and a careful study of statements prepared for the confidential information of the Committee by the Defence authorities—Navy, Army, Air, and Munitions—concerning Australia's oil requirements under peace and especially war conditions leaves no doubt about the urgency and necessity for the encouragement of the internal production of oil."

"The presence of ample supplies of flow oil within Australia has yet to be proved, whereas rich and extensive deposits of oil shale are known, and in some instances facilities are available for their immediate development. The manufacture of power

alcohol and other liquid fuels from vegetable crops, coal, and other sources offers a partial solution of the problem so far as supplies of petrol and the lighter motor spirits are concerned, but in the event of overseas supplies being interrupted it will remain for the shale to provide the equally essential heavier classes of oils—such as fuel oil for the Navy and the Munitions Factories and lubricants demanded by all Services."

"Although our previous correspondence has referred specifically to the shale oil works at Newnes, the Committee recognized, from the outset of its deliberations, that any further Governmental assistance accorded the industry must be available to all who are making bona fide efforts to produce oil from our shale. My Committee has been unable, however, to arrive at a unanimous decision as to the best means by which such assistance should be granted. I therefore submit for your information the following alternative proposals, any one of which, it is considered, will offer a solution of the problem:—

- (a) The Commonwealth Government should as soon as possible make available a sum of money—not less than £100,000—for the encouragement, assistance, and development of the shale oil industry for the purpose of our national defence. This money should be advanced to applicants only after thorough examination of claims submitted, and be repayable on suitable terms under a mortgage or lien to be taken over the applicant's assets and the results of his operations.
- In view of the special circumstances surrounding the Newnes proposition, a sufficient portion of this sum should be immediately made available, under the conditions indicated, to enable the mine to be put in order, the plant reconditioned, and the works generally brought to a production basis. Care should be taken that operations are so conducted that the value of the works from a Defence standpoint is not lessened.
- It might here be mentioned that out of the sum of £270,000 appropriated by the *Shale Oil Bounty Act 1917-1923* for the payment of bounty on shale oil produced in Australia an amount of £144,644 is still available.
- (b) Money for the above purpose could be made available under the Defence Estimates in the form of a grant, with conditions governing the operations of the various works which would ensure adequate supplies in an emergency.
- (c) The control of the shale oil deposits in Australia could be taken over and vested in the Commonwealth Government. It might be added that the Navy Department of the United States of America holds, in reserve, large areas of oil shale.
- (d) The Commonwealth could acquire a controlling interest in the Newnes or other shale works by means of a partnership agreement on the lines of that entered into between the Commonwealth Government and the Anglo-Persian Oil Co. Ltd., but provision should be made for the Commonwealth to have a majority on the Board of Directors and to hold a majority of the shares.

In acknowledging this communication on 1st May, 1925, the Prime Minister intimated that he proposed to ask the Conference of Geologists, which was then being convened (see Report by the Joint Committee of Public Accounts on Expenditure on Oil Exploration, Development, Refining, &c., in the Commonwealth and Papua, Part I, page 15, Parliamentary Paper No. 34 of 1925), to consider the question how best the Commonwealth could assist financially or otherwise in the promotion of the production of fuel oil in Australia. Upon receipt of the report of this Conference, the Prime Minister added, the whole question would again be carefully considered by the Government in connexion with the proposals of the Accounts Committee, and any action that might be necessary or desirable would be taken as early as possible.

A perusal of the Resolutions of this Conference, however, showed that the sole reference to oil shales was a short addendum to recommendations concerning the search for oil in Australia, to the effect that the present provision for a bounty under the *Shale Oil Bounty Act* should be continued. The Committee thereupon directed the Prime Minister's attention to this fact on 2nd July last, and again urged the Government to give serious consideration to the proposals already put forward. No further communication on this subject has been received by the Committee from the Prime Minister, nor has there been, to its knowledge, any recent action by the Government to help this important industry.

Subsequent to the Committee's visit to Newnes, and to its recommendations to the Prime Minister, Dr. Arthur Wade, petroleum technologist, visited the Wolgan Valley district and inspected the shale deposits and the works. Special reference thereto is contained in his Report on Petroleum

Investigations in New South Wales (Parliamentary Paper No. 38 of 1925). Dr. Wade's concluding paragraph strongly supports the Committee's opinion that the oil shale deposits of Australia are a vital asset, and should be developed and conserved:—

"I should like to point out that in the long run these kerosene shales may be more profitable to Australia than oil wells, especially if only small wells and limited pools be eventually discovered. Moreover, there is no certainty that such pools will be discovered. In the meantime, the amount of shale can be ascertained definitely; we can find out what our resources are, what can be done with them, and make plans accordingly. Beds of kerosene shale are not so erratic and uncertain as oil wells. Water troubles and careless drilling will not affect them. They remain where they are, and will not "peter out" when most wanted, as oil wells sometimes do. Their profitable development will depend upon research and business methods, and not so much on wild-cat speculation. I consider them to be one of the greatest assets that Australia possesses, and the day of their very great importance may yet come."

SHALE OIL BOUNTIES.

In an endeavour to foster and encourage the shale oil industry in Australia, the Commonwealth Parliament has from time to time granted assistance by means of bounties, particulars of which are enumerated.

The *Shale Oil Bounties Act 1910* appropriated the sum of £50,000 during the three years commencing on 1st July, 1910, for the payment of bounties of 2d. per gallon on Kerosene and of 2s. 6d. per cwt. on Refined Paraffin Wax, the products to be manufactured from Australian shale. The full amounts claimed and paid under this Act were as follows:—

	Kerosene.	Paraffin wax.
Commonwealth Oil Corporation Limited, Newnes ..	£4,165	£2,299
British Australian Oil Company, Murrurundi ..	£2,328	£137

The period during which these products were required to be manufactured in order that bounty might be claimed expired on 30th June, 1913, and it was not extended.

In 1914 and 1915 the Interstate Commission of Australia conducted an investigation into the shale oil industry, and concluded that a bounty on crude oil would be more satisfactory than on kerosene and wax. It accordingly recommended a bounty of 1d. per gallon on crude oil, the product of kerosene shale mined in Australia.

In 1917 the Shale Oil Bounty Act was passed, under which £270,000 was appropriated for the purpose of paying a bounty in respect of the production in Australia of crude oil from mined kerosene shale, for a period of four years from 1st September, 1917, the rate of bounty being 2½d. on each gallon up to 3,500,000 gallons, 2d. on each gallon exceeding 3,500,000 gallons and not exceeding 5,000,000 gallons; 1½d. on each gallon exceeding 5,000,000 gallons and not exceeding 8,000,000 gallons; and 1d. on each additional gallon. During these four years, 9,719,723 gallons of crude oil were produced, the total amount of bounty paid being £91,122.

In 1921 the period during which bounty would be paid was extended for another year, during which time 2,559,987 gallons were produced, the bounty paid being £24,000.

A further extension of one year was made in 1922, and the rate of bounty previously provided for, viz., 2½d. per gallon of crude oil up to 3,500,000 gallons, was increased to 3½d. per gallon.

Up to the end of January, 1923, when the works at Newnes closed down, 688,053 additional gallons were produced, the bounty amounting to £10,034, making the total production 12,967,762 gallons of crude oil and total bounty paid £125,156, all of which was drawn by John Fell and Company. This crude oil was refined in Australia, and the following products were obtained:—

	Approximate Quantity.
Gas oil	7,744,869 gallons
Kerosene	2,163,132 "
Motor spirit	1,014,786 "
Grease oil	413,505 "
Axle Oil	65,745 "
Pitch	110,835 "

By the *Shale Oil Bounty Act 1923*, a further three years' extension was made, the bounty now being payable up to 31st August, 1926.

In January, 1925, bounty amounting to £335 8s. 4d. was paid to Messrs. W. H. Vidler and Sons in respect of 23,000 gallons of shale oil produced by them at Capertee, in New South Wales.

An amount of £144,508 is therefore still available for the payment of bounty on shale oil, which may be produced up to the 31st of August of the present year.

When the Tariff Board reported on the industry in July, 1922, the conclusion arrived at was that the withdrawal of the bounty at that time would certainly lead to the closing down of the shale mines and the retorts. It was considered that, should it be desired to re-start production at Newnes at any future date, an initial outlay of at least £40,000 would be required to repair the retorts and clear the mines under the most favourable circumstances. At that time the works were employing up to 420 men, and were producing a primary product urgently required by Australia. It was on the Board's recommendation that the amount of bounty was increased from 2½d. to 3½d. per gallon, and the period extended to August, 1926.

