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CONSERVATION THROUGH ENGINEERING

BY

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Extract from the Annual Report of the Secretary of the Interior



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NOTE.

The plea for constructive policies contained in the report of the Secretary of the Interior to the President deserves a hearing also by the engineers and business men who are developing the power resources of the country. The largest conservation for the future can come only through the wisest engineering of the present.

The conditions under which the utilization of natural resources is demanded are outlined by Secretary Lane, and it will be noted that the program recommended calls for the cooperation of engineer and legislator. To bring this power inventory to the attention of the men who furnish the Nation with its coal and oil and electricity, this extract from the administrative report of the Secretary of the Interior is reprinted as a bulletin of the United States Geological Survey.

CONSERVATION THROUGH ENGINEERING¹

By FRANKLIN K. LANE.

In an age of machinery the measure of a people's industrial capacity seems to be surely fixed by its motive power possibilities. Civilized nations regard an adequate fuel supply as the very foundation of national prosperity—indeed, almost as the very foundation of national possibility. I am convinced that there will be a reaction against the intense industrialism of the present, but as it must be agreed that the race for industrial supremacy is on between the nations of the world, America may well take stock of her own power possibilities and concern herself more actively with their development and wisest use.

THE COAL STRIKE.

The coal strike has brought concretely before us the disturbing fact that modern society is so involved that we live virtually by unanimous consent. Let less than one-half of 1 per cent of our population quit their work of digging coal and we are threatened with the combined horrors of pestilence and famine.

It did not take many hours after it was realized that the coal miners were in earnest for the American imagination to conceive what might be the state of the country in perhaps another 30 days. Industries closed, railroads stopped, streets dark, food cut off, houses freezing, idle men by the million hungry and in the dark—this was the picture, and not a very pleasant one to contemplate. There was an immediate demand for facts.

How much coal is normally mined in this country?

By whom is it mined?

What is its quality?

To what uses is it put?

Who gets it?

¹ Extract from the annual report of the Secretary of the Interior for the fiscal year ended June 30, 1919. The page numbers are the same as those in the report.

How much less could be mined if coal were conserved instead of wasted?

What better methods have been developed for using coal than those of ancient custom?

Who is to blame that so small a supply is on the surface?

Why should we live from day to day in so vital a matter as a fuel supply?

What substitutes can be found for coal and how quickly may these be made available?

This is by no means an exhaustive category of the questions which were put to this department when the strike came. And these came tumbling in by wire, by mail, by hand, from all parts of the country, mixed with disquisitions upon the duty of Government, the rights of individuals as against the rights of society, the need for strength in times of crisis, calls for nationalization of the coal industry, for the destruction of labor unions, for troops to mine coal, and much else that was more or less germane to the question before the country.

Many of these questions we were able to answer. But if coal operators themselves had not carried over the statistical machinery developed during the war, we would have been forced to the humiliating confession that we did not know facts which at the time were of the most vital importance.

In a time of stress it is not enough to be able to say that the United States contains more than one-half of the known world supply of coal; that we, while only 8 per cent of the world's population, produce annually 46 per cent of all coal that is taken from the ground; that 35 per cent of the railroad traffic is coal; that in less than 100 years we have grown in production from 100,000 tons to 700,000,000 tons per annum; that if last year's coal were used as construction material it would build a wall as huge as the Great Wall of China around every boundary of the United States from Maine to Vancouver, down the Pacific to San Diego and eastward following the Mexican border and the coast to Maine again; and that this same coal contains latent power sufficient to lift this same wall 200 miles high in the air, according to one of our greatest engineers (Steinmetz).

Such facts are surely startling. They serve to stimulate a certain pride and give us a great confidence in our industrial future; yet they are not as immediately important, when the mines threaten to close, as would be a few figures showing how much coal we have in stock piles and where it is! And months since we called upon Congress to grant the money that we might secure these figures, but no notice was taken of the urged requests until, late in the summer, a committee of the Senate awoke to this need and indorsed our petition.

NATIONAL STOCK TAKING.

The Government should have a more complete knowledge of the coal and of other foundation industries than can be found elsewhere, and we should not fear national stock taking as a continuing process. It is indeed the beginning of wisdom. The war revealed to us how delinquent in this regard we had been in the past. One day when the full story is told of the struggle of the Army engineer to meet war emergency demands, and this is supplemented by the tale of the effort made by the Council of National Defense and the War Industries Board, it will be realized more seriously than now how little of stock taking we have done in this generous, optimistic land.

When any such undertaking is proposed, however, it at once appears to arouse the fear that it is somehow the beginning of a malevolent policy called "conservation," and conservation has had a mean meaning to many ears. It connoted stinginess and a provincial thrift, spies in the guise of Government inspectors, hateful interferences with individual enterprise and initiative, governmental haltings and cowardices, and all the constrictions of an arrogant, narrow, and academic-minded bureaucracy which can not think largely and feels no responsibility for national progress. Needless to say this fear should not; need not be. The word should mean helpfulness, not hindrance—helpfulness to all who wish to use a resource and think in larger terms than that of the greatest immediate profit; hindrance only to those who are spendthrift. A conservation which results in a stalemate as between the forces of progress and governmental inertia is criminal, while a conservation that is based on the fuller, the more essential use of a resource is statesmanship.

To know what we have and what we can do with it—and what we should not do with it, also!—is a policy of wisdom, a policy of lasting progress. And in furtherance of such a policy the first step is to know our resources—our national wealth in things and in their possibilities; the second step is to know their availability for immediate use; the third step is to guard them against waste either through ignorance or wantonness; and the fourth step is to prolong their life by invention and discovery.