Evidence heard by the Public Accounts Committee was unanimous that the continuance of the Commonwealth bounty was essential to the conduct of the industry.

POWER ALCOHOL.

In March, 1917, the Advisory Council of Science and Industry appointed a Special Committee to inquire into and report on the production and utilization of power alcohol in Australia. The members of this Committee were:—Professor Sir Thomas R. Lyle, F.R.S., Chairman; Mr. T. Baker, Managing Director, Kodak Ltd., Melbourne; Mr. W. Russell Grimwade, B.Sc., Manufacturing Chemist, Melbourne; Dr. G. Harker, D.Sc., University, Sydney; Professor W. N. Kernot, M.I.C.E., University, Melbourne; Mr. H. V. McKay, C.B.E., Sunshine; and Mr. G. Lightfoot, M.A., Institute of Science and Industry, and, in submitting an interim report to the Prime Minister in December, 1917, they pointed out that the production and utilization of power alcohol in Australia do not depend solely on results which can be achieved by scientific or technical investigations, but also on economic and fiscal considerations, on the profitable production of raw materials for the manufacture of alcohol, on the return obtainable through its manufacture, as well as on the co-operation both of engineers in the manufacture of efficient alcohol engines and of the users of internal combustion engines.

This Report was published in 1918 as Bulletin No. 6 of the Institute of Science and Industry and was reprinted in 1921, with an addendum by Mr. G. Lightfoot, as Bulletin No. 20.

This publication contains much information concerning the production and utilization of power alcohol in Australia and its development in other countries, but some of the figures and calculations therein concerning costs now require adjustment, in view of the altered economic conditions and lower prices for petrol.

In evidence before the Public Accounts Committee, Mr. Lightfoot briefly summarized the conclusions reached by this Special Committee, and contained in Bulletin No. 20, as follows:—

General.—The world's supplies of liquid mineral fuels are limited, and in view of the rapidly increasing demand there is likely to be a world's shortage before many years. It is probable that as the supplies diminish and the demand increases the price will rise.

Enterprises for the production of mineral oils in Australia have not so far proved successful. Climate, conditions in this country are, however, favorable for the growth of plants containing sugars and starch from which alcohol can be manufactured. Alcohol is in every way suitable for use as a liquid fuel and possesses certain advantages over petrol, viz.:—

- (a) Smoother running.
- (b) Absence of carbonization.
- (c) Absence of unpleasant exhaust.
- (d) Greater safety from fire, owing to miscibility with water.

There are no scientific or technical difficulties in the way of the production and utilization of power alcohol. The whole problem is one which involves questions of an economic, commercial, and fiscal nature.

The question of the utilization of power alcohol on an extensive scale in Australia is naturally divided into three separate main problems, viz.:—

- (a) The production of alcohol.
- (b) The utilization of alcohol.
- (c) Excise regulations and denaturation of the alcohol.

Production.—By far the most suitable raw material at present available for distillation purposes is the sugar molasses now wasted in Queensland and the northern parts of New South Wales. If the total annual quantity of molasses wasted and used for purposes other than distillation (47,500 tons) were used for the purpose in view, it would be sufficient to manufacture about 3½ million gallons of alcohol. On the basis of a yield of 65 gallons of spirit per ton of molasses, if the molasses could be obtained at 20s. per ton, the cost of the raw material required for 1 gallon of alcohol would be about 3½d.; adding the sum of 7d. per gallon for distillation costs the spirit could be produced at the distillery (undenatured) at a price of 10½d. per gallon.

Even if the whole of the molasses now wasted were used for power alcohol, it would not be practicable from that source to supply more than a fraction of the total liquid fuel requirements of the Commonwealth. If, therefore, alcohol is to be distilled on a large scale in the Commonwealth, it will be necessary to find other raw materials. The most important requirements in connexion with suitable raw materials for distillation purposes are:—

- (a) Constant and abundant supply.
- (b) Price.
- (c) Percentage of sugars or starches.
- (d) Ability to stand carriage and storage without deterioration.
- (e) Unsuitability for use as food-stuff or for some purpose other than distilling.
- (f) Suitability for fermentation.

For one or more of the reasons specified above, certain materials, such as wheat, barley, waste fruit, potatoes, and prickly pear are at once ruled out of court as suitable raw materials. On the other hand certain materials, such as cassava, sorghum, and sweet potatoes, offer favorable opportunities as a source of alcohol. The question as to whether any particular raw material can be used profitably for the distillation of power alcohol depends of course on a number of factors, each of which would have to be examined thoroughly before the practicability of any particular scheme could be determined. These factors are—

- Price at which raw material could be delivered at distillery.
- Distillation costs.
- Cost of denaturation.
- Distiller's profits.
- Cost of packages and distribution.
- Retailer's expenses and profits.
- Retail price obtainable for power alcohol.

These costs will, of course, vary in different cases. Assuming that the retail price is to be 2s. 3d., and allowing 1d. per gallon for costs of distillation, denaturation, and distiller's profit, 7d. per gallon for costs of packages and distribution, and 4d. per gallon for retailer's expenses and profits (total costs and profits 1s. 6d.), the distiller could not afford to pay more than 6d. for the raw material required for 1 gallon of spirit.

On this basis, and on the basis of the average yields of alcohol obtainable from various raw materials, the following are the prices which the distiller could pay:—

Prices Payable for various Raw Materials on Basis that Raw Material for 1 Gallon of Spirit must not exceed 6d.

Raw Material.	Yield of Alcohol (40 per cent) in Gallons Per Ton.	Price Payable Per Ton.
		£ s. d.
Maize	85	2 2 6 (= 1s. 3d. per bushel)
Wheat	83	2 1 6 (= 1s. 1½d. per bushel)
Barley	70	1 15 0
Cassava	39	0 19 6
Artichokes	22	0 11 0
Potatoes	20	0 10 0
Sugar Beet	18	0 9 0
Sorghum (Sweet)	12½	0 6 3
Sorghum (Grain)	87	2 3 6
Sweet Potatoes	35	0 17 6

Of the crops which appear to offer possibilities for cultivation as a raw material for the distillation of power alcohol, cassava is not at present grown at all in Australia, sweet sorghum is grown in Victoria and certain other States by farmers for the purposes of feeding stock, sorghum grain has as yet been grown only experimentally (in New South Wales), while sweet potatoes are grown only for use as a foodstuff mainly in Queensland and parts of New South Wales. As the crops mentioned are either not grown at all, or are grown only on a small scale in this country, it is difficult to state definitely whether they could be cultivated profitably as a raw material for distillation purposes. If some stimulus or inducement were offered for the manufacture of alcohol, it appears that there is a favorable opportunity for the establishment of a new and important industry in the Commonwealth.

The development of the cultivation of crops for power alcohol is likely to play an essential part in a complete agricultural policy. It may lead to the cultivation of areas unsuited for other crops, and may assist in the settlement of unoccupied areas of Australia. It is important to observe that the spent mash from the distilleries could be used either for manurial purposes or for stock feed, and the agricultural values of the land would thus be retained.

Utilization of the Alcohol. Experiments, both in Australia and other countries, have shown conclusively that alcohol can be used with entire success in internal combustion engines. The calorific value of alcohol is 14,000 B.T.U. per lb., compared with 18,500 B.T.U. for petrol; but, owing to the greater degree of compression that can be used with alcohol without danger of pre-ignition, a thermal efficiency of 30 per cent. could be obtained in a properly designed alcohol engine, as against 20 per cent. in a petrol engine. The result is that in spite of the fact that the calorific value of alcohol is much less than that of petrol, in a properly designed alcohol engine alcohol could compete successfully at a price of about 2s. 3d. per gallon with petrol used in a petrol engine at 2s. 6d. per gallon.

On the other hand, if alcohol is used in existing types of engines, it would be necessary to use about 33 per cent. more alcohol than petrol. In other words, when used in existing types of petrol engines, alcohol should not cost more than 1s. 10½d. per gallon to compete with petrol at 2s. 6d. per gallon.