COAL AS A NATIONAL ASSET.

Enough has been said, perhaps, to indicate how vast are the fields of coal which this country holds. It may be that any day some genius will release from nature a power that will make of little value our carboniferous deposits save for their chemical content. By the application of the sun's rays, or the use of the unceasing motion of

the waves of the sea, the whole dependence of the world upon coal may be upset. That day, however, has not yet come; and until it does we may consider our coal as the surest insurance which we can have that America can meet the severest contest that any industrial rival can present. It is more than insurance—it is an asset which can bring to us the certainty of great wealth, and if we care to exercise it, a mastery over the fate and fortunes of other peoples.

Next to the fertility of our soil, we have no physical asset as valuable as our coal deposits. Although we are sometimes alarmed because those deposits nearest to the industrial centers are rapidly declining and we can already see within this century the end of the anthracite field, if it is made to yield as much continuously as at present, yet it is a safe generalization that we have sufficient coal in the United States to last our people for centuries to come. An extra scuttleful on the fire or shovelful in the furnace does not threaten the life of the race, even if some Russian or Chinese of the future does not resolve the atom or harness the hidden forces of the air. Whatever fears other nations may justifiably have as to their ability to continue in the vast rush of a machine world, there can be no question of our ability to last.

The present strike, however, makes quite clear, perhaps for the first time, that it is not the coal in the mountain that is of value, but that which is in the yard. And between the two there may be a great gulf fixed. Therefore, we are put to it to make the best of what we have. We turn from telling how much coal we use to a study of how little we can live upon and do the day's work of the Nation. And this is, I believe, as it should be. Indeed I feel justified in saying that the problem of this strike is not to be solved in its deeper significances until we know much more about coal than we know now, and this especially as to the manner in which it is taken from its bed and brought to our cellars.

PUBLIC RESPONSIBILITY.

This transfer is effected by a kind of carrier chain, the links of which are the operator, the miner, the railroad, and the public. We choose, to please ourselves, the link in this chain upon which we place the responsibility for its failure to work; but before indulging ourselves in abuse of arrogant coal barons or dictatorial labor unions, it may be as well to ask whether we of the public are not responsible in some part for this failure to function. I do not refer now to the failure of society to provide methods of industrial mediation or other adjustment of such labor difficulties. My question is, whether or not the public is at all at fault when a nation wealthy beyond all others

in coal finds itself with so small a supply on hand when a strike comes—but a few days removed from the gravest troubles. The answer, to my mind, turns upon the manner in which we have done business.

We have been content to go without insurance as to a coal reserve. Each day has brought its daily supply. There was no thought of railroads stopping or mines closing down, so that large storage facilities have not been provided, and, indeed, we would rebel at paying for our coal the added cost of caring for it outside its native warehouse. We have not thought in terms of apprehension, but, as always, in the calm certainty that the stream of supply would flow without ceasing. In some way there would be coal into which we could drive our shovels when the need was felt.

No wonder, therefore, that we are rudely disturbed when one link in the carrier chain from coal-in-place to coal-in-the-furnace breaks. It simply is one of those things which doesn't happen. And not having happened sufficiently often to give us fear, we have had no thought that we should provide against it. It is a most heterodox thing to say, but we may find that a bit more foresight on the part of the public would certainly have made less sudden the present crisis. Let us look, for instance, into the matter of the coal miners' year and see if it is not fixed in some degree by the habit of the public in its purchasing.

THE MINERS' YEAR.

The record year, 1918, with everything to stimulate production had an average of only 249 working days for the bituminous mines of the country. This average of the country included a minimum among the principal coal-producing States of 204 days for Arkansas and a maximum of 301 for New Mexico. In such a State as Ohio the average working year is under 200 days. In 1917 the miners of New Mexico reached an average of 321 days, and in the largest field, the Raton field, it was actually 336—probably the record for steady operation.

This short year in coal-mine operation is due in part to seasonal fluctuation in demand. The mines averaged only 24 hours a week during the spring months. The weekly report of that date showed that 80 per cent of the lost time was due to "no market" and only 15 per cent to "labor shortage," while "car shortage" was a negligible factor. In contrast with this should be taken the last week before the strike, when the average hours operated were 39 and "no market" was a negligible item in lost time, while "car shortage" was by far

the largest item. It follows that the short year is a source of loss to both operator and mine worker and is a tax on the consumer.¹

With substantially the same number of mines and miners working this year as last, the accumulative production for the first 10 months of this year is 100,000,000 tons less than that mined in the same period last year. This 25 per cent loss in output means that both plant and labor have been less productive, and, in terms of capital and labor, coal cost the Nation more this year than last. For in the long run both capital and labor require a living wage.

The public must accept responsibility for the coal industry and pay for carrying it on the year round. Mine operators and mine workers of whatever mines are necessary to meet the needs of the country must be paid for a year's work. The shorter the working year the less coal is mined per man and per dollar invested in plant, and eventually the higher priced must be the coal. It is obvious that the 264 short tons of coal mined by the average British miner last year could not be as cheap per ton as the 942 tons mined by the average American mine worker, backed up as he was with more efficient plant. (A proud contrast!)

It would clearly appear that the coal business may be stabilized, not wholly, but in a very large measure, in some of the western fields,² if the public does not regard its supply of coal as it does its supply of domestic water, which requires only that the faucet shall be opened to bring forth a gushing supply. Coal does not have pressure behind it which forces it out of the mine and into the coal yard. It rather must be drawn out by the suction of demand. And herein the public must play its part by keeping that demand as steady and uniform as possible.

¹ In spite of the strike order, effective the last day of the week, the production of soft coal during the seven days Oct. 26–Nov. 1 was greater than in any week this year save one. The exception was the preceding week, that of Oct. 25, which full reports now confirm as the record in the history of coal mining in the United States. The total production during the week ended Nov. 1 (including lignite and coal made into coke) is estimated at 12,142,000 net tons, an average per working day of 2,024,000 tons.

Indeed had it not been for the strike, curtailing the output of Saturday, the week of Nov. 1 would have far outstripped its predecessor. The extraordinary efforts made by the railroads to provide cars bore fruit in a rate of production during the first five days of the week which, if maintained for the 304 working days of full-time year, would yield 715,000,000 tons of coal. It is worth noting that this figure is almost identical with the 700,000,000 tons accepted early in 1918 by the Geological Survey and the Railroad Administration as representing the country's annual capacity. During these five days, therefore, the soft-coal mines were working close to actual capacity. There can be little doubt that the output on Monday, Oct. 27, was the largest ever attained in a single day. (U. S. Geol. Survey Bull.)

² It is the western and southern fields that are most affected by the seasonal demand. As a typical example, Illinois may be cited, with 18 per cent of the year's production in 25 per cent of the time, April, May, and June, in 1915, and 15 per cent in 1916. Retail dealers received 27 per cent of the coal from Illinois in the period from August, 1918, to February, 1919, compared with 4 per cent from the Pittsburgh, Pa., field.

HAVE WE TOO MANY MINES AND MINERS?

The problem of the miner and his industry may be stated in another way. We consume all the coal we produce. We produce it with labor that upon social and economic grounds works as a rule too few days in the year. We therefore must have a longer miners' year and fewer miners or a longer miners' year and additional markets. One or the other is inevitable unless we are to carry on the industry as a whole as an emergency industry, holding men ready for work when they are not needed in order that they may be ready for duty when the need arises. There are too many mines to keep all the miners employed all of the time or to give them a reasonable year's work. This conclusion is based on the assumption that we now produce only enough coal from all the mines to meet the country's demand, which is the fact. More coal produced would not sell more coal, but more coal demanded would result in greater coal production. With the full demand met by men working two-thirds or less of the time in the year there can not be a longer year given to all the miners without more demand for coal. This seems to be manifest. Therefore the miners must remain working but part time as now, or fewer miners must work more days, or market must be found for more coal and thus all the miners given a longer year. If we worked all of our miners in all of our mines a reasonable year, we would have a great overproduction. And to have all our mines work a longer period means that we must find some place in which to sell more coal, either at home or abroad.

Why have we so many mines working so many miners? There can be no one-word reply to this question. It penetrates into almost every social and economic condition of the country—the initiative of capital, the size of the country, the pride of localities, the intense competition between railroads, their inability to furnish cars when needed, the manner in which cars are apportioned between mines, the manner in which the railroads are operated so that movement is slow and equipment is short, and this runs into the need for new facilities, such as more yards, more tracks, more equipment, which brings us into the need for more capital and so on and on.

We have none too many mines or too many miners to supply our need if the mines are operated as at present. But we have too many to fill that need if they are operated on a basis nearer to 100 per cent of possible production.

THE LONG VIEW.

Passing from the labor phase of the coal situation to the larger aspect of our coal supply as related to the whole problem of the economical production of light, heat, and power, which Sir William

Crookes has characterized as "first among the immediate practical problems of science," we find ourselves both rich and wasteful, following the primrose path, heedless of the morrow and not yet conscious that the morrow is to be a day of battle.

In the first place we treat coal as if it were a thing which was exclusively for home use, a nonexportable commodity which must be used "on the farm," whereas it should be treated with profound respect, because we know from Paris that sacred treaties and national boundaries turn on its presence. The world wants our coal, envies us for having it, fears us because of it. It is not only useful to us, but it has a cash value in the markets of the world. Therefore it should be saved.

In the next place we treat coal as if it were all alike, not selected by nature for specific uses; whereas we should choose our coal with as scientific a judgment as we choose our reading glasses. There is coal for coke and coal for furnaces and coal for house use and coal adapted for one kind of boiler and a different kind of coal for a different kind of boiler. Therefore we should discriminate in coal.

And again we have shown little willingness to dignify coal by seeking to draw out by improved mechanical processes all the stored content of heat in this lump of carbon. Instead we content ourselves by giving it a mere pauper touch, driving off the greater volume of its value into the air. This is a task for the mechanical engineer.

Then, too, there is the problem of using coal in the form of steam or in the more exalted form of electric current. The lifting, bobbing lid of James Watt's teakettle did not speak the last word in power. We are only beginning to know how we may move on from one form of motive power to another. The wastefulness of steam power as contrasted with electric power is a real challenging problem in conservation by itself.

And then we naturally ask, Why this long haul over mountains and through tunnels and across bridges and along streets and into houses, by railroad, truck, and on the backs of men, when at the very pit mouth, or within the mine itself, this same coal might be transformed into electricity and by wire served into factories and homes 100, 200, 300 miles from the mine? Why burden our congested railroads with this traffic? Why strew our streets with this dirt? This may be a practicable thing, a wise thing; it deserves study if coal is worth conserving.

Are there no substitutes for coal which we can use and can not export? This question immediately raises the water-power possibilities of our land, of which only the most superficial study has been made. Sell coal and use electricity would appear a thrifty policy.