The general custom, however, in other countries where alcohol is used is not to use it alone, but to mix it with other fuels, and when this is done a satisfactory and economical fuel is obtained. For example, in France, Germany, England, the Philippines, and other countries alcohol is used in admixture with such fuels as ether, benzol, petrol, &c.

Excise Regulation and Denaturation. Government regulation of the distillation process (which is necessary in order to protect the revenue) results in an increase in the price of the alcohol. In Great Britain, France, and Germany, the principle has been adopted of granting rebates or bonuses on power alcohol, as it is considered that if alcohol is to compete with imported mineral oils, it is only reasonable to counteract by way of an allowance or bonus the burden which fiscal restrictions impose on its manufacture.

Accurate information as to the extent to which the price of alcohol is enhanced in Australia by reason of government regulation is not available, but on the basis of British experience it is estimated at 6d. per gallon. This estimate has been confirmed by independent inquiries made in Australia. As the margin between the price at which power alcohol could be placed on the market and the price of petrol is small, the sum of 6d. per gallon may very well make all the difference between profit and loss and in attracting the necessary capital for the establishment of an industry of national urgency and importance.

Of the sum of 6d. about 3d. is due to the extra cost caused by fiscal restrictions on the manufacture of alcohol, the remaining 3d. being due to the cost of denaturation under the *Spirits Act 1906*.

Recommendations by Committee.—The Committee recommended—

- That regulations be passed to permit of power alcohol being denatured with 2 per cent. of certain raw materials.
- That an allowance of 3d. a gallon be granted by the Commonwealth Government on power alcohol manufactured in Australia by way of reimbursement of the extra cost caused by fiscal restrictions.
- That a bonus of 3d. a gallon be granted on power alcohol, in order to encourage its manufacture and to develop the primary industries on which a supply of the necessary raw material depends.

These recommendations were confirmed by the Executive Committee of the Advisory Council, and transmitted to the Commonwealth Government.

The Institute of Science and Industry was advised by the Department of Trade and Customs in July, 1920, that the Commonwealth Board of Trade, after considering the recommendations, had decided that it would be unwise to relax the denaturation regulations, and that a bonus on power alcohol could not then be justified; but further representations by the Institute resulted in the Board of Trade reconsidering the question.

In October, 1920, the Institute of Science and Industry convened a conference of persons specially interested in the production and use of motor fuels and manufacturers of motor bodies, accessories, internal combustion engines, &c. This conference endorsed the recommendations of the Institute as contained in Bulletin No. 20, and urged the Commonwealth Government to give effect to them.

The Conference decided also to establish a fund for the purpose of investigating the production of motor fuels in Australia, and suggested that contributions to the fund be made up on a pound for pound basis up to a limit of £5,000 each by the Commonwealth Government and the users and trade interests concerned. The Executive Council of the Institute endorsed the proposal, and recommended the Commonwealth Government to grant up to £5,000 for this purpose. The recommendation was not, however, approved by the Government.

During recent years various efforts have been made to float companies in Australia for the production of power alcohol, but without success. It was stated, however, that there would appear to be little difficulty in establishing the power alcohol industry in Australia by using molasses as the raw material, but as the quantity of spirit which could be produced under existing conditions would not meet one-twenty-fifth of Australia's demands, it was necessary to direct attention to other sources of raw material, such as the cultivation of certain starch-bearing crops which offer possibilities in the production of alcohol. But as suitable raw materials are either not yet cultivated at all in Australia, or are cultivated only on a comparatively small scale, and as the margin of profit available when using such materials for the distillation of power alcohol will initially, at any rate, be small, it would probably be necessary to afford certain facilities and inducements to attract the requisite capital and enterprise. Nevertheless, motor fuel derived from molasses has been manufactured and used in Australia.

The Colonial Sugar Refining Company Limited has manufactured from Australian and Fijian molasses alcohol motor fuel when it has had available a temporary surplus of alcohol, after providing adequate supplies for all ordinary industrial and household purposes within the Commonwealth and New Zealand. This product has been marketed under the name of "Alkol," and contained 10 per cent. benzoline, 1 per cent. wood naphtha, and ½ per cent. pyridine. In all, only about 150,000 gallons have been manufactured, the quantity produced during the past four years being:—

1922	22,186 gallons.
1923	39,036 "
1924	6,009 "
1925	38,426 "

The Company pointed out that it is only since the scale of its operations at Pyrmont has been enlarged that sufficient alcohol has become available for again marketing "Alkol," and added that it has only been used on what might be classed as an experimental scale within the Commonwealth, though it has been thoroughly tested out on a large scale in Fiji.

At the Commonwealth Government Acetate of Lime Factory, Brisbane, the manufacture of alcohol fuel has been carried on for some time. This factory was established during the war to ensure a supply of acetone, an essential raw material for the manufacture of cordite—acetone being produced from acetate of lime, which is derived from molasses. In 1919–20 portion of the stock of molasses was utilized for the production of alcohol, which is also used in the preparation of cordite and other munitions. Two years later, when accumulated stocks of acetate of lime were sufficient to meet peace-time requirements for a number of years, all the molasses available for the factory was diverted to the production of alcohol. Some of this spirit was methylated and sold to hospitals and other users, but subsequently it was proposed to utilize the spirit in the

manufacture of alcohol fuel for supply to Commonwealth Departments. This course was approved by the Government in January, 1924, as it would ensure the proper maintenance of the factory plant and buildings, and permit of the retention of the services of the trained staff, and generally assist in maintaining the factory as an effective munitions unit.

As it was known that greater efficiency could be obtained in ordinary motor engines by a blended fuel than by alcohol alone, it was proposed to mix the alcohol produced at the factory with ether, to be manufactured from such alcohol at the factory and with benzol procured from the Newcastle Steel Works. Numbers of experiments and severe road trials with mixtures containing different proportions of alcohol, benzol and ether were conducted with satisfactory results, and in August, 1924, the factory commenced supplying the Postal Department in Melbourne. Up to the end of 1925 the Factory has manufactured approximately 138,000 gallons of alcohol fuel, which were distributed as follows:—Postal Department, 112,000 gallons (Melbourne 96,000 gallons, Brisbane 16,000 gallons); Royal Australian Air Force, 14,000 gallons; Cordite Factory, 11,000 gallons; and Small Arms Ammunition Factory, 1,000 gallons. The alcohol fuel at present being used comprises:—alcohol, 67½ per cent.; benzol, 22½ per cent.; and ether, 10 per cent.; to which is added, as a denaturant, ½ per cent. pyridine. Until 30th June last there was also added, as a denaturant, 1 per cent. wood naphtha in accordance with the Spirits Regulations, but as the fuel is for Departmental purposes only, the use of wood naphtha has been waived.

According to Mr. N. K. S. Brodribb, Chief Chemical Engineer of the Munitions Supply Board and Manager of the Cordite Factory, which establishment controls the Acetate of Lime Factory, the costs of the raw materials comprising the alcohol fuel and of the raw materials in the fuel itself are as under:—

Material.	Cost per gallon.	Percentage in the Mixture.	Cost in the Mixture per gallon.
	Pence.		Pence.
Alcohol	10.56	67.5	7.10
Benzol	24.0	22.5	5.40
Ether	16.16	10.0	1.62
Denaturant (pyridine)	264	0.25	0.06
			14.78

or, say, a total of 1s. 2½d. per gallon of alcohol fuel represents the cost of the raw materials used in its manufacture.

The cost of the alcohol, 10.56d. per gallon, is based on a price of £2 15s. per ton for molasses, viz., average cost at the mills, £1; freight and handling at Cairns, 10s.; steam freight Cairns to Brisbane, £1 5s. The ether is manufactured in small plants installed on a nucleus, and not on a commercial basis, at the Acetate of Lime Factory at Brisbane and at the Cordite Factory, Maribyrnong, Victoria, and in consequence operating costs are high, viz., 2.08d. per gallon, exclusive of depreciation and interest—labour representing 1d., or nearly 50 per cent. As 4 gallons of alcohol are required to produce 3 gallons of ether, the cost of the material used in the manufacture of ether equals four-thirds of 10.56 pence, or 14.08d. per gallon—making the total cost of ether 16.16d. per gallon. The benzol is obtained from the Newcastle Steel Works at 2s. per gallon, and the pyridine from the Australian Gas Light Company of Sydney at 22s. per gallon. The mixture is consequently composed of all Australian ingredients, and it has been found to give an average efficiency of 75 per cent. of petrol used without any special attachment to the ordinary motor engines.