As petroleum is being used as a substitute for coal—and inasmuch as the whole problem of fuel supply is one—we are ultimately compelled to an investigation of the ability of our petroleum supply to meet its present drain and to meet the expansion in its use, which is the most surprising development of our day in the study of power creation.

This spells a program of development and conservation which should challenge the ambitions of this Nation, and on a few of its features perhaps a few further words would be justified.

SAVING COAL.

The two ways by which coal in greatest volume can be saved are the discovery of the method by which more power can be taken from the ton and the discovery of what kind of coal is best fitted for any particular use.

It has been everyone's business to save coal, hence The railroads have experimented with some success. They get perhaps 10 per cent of the heat energy from a ton shoveled beneath the locomotive boiler, 10 per cent of the total in the ton. They use one-quarter of all the coal mined. Next to labor this is the greatest expense which our railroads have. This shows how great the problem is to them. Some have adopted a system of paying a bonus for the greatest distance made on a given quantity of a given coal. But this laudable effort has not met with the cooperation that would be expected from the firemen, for reasons that go far afield. Industries, especially those which generate electric power, have made similar effort to gain from their fuel its greatest potentiality, and with varying success. We can overlook the stoking of the domestic furnace as a national concern, for the amount of coal used in this way amounts to not more than 17 per cent of the national coal bill, and this whole charge could be saved, it is estimated, by giving care to the 75 per cent of our coal which is burned under boilers to make steam. Here there is a maximum figure of 13 per cent of the energy of the coal put into harness, and the average is less than 10 per cent, even in the larger plants.

In one establishment visited by the fuel engineers of this department during the war a preventable waste of 40,000 tons a year was discovered. By changes in the admission of air to the furnaces and in the "baffling" of the boilers the engineers of the Bureau of Mines are confident that they have been able to increase the economy of coal in the ships of the Emergency Fleet Corporation by 16 per cent, making 6 pounds of coal do the work of 7. If such a percentage of economy could be generally effected it would mean the saving of as much coal as France and Italy together will need in this year of their greatest distress.

COAL AND COAL.

The Government should sample and certify coal. We do this as to wheat and meat; it is just as necessary to avoid injustice in the case of coal, and it is thoroughly practicable. The public should know the kind of coal it is buying, because it should buy the coal it needs. There need be no prohibition against the mining or selling of any coal,¹ but coal should sell in terms of its capacity to deliver heat. Some coal that is only a pint bottle is selling as a quart bottle. And the quart is hurt by the competition of the pint. A bill to effect such fuel inspection has been drafted and will be presented to Congress. It is not a bill commanding anything, but rather gives to those who are willing an opportunity to have their product inspected and attested and thus acquire merit in the eye of the world as against those who are not willing to subject their coal to the official test tube. Coal is coal in the sense of the classic traffic classification. Coal is, however, not always coal, nor is it altogether coal when put to the pragmatic test of the furnace. If such a bill were passed it would promote the interests of those who schedule their price upon the merit of their goods and make against the hauling of slate and dirt, its storage and handling under an assumed name. The plan is not to punish the malefactor who attempts to impose upon the public a slender number of thermal units as a ton of coal, but rather to give to every man an opportunity to advertise the number of such units

¹ In every trainload of coal hauled from the mines to our coal bins, 1 carload out of every 5 is going nowhere. In a train of 40 cars, the last 8 are dead load that might better have been left in the bowels of the earth. No less an authority than Martin A. Rooney states: "Every fifth shovel full of coal that the average fireman throws into his furnace serves no more useful purpose than to decorate the atmosphere with a long black stream of precious soot. At best one-fifth of all our coal is wasted."

The first requisite toward effecting fuel economy is to secure cooperation between owners, managers, and the men who fire the coal. Mechanical devices to increase efficiency in the use of coal can not produce satisfactory results unless the operators who handle them are impressed with the importance of their duties.

It is not essential for the plant manager to be a fuel expert, but he should be familiar with the instruments that give a check on the daily operations. It is a mistake not to provide proper instruments, for they guide the firemen and show the management what has taken place daily. Instruments provided for the boiler room manifest the interest taken by the management toward conserving fuel. It indicates cooperation and encourages the firemen to work harder to increase the efficiency.

A second factor effecting fuel economy is the selection of fuel for the particular plant. It is not expected of a plant manager that he should be thoroughly informed as to the character of all fuels; but he can enlist the services of a man who is thoroughly trained in this field. The Bureau of Mines has compiled valuable information on the character and analyses of coal from almost every field in the United States. Information concerning the character and chemical constituents of the coal, together with knowledge pertaining to the equipment of the plant, makes it possible to select a fuel adapted to the equipment, thereby insuring better combustion. Hundreds of boiler plants operate at no greater than 60 per cent efficiency, and it would be a comparatively simple matter to bring them up to 70 per cent efficiency. The saving in tonnage would be more than the combined yearly coal-carrying capacity of the Baltimore & Ohio and the Southern Railway systems. The direct saving to our industries at \$5 per ton would amount to \$200,000,000 worth of coal per year.

which his particular article contains, thus enabling the injured public to strike against an unfair mine.

Furthermore we are to become great exporters of coal, unless all signs fail, and such certification should be required as to every ton sent abroad.

EXPANSION ABROAD.