Experiments have also been conducted with a mixture comprising alcohol 50 per cent. benzol 40 per cent., and ether 10 per cent., and have given up to 90 per cent. efficiency as compared with petrol, but from the factory stand-point the mixture containing the greater proportion of its own manufacture is considered the more desirable. It might be explained that the Departments using the alcohol fuel supplied by the Acetate of Lime Factory pay only the equivalent price of petrol based on the relative mileage efficiency of the two fuels, as it was not intended that the product was to compete with petrol.

In submitting these costs to the Committee the witness explained that the Factory is being maintained on a nucleus basis only, and that although the Factory can make and blend 250,000 gallons per annum, it is working at only 50 per cent. of its rated capacity.

Discussing the question of the production of power alcohol generally, Mr. Brodribb was of opinion that it was not an economical proposition unless the output amounted to one or two million gallons, and further, that such production should be developed in definite areas so as to

avoid the heavy costs of distribution, and the difficulties attending the interchangeability of alcohol and petrol in motor vehicles. These difficulties, it was stated, do not occur in the case of alcohol blended with benzol, or with benzol and ether.

When in Brisbane in December, 1924, there appeared before the Public Accounts Committee, Mr. A. V. Board, representing the International Sugar and Alcohol Company of London, a company founded by the Distillers Company Limited, for the purpose of dealing with the production of power alcohol within the Empire. This Company had already carried out extensive research and experimental work, and at the invitation of the former Premier of Queensland (Mr. E. G. Theodore) was investigating the possibilities of establishing the industry in Australia. In the event of the initial scheme which the Directors had in mind proving successful it was intended to establish an Australian company, under Australian management, and largely with Australian capital.

Mr. Board explained that his Company at the outset of operations proposed to encourage the growth of cassava as an additional crop on the sugar lands of Queensland, for the purpose of obtaining material for conversion into alcohol. The distillation plants would be established in various centres in the sugar districts in close proximity to the sugar mills, and would thus enable all spare molasses as well to be utilized in the manufacture of alcohol. This scheme would also enable sugar mills and employees to be continuously employed throughout the year. The Company's proposals were viewed favorably by the Queensland Government, which was interested on account of the additional opportunities thus offered for land settlement, and had guaranteed an advance of £25,000 to enable the Plane Creek Sugar Company at Sarina to erect, in conjunction with its sugar mill, a distillery for experimental purposes on a commercial scale. In the event of success being achieved, operations would be extended to other States.

Mr. Board pointed out that although molasses would form a valuable nucleus to assist the industry—and he proposed to use such molasses as were available—if alcohol were to be produced on a large scale crops must eventually be utilized, and although cassava was the crop which he favoured, other starch-bearing crops such as arrowroot and sweet potatoes would be accepted. The witness considered that the yield of cassava would average 12 tons to the acre, and that each ton would produce from 39 to 40 gallons of 95 per cent. alcohol. The estimated cost of raw material would be 6d. or 7d. per gallon, and it was anticipated that the Company would be able to turn out power alcohol for 1s. 3d. a gallon when using cassava, and about 11d. when using molasses. The fuel proposed to be placed on the market would contain from 60 to 70 per cent. of alcohol, the balance being Australian benzol or petrol.

As cassava had not been grown in Queensland on a commercial scale, Mr. Board anticipated that agriculturists might at the start get only a small return from their crops, and moreover, as the spirit produced would have to compete with petrol, the Company could not afford to pay more than £1 per ton for its raw material. He was of opinion that by the adoption of economical methods cassava could be cultivated and delivered at the distillery for £7 per acre, which would give a net return to the grower of only £5 per acre. The Company therefore asked for a bounty of 4d. per gallon on alcohol produced from crops, but not from molasses, to be divided into three portions—1d. to meet the cost of denaturation, and two portions of 1½d.; 1½d. would enable the grower to receive an additional 5s. per ton for his crop, and the remaining 1½d. the distiller proposed to hold in abeyance; and if necessary make it available to the farmer if his costs of production warranted it.

To carry out its distillation work the Company proposed to adopt the Boulard system—a continuous process carried out in an enclosed plant, and now used extensively in Europe. It was claimed that this process not only gives from 95 per cent. to 98 per cent. of the theoretical yield of alcohol from the substance treated, but provides a larger measure of control of fermentation than is possible by the ordinary systems of distillation. Although the existing Distillation Regulations did not permit of the use of such a process in Australia, the Comptroller General of Customs informed the Committee that permission had been given for its use.

Subsequent to Mr. Board's appearance before the Accounts Committee he made formal application to the Tariff Board, which recommended the payment of a bounty of 4d. per gallon on all power alcohol produced in Australia from cultivated crops, one half of this amount to be reserved for the growers—the bounty to extend over a period of five years from 1st January, 1926, and not to exceed a total of £25,000.

Incorporating certain of these recommendations a Bill to provide for the payment of bounty on the manufacture of power alcohol was introduced into the House of Representatives on 26th June, 1925. The Bill lapsed on prorogation, but was introduced in its original form in the present Parliament on the 14th January, 1926. This Bill provides for the payment of bounty at the rate of 4d. per gallon on power alcohol manufactured in Australia from the following products grown in Australia:—Cassava, sweet potatoes, arrowroot, or such other cultivated

starch bearing plants as the Minister approves. The amount of bounty to be paid is limited to £5,000 per annum for the period from 1st January, 1926, to 31st December, 1931, and the Minister is given power to withhold the whole or any part of the bounty unless he is satisfied that a reasonable price has been paid for the materials used in the manufacture of the power alcohol, and that the price includes an amount which is the equivalent of not less than one-half of the bounty payable.

In the meantime Mr. Board has proceeded with his project—a distillery capable of producing 450,000 gallons of alcohol per annum is being erected at Sarina in connexion with the Plane Creek sugar mill and will shortly commence operations using molasses as raw material. Later it is proposed to utilize cassava as well as an area of about 300 acres in the district having been planted with cassava, the cuttings of which were specially selected in Java by the Queensland Government Agriculturist, who also supervised their planting in Australia. Although it is yet too early to say what the result of this experimental planting will be, present indications are said to be very promising.

In view of the proposals concerning the utilization of cassava, the Committee endeavoured to ascertain reliable information concerning the cost of growing cassava in Australia and its yield under local conditions, but it appears that the only previous attempt to grow cassava in Australia was made about twenty years ago on an experimental plot at Mackay in Queensland.

Knowing, however, that arrowroot, which might to some degree be comparable to cassava, was being grown in Queensland, the Committee ascertained from the Queensland Department of Agriculture that the yield of arrowroot throughout the State, taken over a seven years' period, was 12 tons per acre, and that the price paid for arrowroot bulbs delivered at the mill for manufacturing purposes was £2 per ton. Co-operative mills, however, made additional payments from profits—these payments included growers' profit estimated at from ten to fifteen shillings a ton. The Department intimated that no information was available concerning the growing of cassava under Queensland conditions, but it was estimated that the cost of production would be about the same as arrowroot, and that the yield per acre would approximate 8 tons.

In his publication *Power Alcohol—its Production and Utilization* (1922), G. W. Monier-Williams says:—

Cassava is a branched shrub which reaches a height of 6 to 12 feet, and forms large root tubers from 1½ to 4 feet long and 1½ to 2½ inches in diameter. The fresh tubers contain from 21 to 30 per cent. of starch and 5 per cent. of sugar, and are the source of the tapioca of commerce. The plant is sensitive to cold and is easily killed by slight frost. The area over which it can be grown is therefore restricted to tropical districts. It succeeds best in dry sandy soils with little rainfall, and will withstand prolonged and extreme drought without injury, properties which render it a valuable foodstuff in many localities. The yield of roots varies with the character of the soil. On poor soils it may not be more than 2 to 2½ tons per acre, while in the United States as much as 15 tons has been obtained on an exceptionally good soil. An average yield would be about 9 tons per acre, or half as much again as that of potatoes in this country. The plant is propagated by cuttings, and the crop is ready for harvesting at from eight to fifteen months after planting. On good land several successive crops may be grown, but after this the soil deteriorates rapidly, unless a proper system of crop rotation is practised. In West Africa maize or sorghum and leguminous crops are grown in rotation with cassava. In countries where sugar cane is cultivated, this may with advantage be introduced into the rotation. Thus at least two-thirds of the cultivated area would be constantly under a starch or sugar yielding crop, the remaining third being occupied by ground-nuts or beans. The yield of 95 per cent. alcohol from 1 ton of roots would be from 35 to 40 gallons, as compared with 21 gallons from a ton of potatoes. Per acre of land the yield would be about 330 gallons, the corresponding figure for potatoes being 137 gallons.