It has been said that we have too many mines in operation, as we appear to have too many miners, if we are to maintain only our present output. Rapid expansion in the development of industry in general may justify the existence of such mines and so large a corps of workers, even with an adequate car supply and more abundant local storage facilities, which are greatly needed in almost all places, and a more even demand. If, however, this should not be so, there is a foreign demand for the best of our bituminous coals, which at present we are altogether unable to meet for lack of credits on the part of those who wish the coal, and lack of ships to carry it. England's annual production has fallen 100,000,000 tons, according to Mr. Hoover, and the European demand next year will be more than 150,000,000 tons above her production. Whatever the world need, it can not be supplied. It is too large for any possible supply by ship, even if all necessary financial arrangements could be made, either by loan or credit. Europe, indeed, will sadly learn through this winter how little coal she can live on and how more than perilous is the state of a people who are short of power, light, and heat.

As this country prior to the war sold abroad no more than 4,500,000 tons as against England's 77,000,000, it is quite manifest that here will be a new field for American enterprise, the enterprise being needed not for the winning of markets as much as for finding ways of dealing with the larger phases of a heavy overseas trade with those who are without immediate resources.

SAVING COAL BY SAVING ELECTRICITY.

It is three years since Congress was urged that we should be empowered to make a study of the power possibilities of the congested industrial part of the Atlantic seaboard, with a view to developing not only the fact that there could be effected a great saving in power and a much larger actual use secured out of that now produced, but also that new supplies could be obtained both from running water and from the conversion of coal at the mines instead of after a long rail haul. A stream of power paralleling the Atlantic from Richmond to Boston, a main channel into which run many minor feeding streams and from which diverge an infinite number of small delivering lines—the whole an interlocking system that would

take from the coal mine and the railroad a part of their present burden and insure the operation of street lights, street cars, elevators, and essential industries in the face of railroad delinquencies—this is the dream of our engineers, and a very possible dream it has seemed to me; of such value, indeed, that we might well spend a few thousand dollars in studying it, not with the thought that the Government would construct or operate even the trunk line, but that it might so attract the attention of the engineering and financial world as to make it a reality.

To tie together the separated power plants of 10 States so that one can give aid to the other, so that one can take the place of the other, so that all may join their power for good in any great drive that may be projected—this would be the prime purpose of the plan; and from this would evolve the development of the most practicable method of supplying this vast interdependent system with more power—perhaps from the conversion of coal, as it drops from the very tipple, using the mine as one might use a waterfall, or by the development of great hydroelectric plants on the many streams from the Androscoggin to the James.

WHITE COAL AND BLACK.

This would be a plan for the wedding of the stream and the mine, the white coal with the black. "White coal" they call it in imaginative France, this tumbling water which is converted into so many forms; and a much cleaner, handier kind of coal it is than its black brother. And cheaper, for the water goes on to return again and fall once more and forever into the pockets of the turbine which whirls the dynamo and so gathers or releases that mystery which we name but never define. Farsighted, purposeful Germany fought four and a half years upon the strength of great power plants run by the snows of the Alps. She did not rely on these alone for power, nor were they her main reliance, but they gave her a lasting power which otherwise she would not have had. And we may expect her to improve on that war-time experience for the conduct of the hard fight she is to make in the industrial field. France saved enough territory from the invader to permit her to make new adventures into this field and so to some degree offset the coal loss of Lens. Italy found that she had still left unused opportunities for hydroelectric development sufficient with the coal she could secure from England and America to see her through the war. And with coal conditions as they are in Europe we may expect a still greater push to make use of water power to turn the industrial wheels of peace. It must be so likewise here.

And it is likely that the long-pending power bill which will make available the dam and reservoir sites on withdrawn public lands

and make feasible the financing of many projects on both navigable and unnavigable streams will soon have become law. We shall then have an opportunity that never before has been given us to develop the hydroelectric possibilities of the country. And this raises the question as to their extent.

The theoretical maximum quantity of hydroelectric power that can be produced in the United States has recently been estimated by Dr. Steinmetz, who calculates that if every stream could be fully utilized throughout its length at all seasons, the power obtained would be 230,000,000 kilowatts (320,000,000 horsepower). It is clear that only a fraction of this absolute maximum can ever be made available. The Geological Survey estimates that the water power in this country that is available for ultimate development amounts to 54,000,000 continuous horsepower.

The census of 1912 showed that the country's developed water power was 4,870,000 horsepower, about 9 per cent of the maximum power available for economic development and less than 2 per cent of the total that may be supplied by the streams as estimated by Dr. Steinmetz. According to the census, stationary prime movers representing a capacity of more than 30,000,000 horsepower, furnished by water, steam, and gas, were in operation in the United States in 1912. (This amount does not, of course, include power generated by locomotives, marine engines, automobiles, and similar mobile apparatus.) The average power furnished by these stationary prime movers was probably not more than 20 per cent of their installed capacity, so that the power produced in 1912 was equivalent to probably not more than 6,000,000 continuous horsepower.

As the estimated available water power given above represents continuous power the country evidently possesses much more water power than it now requires, so that there would be an ample surplus for many years if the power were so distributed geographically that it could be economically supplied to the industries that need it. But as a matter of fact the water-power resources of the country are by no means evenly distributed. Over 70 per cent of the available water power is west of the Mississippi, whereas over 70 per cent of the total horsepower now installed in prime movers is east of the river. Therefore unless the East is to lose its industrial supremacy it must press and press hard for the development of all water-power possibilities!

THE AGE OF PETROLEUM.

For a full century now we have been passing through different phases of industrial and commercial life which have been characterized by some form of power. First the age of steam, and then the age of electricity. We have passed out of neither and yet we have

come into another age—that of petroleum. As a lubricant, it has become of such universal use that it has been called the barometer of industry, and no doubt after it has ceased to be a popular illuminant or a source of power it will live invaluable as the thing which lets the wheels go round. Its greatest popularity now arises out of its use in the internal-combustion engine, and of the making of these there is no end. It draws railroad trains and drives street cars. It pumps water, lifts heavy loads, has taken the place of millions of horses, and in 20 years has become a farming, industrial, business, and social necessity. The naval and the merchant ships of this country and of England are fitted and being fitted to use it either under steam boilers as fuel or directly in the Diesel engine. The airplane has been made possible by it. It propels that modern juggernaut, the tank. In the air it has no rival, while on land and sea it threatens the supremacy of its rivals whenever it appears. There has been no such magician since the day of Aladdin as this drop of mineral oil. Medicines and dyes and high explosives are distilled from it. No one knows whence it cometh or whither it goeth. Men search for it with the passion of the early Argonauts, and the promise now is that nations will yet fight to gain the fitful bed in which it lies.

In Persia and in Palestine, in Java and in China, in southern Russia and in Rumania we know that petroleum is, for it has been found there. How great these fields or others in Europe, Asia, or Africa may be no one would dare to say. As yet, however, the petroleum of the world has come from this hemisphere.

The "oil spring" which George Washington found in western Virginia and by his last will called to the especial consideration of his trustees was the promise of a continental well which last year yielded 356,000,000 barrels. Each year has seen the prophecy unfulfilled that the peak of the possible yield had been reached.

From the mountains of western Pennsylvania into the very ocean bed of the Pacific and even beyond and into the broken strata of upturned Alaska, the oil prespector bored with his sharp tooth of steel and found oil. Hardly has one field fallen into a decline when another has come rushing into service. Only three years ago and all hopes were centered in Oklahoma, and then came Kansas, and then the turn went south again to Texas, and now it looks toward Louisiana. Geologists have estimated and estimated, and they do not differ widely, for few give more than thirty years of life to the petroleum sands of this country if the present yield is insisted upon. And yet there is so much of mystery in the hiding of this strange subterranean liquid that honest men will not say but that it will become a permanent factor in the world of light, heat, and power. If this is not so

we are a fatuous people, for with every fifth man in the country the owner of an automobile and the expenditure of hundreds of millions of dollars for roads fit only for their use, and with ships by the hundred specially constructed to burn oil, we have surely given a large fortune in pledge of our faith that our pools of petroleum will not soon be drained dry, or that others elsewhere will come to our help.

In 1908 the country's production of oil was 178,500,000 barrels, and there was a surplus above consumption of more than 20,000,000 barrels available to go into storage. In 1918, 10 years later, the oil wells of the United States yielded 356,000,000 barrels—nearly twice the yield of 1908—but to meet the demands of the increased consumption more than 24,000,000 barrels had to be drawn from storage. The annual fuel-oil consumption of the railroads alone has increased from $16\frac{3}{4}$ to $36\frac{3}{4}$ million barrels; the annual gasoline production from 540,000,000 gallons in 1909 to 3,500,000,000 gallons in 1918. This reference to the record of the past may be taken not only as justifying the earlier appeal for Federal action, but as warranting deliberate attention to the oil problem of to-day.

Fuel oil, gasoline, lubricating oil—for these three essentials are there no practical substitutes or other adequate sources? The obvious answer is in terms of cost; the real answer is in terms of man power. Whether on land or sea, fuel oil is preferred to coal because it requires fewer firemen, and back of that, in the man power required in its mining, preparation, and transportation the advantage on the side of oil is even greater. So, too, the substitute for gasoline in internal-combustion engines, whether alcohol or benzol, means higher cost and larger expenditure of labor in its production.

There are large bodies of public land now withdrawn, which, under the new leasing bill which seems so near to final passage after seven years of struggle and baffled hope, will in all likelihood make a further rich contribution to the American supply.

OIL SHALE.

And beyond these in point of time lie the vast deposits of oil shale which by a comparatively cheap refining process can be made to yield vastly more oil than has yet been found in pools or sands. The value of this oil shale will depend upon the cheapness of its reduction, and this must be greatly lessened by the value of by-products before it can compete with coal or the oil from wells. There is every reason to believe, however, that some day the production of oil from shale will be a great and a permanent industry. And the country could make no better immediate investment than to give a large appropriation for the development of an economical shale-reducing plant.

So conservative an authority as the Geological Survey estimates that the oil shales of the Western States alone contain many times over the quantity of oil that will be recovered from our oil wells. The retorting of oil from oil shale has been a commercial industry for many years in Scotland and France; in fact, oil was obtained from oil shale here in the United States before the first oil well was drilled. The industry is in process of redevelopment to-day and if successful will assure us of a future supply, but at the best it will take years of time and a vast investment of capital to build up the industry to such a point that it can supply any considerable proportion of our needs. It is imperative, however, that the development of this latent resource be furthered and brought to a state of commercial development as soon as possible.

SAVE OIL.

Yet with all the optimism that can be justified I would urge a policy of saving as to petroleum that should be rigid in the extreme. If we are to long enjoy the benefits of a petroleum age, which we must frankly admit fits into the comfort-loving and the speed-loving side of the American nature, we must save this oil.

We must save it before it leaves the well; keep it from being lost; keep it from being flooded out, driven away by water. Through the cementing of wells in the Cushing field, Oklahoma, the daily volume of water lifted from the wells was decreased from 7,520 barrels to 628 barrels, while the daily volume of oil produced was increased from 412 barrels to 4,716. These instances show what can and should be done in our known oil fields.