Cassava possesses the disadvantage, common to many root crops, of requiring considerable manual labour for cultivation and harvesting. The tubers are long and spreading, and can only be ploughed out with difficulty. Usually it is necessary to pull them up by hand or dig them out. They quickly decay after harvesting, and cannot be stored for subsequent distillation unless thoroughly dried. In 1913 dried cassava roots exported to France from the French colonies were valued at about £5 to £6 per ton. This would correspond to approximately £1 10s. to £1 16s. per ton for the fresh roots. At this figure, the raw material for 1 gallon of 95 per cent. alcohol would cost about 1s., corresponding with maize at £4 6s. per ton.

Mr. A. J. F. de Bavay, consulting chemist, whose scientific researches and processes are a feature of Australia's industrial development, informed the Committee that he considered the utilization of molasses provided the best means whereby the power alcohol industry could be established in Australia. He had studied the problem for many years, and had recently discussed the economic practicability of certain schemes put forward by representatives of the sugar growers in the Cairns district known as the Northern Power Alcohol Committee, whereby it was proposed to so treat the Queensland sugar crop that a greater quantity of molasses would be available and be used in the production of alcohol in order to lessen the loss on the surplus sugar exported. The Committee was informed, at a later stage of its inquiry, that although the sugar producers proposed to further utilize molasses for the production of alcohol the project concerning the exportable surplus was being held in abeyance.

During its inquiry, there was placed before the Public Accounts Committee, in evidence, by the discoverer, a proposition for the production of alcohol from prickly pear. The witness, Dr. W. M. Sinclair, a director of Power Alcohol Limited of Sydney, explained to the Committee

that as the result of extensive research work it had been discovered that by the use of his patented process, alcohol could be obtained from this plant. He estimated that each ton of prickly pear would produce 14 gallons of alcohol at a cost of 6d. per gallon, calculated on a yield of 100 tons of prickly pear to the acre. Allowing for expenses, profit, &c., the Company considered it could produce power alcohol for 1s. 3d. per gallon.

The Company has erected a small experimental plant at Coogee, but to work on a proper scale the plant would cost £100,000. Dr. Sinclair stated that if the Company could obtain, in addition to the capital of £100,000 for which it was calling, assistance to the extent of £10,000 to carry it over the initial stages and £10,000 towards the cost of a plant on a commercial scale, it would be possible to establish a factory in the field within six months. Although Dr. Sinclair does not advance his process primarily as a means for the eradication of prickly pear, he claims that from his process a product is evolved which so affects the pear that with the addition of 2 per cent. of arsenic, an inexpensive and efficient eradicator is available. Furthermore, he found that after a few years' continuous cutting the pear plants die out.

A representative of Power Alcohol Limited appeared before the Tariff Board in support of the application by Mr. Board for a bounty of 4d. per gallon, and explained that his Company expected to participate in any bounty granted for the manufacture of power alcohol. The witness was, however, unable to submit any details concerning costs, and undertook to do so at a later date. In its report, the Tariff Board intimated that, whilst it had no hesitation in recommending that the bounty should be wide enough to cover the activities of Power Alcohol Limited, it was not in a position to make any recommendation concerning the amount of the bounty or the conditions under which it might be granted.

On 13th July last at Coogee, New South Wales, the members of the previous Public Accounts Committee witnessed a demonstration of the production of aldehydes from prickly pear, but the plant for further processes was not then working. Meanwhile Dr. Sinclair has effected alterations and improvements in his process whereby the time occupied in fermentation has been shortened and the necessity for large vat accommodation eliminated, the result being a better yield at less cost. The Committee witnessed a demonstration of the later process on the 4th February, 1926, in a small plant erected at the Commonwealth Laboratory at Melbourne.

Previous evidence placed before the Committee indicated that experiments to utilize prickly pear for the production of alcohol have been made in other countries as well as in Australia, but without results which justified any hope of its being a commercial success. Experimental work conducted in Queensland, under conditions which were regarded as perfect as possible for fermentation and distillation, showed that the yield of alcohol obtained was 0·5 per cent. of the weight of the plant used, or an equivalent of about 1½ gallons of spirit per ton.

Reference was also made in evidence before the Committee to experiments which have been conducted with various commodities to ascertain whether alcohol in commercial quantities can be obtained, and it was indicated that an important field of research lies in the discovery of improved methods for converting cellulose materials (i.e., wood, straw &c.) into fermentable sugars for distillation into alcohol. Although this was actually accomplished on a large scale in America during the war, it is admittedly too expensive for normal times. These problems are being studied in various parts of the world, and the desirableness for further research work in Australia on this question was stressed.

Dr. Hargreaves, Director of Chemistry, in South Australia, who investigated the question of the hydrolization of straw, reported for the information of the Accounts Committee as follows:—

"A few years ago a preliminary investigation was begun in this Department, having for its object the manufacture of power alcohol from straw. Although we made some alcohol and obtained a few results which were of an encouraging nature, tending to show that there was a possibility of finding a practical method for making alcohol on a commercial basis, the work had to be discontinued for lack of funds. We were, therefore, unable to check and confirm the results obtained, and until that is done I am not in a position to publish any results.

I have since then endeavoured in various ways to arouse public interest in this subject, with the idea that perhaps a company might be formed to subscribe the funds required to carry on the investigation, but up to the present there has been no response."

In the Philippine Islands the production of alcohol from the juice of the Nipa palm has been undertaken for some years, and it was lately reported that an experimental plant which had been operating in British North Borneo had proved satisfactory, and had shown that if a plant with a capacity of 1,000 gallons per day were erected, it would prove a commercial success.

The Committee ascertained that the Nipa palm grows profusely over considerable areas in the deltas of the Papuan rivers, and although it made inquiry at Port Moresby, was unable to obtain any definite information concerning the extent of this tropical plant or of its possibilities.

The Director of Agriculture in Papua was of opinion that the Territory offers every reasonable facility for the exploitation of the palm, and that the coastal natives would supply plenty of good unskilled labour. He added that some years ago a company had taken up leases in Papua for the purpose of obtaining industrial alcohol from Nipa palm, but beyond carrying out a survey of certain areas no work was done.

DENATURATION.

Since the recommendations of the Institute of Science and Industry were published, there has been some modification of denaturation requirements.

The present standards prescribed by the Spirits Act Regulations are as follow:—

Standard for Mineralized Spirits.—The spirit before methylation to be of a strength of not less than 65 degrees overproof (or approximately 94 per cent. of alcohol), and to be methylated by the addition of 1 per cent. of wood naphtha, $\frac{1}{2}$ per cent. of pyridine, 2 to 20 per cent. of benzene, and $\frac{1}{2}$ per cent. of a solution of aniline, violet, or blue dye.

Standard for Alcohol Fuel. The spirit before methylation to be of a strength of not less than 65 degrees overproof (or approximately 94 per cent. of alcohol), and to be methylated by the addition of 1 per cent. wood naphtha, $\frac{1}{2}$ per cent. pyridine, and not less than 2 per cent. of one of the following:—Approved coal tar, naphtha, benzole, shale naphtha, petrol, gasoline, petroleum benzene, petroleum naphtha, ether (sulphuric), or the like substances.

The Power Alcohol Bounty Bill provides that the power alcohol on which bounty is to be paid must comply with the standard for the time being prescribed for mineralized spirits.

According to present prices the addition of wood naphtha adds to the cost $\frac{1}{2}$ d. per gallon, and pyridine two-thirds of a penny per gallon. In view, however, of the reported production on a commercial scale of synthetic methyl-alcohol, the cost of denaturants may be considerably varied at any time.

It was stated in evidence that although pyridine is manufactured in Australia, the local wood naphtha industry is decadent, and the amount produced here would not supply the demand should power alcohol be manufactured on an extensive scale. In other countries the regulations have been relaxed to encourage the use of power alcohol, and the use of wood naphtha is not insisted upon where the spirit is intended for fuel purposes.

LIQUID FUELS FROM COAL.

Evidence heard by the Committee emphasized the urgent necessity for early attention also being directed to the technical and economic study of means whereby liquid fuels may be derived from coal, and so serve to supplement supplies from shale, cultivated crops, or other sources. The importance of such an avenue of research is being recognized throughout the world, and other countries are devoting considerable attention to fuel technology—the satisfactory development of which demands protracted research according to each country's own resources.

The question of fuel research in Australia was considered by the Temporary Advisory Council of Science and Industry in 1919. The unanimous opinion was that the Australian fuel problem, having special features peculiar to the country, could only be satisfactorily approached by the establishment of an organization comprising the various interests which should co-operate in making a systematic examination of the whole position. Subsequently the Institute of Science and Industry established a "Fuel Research Committee," which was created initially for the purpose of collecting all available information concerning the fuel problem, but owing to lack of funds the Committee did not function. At a later stage the Institute convened a conference of persons interested in the liquid fuel problem, and although the trade interests represented indicated their sincerity by offering to subscribe up to £5,000 on a pound for pound basis with the Commonwealth, the necessary funds were not made available by the Government.

Recognizing that an essential preliminary to effective research was a thorough and expert examination of the problem concerning the production of liquid fuels, and of the existing state of knowledge in regard thereto, both in Australia and other countries, the Institute of Science and Industry published, in April, 1923, a Bulletin (No. 24) entitled *The Production of Liquid Fuels from Oil Shale and Coal in Australia*. The work of compiling this publication was entrusted to Mr. R. E. Thwaites, M.A., who had for some years made a special study of fuel problems, and had carried out experimental investigations. This bulletin makes a comprehensive review of the subject, indicates the development reached in other countries, and summarizes Australia's resources of raw material.

This information having been so compiled, it was emphasized that the next step should be to establish a Fuel Research Laboratory to carry out the systematic investigation of selected raw materials and of processes likely to yield successful results under Australian conditions.

In Great Britain a Fuel Research Board has been established, and is devoting special attention to the question of the low temperature distillation of coal, with a view primarily to the production of smokeless liquid fuels. Canada also has established a Dominion Fuel Board.

From present knowledge, however, an important source for supplementing supplies of oil appears to lie in the carbonization of coals, and in the recovery of gases during the process of coke-making for the manufacture of benzol. Although in New South Wales alone over 500 000 tons of coke were produced during 1924, the method of manufacture, with one exception, had not kept pace with modern practice by the installation of by-product recovery ovens. In consequence, benzol as a motor fuel was until quite recently almost unknown in Australia, although it had been well established in Great Britain, Europe, and America for many years as a satisfactory, economical, and efficient motor spirit. During the war so much importance was attached to the production of benzol that the British Government compelled the large coke-producing works to install benzol distilling plants to save this valuable product from passing into the air as smoke and waste gas. In Australia limited quantities of benzol have been manufactured by various gas companies, but not on a commercial scale. The only large benzol refinery at present operating in Australia is that installed by the Broken Hill Proprietary Company Limited at its steel works at Newcastle, where the benzol is produced from the company's coke ovens plant. From this source about $1\frac{1}{2}$ million gallons of benzol are made available each year. In round figures 2 gallons of benzol are recoverable from each ton of coal. But it was explained to the Committee that so far as this company is concerned, the production of the motor spirit is merely a by-product of the works, and that the quantity available is entirely dependent on the total output of steel manufactures. Although the company considered that judging by the demand for benzol it would have no difficulty in selling twice the quantity now manufactured, to double the output would cost, it was estimated, from £600,000 to £1,000,000. Such expenditure merely for the production of benzol would not be a commercial proposition, and increased production of benzol could come about only as an integral part of an extension of the steel works—a factor governed by the demand for their products.

It was also indicated to the Committee that the gasworks of Australia might form another source for the supply of benzol. It is estimated that approximately one and one-third million tons of coal are used annually in Australia for the production of gas, and it was considered that from this quantity nearly 3,000,000 gallons of benzol could be obtained.

One factor governing this question, however, is the statutory standard for gas, which in most of the States is based on the illuminating standard, and not on the calorific value, notwithstanding the almost universal use of the incandescent mantle where gas is employed as an illuminant. Whether the extraction of the benzol from gas would tend to lower the standard and necessitate its being replaced by another substance is a matter for expert investigation. During the war gas companies in Great Britain were compelled to debenzolize their gas; but, as soon as permitted, they reverted to their previous practice, evidently being of opinion that the value of the benzol was greater to them in the gas than in liquid form.

The Australian Gas Light Company, of Sydney, has to a moderate extent only manufactured benzol by treating portion of its available tar, and the spirit so produced has been utilized for the company's own transport vehicles. The engineer of this company, Mr. Andrew Wilson (now general manager and secretary), was of opinion that in time of emergency gas works would undoubtedly be a good source for supplies of benzol, but before expressing a definite opinion concerning the practicability of the production of benzol by gas companies, the witness undertook to conduct experiments and to advise the Committee of the result.

From a defence standpoint, an important by-product from coke ovens is toluol, the basis of T.N.T. and other high explosives. At present this product is left in the benzol, but in an emergency it could be extracted without, it was claimed, detracting from the efficiency of benzol as a motor spirit.

It was also stressed that the extraction of benzol does not by any means exhaust the possibilities of the application of coal products to motor transport. Extensive investigations are being conducted in various countries into the carbonization of coals—particularly low-temperature carbonization—as it is recognized that the utilization of coal as a source of motor fuel is capable of great development.

In discussing the possibilities, as a source of oil production, of the enormous deposits of brown coal known to exist in Victoria, Dr. Herman, formerly Director of Geological Survey in Victoria, and now in charge of briquetting and research work for the State Electricity Commission of Victoria, informed the Committee that, speaking broadly, the results of experiments conducted so far in both high and low temperature carbonization of brown coal, were not favorable to such brown coals as had been found in Victoria being successfully treated in a commercially profitable way for the primary purpose of producing oil. Dr. Herman added that the work of carbonizing brown coal in Germany, which was the most advanced in the world, had been carried out with a grade of brown coal of which, up to the present, no close counterpart had been discovered in Victoria; in fact, no real distillation brown coal had yet been found in the State. In Germany less than 1 per cent. of the brown coal produced is sent to the distillation works, and even with their high grade brown coal the yield of motor spirit is little more than 1 gallon to the ton—although several gallons of other oils are obtained.

OIL SUPPLIES.

As much of the evidence advocating the establishment of the power alcohol industry in Australia and the manufacture of other liquid fuels has been based upon the possibility of a shortage in the world's supplies of flow oil, the Committee endeavored to ascertain authentic information on this phase of the subject. The Director of the Commonwealth Institute of Science and Industry quoted, for the information of the Committee, estimates of the world's oil reserves by the Director of the United States Geological Survey, published 1920, which placed these reserves at 6,000 million tons—representing 60 years' supply at the 1920 rate of consumption; but if consumption increased at the rate of 10 per cent. per annum it was considered that there would be only 20 years' supply of oil available. In evidence Mr. de Bavy stated that:—"It is the opinion of the highest authorities in America that there will be a shortage of petrol before five years, and when that happens America will stop exportation, and the price of petrol from other fields will leap up."

On the other hand, it was pointed out by representatives of the principal oil companies and by other witnesses that in the opinion of experts it is absolutely impossible to forecast the reserves of oil still to be drawn from the earth. The colossal increase in the consumption of oil throughout the world had been met by a corresponding increase in production, and, in fact, during recent years there had been over-production. Further, the general trend in the oil industry was towards improved and more economical means of production and refining; and by the adoption of new methods of extraction it was considered that apparently exhausted fields will yield additional supplies, whilst cracking processes recently introduced had increased by 100 per cent. the yield of petrol from crude oil. Oil supplies were also being conserved by further elimination of waste and increased efficiency in their utilization. In this connection the following "Summary of Conclusions" from a report submitted to the Federal Oil Conservation Board by the American Petroleum Institute is of particular interest. This report, which dealt in detail with the supply and demand for petroleum, was prepared by a special committee of eleven members of the Board of Directors of the American Petroleum Institute appointed in January, 1925, as the result of the naming of the Federal Board by President Coolidge in the previous month.