We must save the oil after it leaves the well, save it from draining off and sinking into the soil, save it from leaking away at pipe joinings, save it from the wastes of imperfect storage.

Then we come to the refining of the oil. How welcome now would be the knowledge that we could recover what was thrown away when kerosene was petroleum's one great fraction. (The loss in refineries is still startling, some 14,556,000 barrels last year—4½ per cent of the crude run in the refineries.)

The self-interest of the American refiner, notably the Standard Oil Co., has done a work that probably no mere scientific or noncommercial impulse could have equaled, in torturing out of petroleum the secrets of its inmost nature. And yet the thought will not altogether give place that in that residue which goes to the making of roads or to be burned in some crude way there may be things chemical that will work largely for man's betterment. This is the fact, too—that where the oil is produced by some small companies which have not the financial ability to make it yield its full riches there is a greater danger of loss of this kind. It would be well indeed if there could be

such regulation as would require that all petroleum must be refined. That this is done generally is not denied. It should be universal. And all the skill and study and knowledge of the ablest of chemists and mechanics should find themselves challenged by the problem of petroleum.

Coming to the use of petroleum in its various forms we find a field of promise. The engine that doubles the number of miles that can be made on a gallon of gasoline doubles our supply. There is where we can apply the principle of true conservation—find how little you need; use what you must, but treat your resource with respect. Has the last word been said as to the carburetor? Mechanical engineers do not think so. Have all possible mixtures which will save oil and substitute cheaper and less rare combustibles therefor been tried? Men by the hundred are making these experiments, and almost daily the quack or the stock promoter comes forward with the announcement of a discovery which proves to be a revelation—a revelation of human stupidity or criminal cupidity. On this line the men of science do not sing a song of the richest hope; they shrug their shoulders, exclaiming with uplifted hands: "Well, may be, may be."

There are possible substitutes for some petroleum products, but not for the whole barrel of oil; furthermore, petroleum is the cheapest material, speaking quantitatively, from which liquid fuels and lubricants can be made; therefore, any substitutes obtained in quantity must cost more. Alcohol can be substituted for gasoline, but only in limited quantity and at increased cost. Benzol from by-product coking ovens also can be used, but quantitatively is totally inadequate. For kerosene no quantitative substitute is known. Lubricants can be obtained from animal and vegetable fats, but mostly are inferior in quality, and there seems no hope of obtaining them in quantity. Fuel oil can be largely supplanted by coal, but for the internal-combustion engine there is no quantitative substitute.

USE THE DIESEL ENGINE.

We have ventured on a great shipbuilding program. Our people are to once again respond to the call of the sea. On private ways and on Government ways ships are being built to go round the world—ships that are to burn oil under boilers and produce steam. I presume that there is a justification for this policy, perhaps one that is as good, if not better, than can be made for the railroads of the West pursuing the same policy. I submit, however, that there should be justification shown for the construction of any oil-burning ship which does not use an engine of the Diesel type. To burn oil under a boiler and convert it into steam releases but 10 per cent of the thermal units in the oil, whereas if this same fuel oil were used directly in a Diesel engine, 30 to 35 per cent of the power in the oil would be secured.

Substitute the internal-combustion engine for the steam boiler and we multiply by three or three and one-half the supply of fuel oil in the United States. Instead of our fuel-oil supply being, let us say, 200,000,000 barrels, it would at once rise to 600,000,000 barrels or 700,000,000. I recognize that this is an impractical and unrealizable hope as applied to things as they are, but there is no reason why this should not be a very definite policy as to things that are to be.

This Government might itself well undertake to develop an engine of this type for use on its ships, tractors, and trucks. We simply can not afford to preach economy in oil when we do not promote by every means the use of the internal-combustion engine for its consumption. No other one thing that can be done by the Government, our industries, or the people will save as much oil from being wasted and thereby multiply the real production of the United States. If such engines are delicate of handling and need specially trained engineers, which appears to be the fact, there should be little difficulty experienced in training men for such work. A nation that could educate 10,000 automobile mechanics in 60 days might indeed develop 1,000 Diesel engineers in a year. The matter is of too great moment for delay. It touches the interest of everyone. We are in the petroleum age, and how long it will last depends upon our own foresight, inventiveness, and wisdom.

WANTED—A FOREIGN SUPPLY.

Already we are importers of petroleum. We are to be larger importers year by year if we continue—and we will—to invent and build machines which will rely upon oil or its derivatives as fuel. Our business methods have been and doubtless will continue to be developed along lines that make a continuing oil supply a necessity. Some of that oil must come from abroad, as nearly 40,000,000 barrels did last year, and for that we must compete with the world. For while we are the discoverers of oil and of the methods of securing it and refining it, piping it, and using it, our pioneering is but a service unto the world.

This situation calls for a policy prompt, determined, and looking many years ahead. For the American Navy and the American merchant marine and American trade abroad must depend to some extent upon our being able to secure, not merely for to-day but for to-morrow as well, an equal opportunity with other nations to gain a petroleum supply from the fields of the world. We are now in the world and of it in every possible sense, otherwise our Navy and our merchant fleet would have no excuse. No one needs to justify them—they are the expression of an ambition that carries no danger to any people. For their support we can ask no preference, but in their maintenance we can insist that they shall not be discriminated against.

Sometime since I presented to a board of geologists, engineers, and economists in this department this question:

If in the next five years there should develop a new demand for petroleum over and above that now existing, which would amount to 100,000,000 barrels a year, where could such a supply be found, and what policy should be adopted to secure it?