- 1 There is no imminent danger of the exhaustion of the petroleum reserves of the United States.
- 2 It is reasonable to assume that a sufficient supply of oil will be available for national defence and for essential uses in the United States beyond the time when science will limit the demand by developing more efficient use of, or substitutes for, oil, or will displace its use as a source of power by harnessing a natural energy.
- 3 Current supply and demand cannot stay in balance, since the amount of both supply and demand are constantly changing. Generally, current supply will exceed or be less than the current demand, creating surplus or shortage; either condition will be reflected in price, but price will in time correct either condition.
- 4 Petroleum recoverable by present methods of flowing and pumping from existing wells and acreage thus proven consist of 5,300,000,000 barrels of crude oil.
- 5 It is estimated that after pumping and flowing there will remain in the area now producing and produced 26,000,000,000 barrels of crude oil, a considerable portion of which can be recovered by improved and known processes such as flooding with water, the introduction of air and gas pressure and mining, when price justifies.
- 6 Improved methods of deep drilling below oil sands now producing will disclose in many areas deposits not hitherto available, which will be tantamount to the discovery of new fields. Improved methods of producing have been perfected, which will make possible recovery of oil from these lower levels. The limit of deep drilling has not been reached.
- 7 The major oil reserves of the United States lie in some 1,100,000,000 acres of lands underlain by sedimentary rocks and not fully explored, in which geology indicates oil is possible. With extended search new supplies will be found therein.
- 8 The nation has an additional reserve in the vast deposits of oil shale, coal, and lignites, from all of which liquid fuel and lubricants may be extracted if and when the cost of recovery is justified by the price of these products. These deposits are so huge that they promise under conservative estimates an almost unlimited supply.
- 9 While this report is confined to the petroleum supply and demand within continental United States, the importance of imports cannot be ignored. Countries to the south are known to have large petroleum resources, for the output of which the United States is a natural market, and the supply therefrom must inevitably have its influence on the consumption of American reserves.
10. The availability of future petroleum supplies from the vast area of land mentioned above depends upon adequate incentives to the exploration which in the past has given the nation a sufficient supply of petroleum, in peace and war, throughout the history of the oil industry, from its inception in 1859.

There must be—

- (a) Security in the ownership of oil lands and of the right to lease.
- (b) Conditions of exploration and development by owners or lessees permitting exercise of initiative, liberty of action, the play of competition, and the free operation of the law of supply and demand.
- (c) Prices that will provide a return to producers, refiners, and distributors commensurate to the risks involved and the capital invested.

11. The supply of petroleum will be made to go much further through more efficient utilization. Automotive experts state that the mileage of the motor car per gallon of gasoline may be doubled through structural mechanical changes, when price justifies such changes. Improved mechanics will also result in smaller consumption of lubricants.

12. Through improved methods, principally the process known as cracking, the refining branch of the industry has already increased the yield of gasoline, now the major product of petroleum. Through further improvements and extensions the supply of gasoline will be augmented still further by the cracking of fuel oil. In consequence the supply of fuel oil will be correspondingly diminished, thus eventually removing fuel oil from competition with coal.

13. Waste in the production, transportation, refining, and distribution of petroleum and its products is negligible.

Although the report quoted deals only with the oil fields of the United States, there are, according to expert opinion, vast areas in other countries which yet remain to be further developed, namely—Mexico, Central and South America, Russia, Persia and Mesopotamia, whilst India, China, Alaska and other places hold considerable possibilities.

Questioned concerning their attitude towards the development within Australia of shale oil, power alcohol, and other liquid fuels, representatives of oil companies informed the Committee that they were not opposed to the establishment of such industries nor to the admixture of power alcohol with petrol, provided the resultant mixture was not less efficient or economical than the original petrol. They were of opinion that such fuels could not compete commercially with flow oil, and pointed out that efforts to establish such industries in other countries had not proved successful; in France, for example, the compulsory admixture of 10 per cent. of power alcohol to petrol had been a failure owing to the non-production of the alcohol. It was emphasized that an important factor in the establishment of the power alcohol industry in Australia would be the cost of distribution, and moreover, owing to its relative inefficiency compared with petrol when used in existing types of engines, it would have to be sold at from 1s. 3d. to 1s. 4d. a gallon to compete with petrol at 2s. In addition, motorists would be obliged to carry a greatly increased quantity of spirit to cover the same distance.

The Committee ascertained that under normal conditions supplies of oil on hand in Australia are sufficient for seven months' requirements, and that by the adoption of modern methods petrol can be stored almost indefinitely without loss or deterioration. The leading oil companies are at present engaged in increasing their bulk storage, and extending their depôts for the handling of supplies in bulk. Such a system naturally tended to reduce distributing and other costs, and enabled petrol to be sold at cheaper prices. In erecting their bulk storage tanks, however, the oil companies had placed them in commercial centres, and had not consulted the Defence authorities on the strategic aspect of their location. The capacity of the bulk storage for petrol, kerosene and fuel oil now being installed in Australia may be set down at approximately 60 million gallons.

COMMITTEE'S OBSERVATIONS AND RECOMMENDATIONS.

The use of petroleum and its products now enters so much into the activities of a nation, both for industrial and defence purposes, that countries not possessing oil wells and desirous of being independent of outside sources of supply must examine the question of finding suitable substitutes or discovering means whereby oil may be recovered or distilled from other materials. Owing to the unfavorable prospects of commercial supplies of flow oil being discovered within the Commonwealth, the urgent necessity exists for this problem to be faced in Australia. Other countries similarly situated are already engaged in extensive research work, and whilst a study of the results achieved by them may be helpful, different conditions and the varying nature of the materials to be investigated make it imperative for each country to conduct its own experiments.

Australia undoubtedly possesses many sources from which supplies of various liquid fuels may be derived; but much research work yet remains to be done, and it is certain that if such work is to be performed for the development of these resources, Governmental encouragement will have to be given.

In view of the entire dependence of Australia on importation for its oil supplies, it is imperative that early action be taken for this country to reach as great a measure of self-containment in this regard as is practicable on a commercial basis.

Having regard to Australia's known and probable deposits of oil shale, the Committee is of opinion that the successful exploitation of these deposits will be an important factor in the supply of Commonwealth requirements from within its own shores, whilst in a time of emergency the presence of such a supply will be of vital importance. As Dr. Wade said when referring to the oil shale deposits of Australia, "I consider them to be one of the greatest assets that Australia possesses, and the day of their very great importance may yet come."

A review of the shale oil industry in Australia and elsewhere indicates, however, that so long as ample supplies of mineral oil are available, the production of oil from shale cannot be regarded seriously as a commercial undertaking, as conditions of competition are too unequal,

and it is significant to note that the Special Committee of the American Petroleum Institute in its report (already referred to herein) reached the following conclusion regarding the time when the use of substitutes for petrol will be undertaken:—

"If and when the cost of recovery of oil and gasoline from shale coal and lignite will permit this oil and gasoline to be sold in competition with similar products from present and other sources of supply, then, and then only, will these products be commercially available."

Even with the assistance already given by the Commonwealth by way of bounty and duties, the industry has not flourished, and it is not surprising that capital has been difficult to obtain, and that financial institutions are not favorably disposed to help it.

As the Committee recognized the limitations of this industry when regarded purely as a commercial proposition, it approached the question as to what means might be adopted to ensure its continuance from the defence aspect. The Committee therefore had prepared for its own information and guidance statements by the Defence authorities—Navy, Army, Air, and Munitions—setting out at length Australia's oil requirements under peace and war conditions, together with the present source of supply and the price paid in each case. A careful study of these statements left no doubt about the urgency and necessity, particularly for defence purposes, for the encouragement of the production of oil in Australia and for increased facilities for storage.

Although the manufacture of power alcohol and other liquid fuels from vegetable crops, coal, and other sources offers a partial solution, so far as supplies of petrol and the lighter motor spirits are concerned, it will remain for the shale deposits to provide the equally essential heavier classes of oil, in addition, of course, to a certain percentage of lighter oils.

But extensive and rich as are Australia's shale deposits they are by no means inexhaustible, and on a conservative estimate the amount of oil in the known deposits will suffice only to supply Commonwealth requirements, at the present rate of consumption, for approximately 25 years.

It appears to the Committee, therefore, that these deposits, forming as they do a valuable asset, should be regarded purely as a national reserve and conserved as an insurance against the time when Australia's supplies from overseas may be threatened; and the Committee unanimously recommends that, as a defence measure, steps should be taken to have the oil-shale deposits of Australia vested in the Commonwealth.

To leave the development of these deposits until an emergency arises would be hazardous: research and experimental work should, therefore, be carried on to the point of production, and the works then placed on a nucleus basis in conformity with the policy already controlling the Munitions Factories so that, when the necessity arises, full production could be reached without undue delay.

The Committee was informed in evidence that notwithstanding the large production of flow oil in the United States of America, the Navy Department of that country holds in reserve large areas of oil shale.

The Committee is of opinion that for the study of the better utilization of our coal resources and allied matters there should be established without further delay an Australian Fuel Research Committee to investigate and advise on the technical and economic problems involved, particularly so far as Australia and its local materials are concerned. Such a Committee should be composed of experts and function as one of the bureaux of the Institute of Science and Industry.

In view of the importance of a greater output of benzol within Australia, the Committee is of opinion that the recovery, to a greater extent, of benzol and other by-products, should be encouraged in connexion with steel works, coke ovens and gas companies. At present, owing to the absence from almost all the coke-producing works in Australia of by-product recovery plants, many valuable products pass into the air as waste. These products comprise benzol (which is of value not only as a motor fuel itself, but as an important constituent in alcohol fuels), sulphate of ammonia, tar, cresote oil, pitch, solvent naphtha, naphthalene, middle oils, toluol and many other substances. At present toluol, which is the basis of the high explosive known as T.N.T., goes into the benzol and becomes part of the motor spirit. As it is recognized, however, that the installation of such plants would necessitate heavy expenditure from which little commercial return could be expected, the Committee considers that action should be taken to encourage the installation of more by-product recovery plants.

As an initial step towards lessening Australia's enormous importations of petrol, the Committee is of opinion that the production of power alcohol from various vegetable and other products available within Australia should be scientifically investigated and, where proved advisable, assisted.

From a technological standpoint molasses forms an almost ideal raw material for the production of alcohol. This by-product of the sugar industry is used successfully and extensively for this purpose in other countries, but in Australia it has been so used to only a limited extent

and each year many thousands of tons of molasses are run to waste. Yet according to expert evidence, by the utilization of molasses for the production of alcohol there are reasonable prospects of being able to manufacture an alcohol fuel which can successfully compete with petrol on a commercial basis, especially if, during the initial stages, the use of such a fuel is limited to the localities where it is manufactured. By the admixture of ether, which can be manufactured from the alcohol itself and of Australian petrol or benzol in certain proportions, it is considered that there can be produced a motor fuel which can be readily substituted for petrol in existing types of engines. Actual road tests have shown that such mixtures compare favorably with petrol even when used in standard motor car engines designed for the use of petrol. In stationary engines, tractors, &c., it is contended that an alcohol fuel will give results superior even to petrol.

Although the quantity of alcohol obtainable if all the molasses at present wasted were distilled would amount to eight million gallons, it would not be economical to convey molasses from isolated centres, so that the raw material which would be readily available would yield five million gallons. This quantity would suffice to meet only one-half of Queensland's present demand for petrol, nevertheless the utilization of what would otherwise be wasted would form a valuable nucleus on which to establish in Queensland the manufacture of alcohol for power purposes.

As the development of the industry proceeds and the available molasses becomes absorbed, other sources for the supply of raw materials will have to be found which can be depended upon for regular and adequate supplies of alcohol.

Reviewing the evidence heard concerning the possibilities of various starch-bearing crops the Committee considers that there is room for doubt as to whether such crops can be grown at a price which will permit of their being utilized for the production of alcohol on a commercial basis.

Cassava, however, appears to be the most favorable of these crops, provided it can be successfully cultivated at reasonable cost in the tropical parts of the Commonwealth. Owing to the fact that the cultivation of this crop has not been hitherto attempted on a commercial scale in Australia, no evidence is yet available on which accurate costs of production, its yield per acre or the alcohol contents of Australian-grown cassava can be based. The experiments with cassava now being conducted in Queensland will no doubt give useful information which will form a valuable guide for the future.

Concerning the experiments being conducted by Dr. W. M. Sinclair to utilize prickly pear for the production of power alcohol, it can be said that the process has advanced beyond the laboratory stage, though much has yet to be accomplished before it becomes a commercial proposition. In Australia, an area of about sixty million acres is covered with pear, and it is now increasing at the rate of one million acres per annum; of this area, over ten million acres are said to carry dense pear averaging at least 100 tons to the acre. Assuming, therefore, that the witness's claim to produce 14 gallons of alcohol to the ton of pear is substantiated, 896,000 gallons of alcohol would be obtained from each square mile of country carrying 100 tons to the acre, or 11,000,000,000 gallons from the densely covered area alone. There is little doubt, therefore, that should success attend these efforts the whole question of the production of power alcohol will be revolutionized. The persons interested in the process have already spent £15,000 in experimental and research work and now claim to be ready to undertake work in the field provided they can obtain the necessary financial assistance, which they put down at £20,000—£10,000 for plant and £10,000 for contingencies—such assistance to be regarded as a loan only.

The claims of this process are certainly at variance with the usually accepted theories as to the alcohol yield from prickly pear, but the successful utilization of what is at present one of Australia's greatest pests would be of immeasurable value to the country, and the Committee is of opinion that this process warrants expert investigation by the Government. Such an investigation would be welcomed by the patentee to prove his bona fides and he has intimated his willingness to give the Government such control as is considered necessary for the purpose. It is therefore recommended that a qualified person, unbiased by preconceived ideas as to the possibilities of prickly pear for alcohol production, should be appointed to fully investigate the process and subject it to a technical and critical examination, with a view to determining the extent to which the project should be helped if the claims are substantiated.

Dealing generally with the manufacture of power alcohol in Australia, the Committee considers that, in view of the heavy costs of distribution, it would be more economical and better results would be achieved if, particularly during the early stages, the local product were utilized as far as possible in the centres of production.

Whilst the Committee is in entire sympathy with economically sound proposals which will help to make Australia less dependent on outside countries for supplies, it is of opinion that the

present normal channels through which Australia draws her petroleum products cannot be disregarded.

Dealing with the question of self-containment, the Joint Committee of Public Accounts, in its Report on the Expenditure on Munitions Supply (Parliamentary Paper No. 88 of 1923-24) stated :—

“ If the required munitions can be made in Australia so much the better, but if our industrial resources do not promise early production, it would be unwise to permit the laudable desire for self-containment to stand in the way of efficient defence. Self-containment is, after all, only relative and advances with the development of raw materials and the growth of the manufacturing capabilities of a country. At the outset, therefore, the wisest policy is to concentrate on the manufacture of those goods which can be produced locally and build up stocks of such goods as must be imported, pending their ultimate production in Australia.”

The same position applies to our oil supplies. The oil industry is one of the best organized in the world. The companies operating in Australia have powerful concerns behind them, and have met the ever-increasing demands for their products; much capital has been spent locally, and their bulk storage facilities are being extended throughout the country, with the result that practically a seven months' stock is always in hand, and for normal consumption an even larger supply could readily be arranged should the Commonwealth desire to enlist the co-operation of the companies concerned. Naturally the companies have erected their bulk storage tanks in localities best situated for commercial purposes, but the Committee recommends that when further installations are contemplated the Defence authorities should invite the companies to confer with them so that, in future, tanks will be placed as far as practicable in locations satisfactory from both strategic and commercial standpoints.

The possible cessation of the world's oil supplies has been widely discussed during recent years and though some authorities consider that the excessive exploitation which has been taking place will mean their early exhaustion, others contend that it is impossible even approximately to foretell the end of the world's oil supplies. During recent years the tremendous increase in the demand for oil has been met by a more than corresponding increase in supplies, resulting in over-production. The adoption of new methods of extraction, improved and more economical means of production and refining, the elimination of waste and increased efficiency in the utilization of oil all tend to support the view that any impending shortage in oil supplies is not justified.

THOMAS PATERSON,
Chairman.

Office of the Joint Committee of Public Accounts,
Federal Parliament House, Melbourne,
23rd February, 1926.