The conclusions of this board may be summarized as follows:

- (1) Such an oil need could not be met from domestic sources of supply.
- (2) It could not be assured unless equal opportunities were given our nationals for commercial development of foreign oils.
- (3) Assurance of this oil supply therefore inevitably entails political as well as commercial competition with other nationals, as other nationals controlling foreign sources of supply have adopted policies that discriminate against, hinder, and even prevent our nationals entering foreign fields.
- (4) The encouragement of and effective assistance to our nationals in developing foreign fields is essential to securing the oil needed.
- (5) Commercial control by our nationals over large foreign sources of supply will be essential if the estimated requirements are to be assured.
- (6) It is necessary that all countries be induced to abandon or adequately modify present discriminatory policies and that the interest of our nationals be protected.
- (7) Some form of world-wide oil-producing, purchasing, and marketing agency fostered by this Government seems essential to assure the commercial control over sufficient resources to meet the competition of other nationals. England has apparently adopted such a policy.

This board proposed the following program of action:

- (1) To secure the removal of all discriminations to the end that our nationals may enjoy in other countries all the privileges now enjoyed by other nationals in ours:
 - (a) By appropriate diplomatic and trade measures.
 - (b) By securing equal rights to our nationals in countries newly organized as mandatories.
- (2) To encourage our nationals to acquire, develop, and market oil in foreign countries:
 - (a) By assured adequate protection of our citizens engaged in securing and developing foreign oil fields.
 - (b) By promotion of syndication of our nationals engaged in foreign business, in order to effectually conduct oil development and distribution of petroleum and its products abroad.
- (3) Governmental action—through special agency or board:
 - (a) Through the organization of a subsidiary governmental corporation with power to produce, purchase, refine, transport, store, and market oil and oil products.
 - (b) Through the formation of a permanent petroleum administration.
- (4) To assure to our nationals the exclusive opportunity to explore, develop, and market the oil resources of the Philippine Islands, provided discriminatory policies of other nations against our nationals are not abandoned or satisfactorily modified.

I have given much thought during the past year to this problem of adding to our petroleum supply, and it has seemed to me but fair

that we should first make every effort to increase the domestic supply through the methods that have been indicated—

(1) The saving of that which is now wasted, below ground and above ground.

(2) The more intensive use, through new machinery and devices, of the supply which we have.

(3) The development of oil fields on our withdrawn territory and in new areas such as the Philippines.

In addition, we must look abroad for a supplemental supply, and this may be secured through American enterprise if we do these things:

(1) Assure American capital that if it goes into a foreign country and secures the right to drill for oil on a legal and fair basis (all of which must be shown to the State Department) it will be protected against confiscation or discrimination. This should be a known, published policy.

(2) Require every American corporation producing oil in a foreign country to take out a Federal charter for such enterprise under which whatever oil it produces should be subject to a preferential right on the part of this Government to take all of its supply or a percentage thereof at any time on payment of the market price.

(3) Sell no oil to a vessel carrying a charter from any foreign government either at an American port or at any American bunker when that government does not sell oil at a nondiscriminatory price to our vessels at its bunkers or ports.

The oil industry is more distinctively American than any other of the great basic industries. It has been the creation of no one class or group but of many men of many kinds—the hardy, keen-eyed prospector with a “nose for oil” who spent his months upon the deserts and in the mountains searching for seepages and tracing them to their source; the rough and two-fisted driller, a man generally of unusual physical strength, who handled the great tools of his trade; the venturesome “wildcatter,” part prospector, part promoter, part operator, the “marine” of the industry, “soldier and sailor too”; the geologist who through his study of the anatomy of the earth crust could map the pools and sands almost as if he saw them; the inventor; the chemist with still and furnace; the genius who found that oil would run in a pipe—these and many more, in most of the sciences and in nearly all of the crafts, have created this American industry. If they are permitted they will reveal the world supply of oil. And upon that supply the industries of our country will come to be increasingly dependent year by year.

BY WAY OF SUMMARY.

It would seem to be our plain duty to discover how little coal we need to use. To do this we must dignify coal by grading it in terms

not merely of convenience as to size, but in terms of service as to its power. We should save it, if for no better reason than that we may sell it to a coal-hungry world. We should develop water power as an inexhaustible substitute for coal and if necessary compel the coordination of all power plants which serve a common territory. New petroleum supplies have become a national necessity, so quickly have we adapted ourselves to this new fuel and so extravagantly have we given ourselves over to its adaptability. To save that we may use abundantly, to develop that we may never be weak, to bring together into greater effectiveness all power possibilities—these would seem to be national duties, dictated by a large self-interest.

I have gone only sufficiently far into this whole question to realize that it is as fundamental and of as deep public concern as the railroad question and that it is even more complex. No one, so far as I can learn, has mastered all of its various phases; in fact, there are few who know even one sector of the great battle front of power. A Foch is needed, one in whom would center a knowledge of all the activities and the inactivities of these three great industries, which in reality are but a single industry. We should know more than we do, far more about the ways and means by which our unequalled wealth in all three divisions can be used and made interdependent, and the moral and the legal strength of the Nation should be behind a studied, fact-based, long-viewed plan to make America the home of the cheapest and the most abundant and the most immediately and intimately serviceable power supply in the world. If we do this, we can release labor and lighten nearly every task. We will not need to send the call to other countries for men, and we can distribute our industries in parts of the country where labor is less abundant and where homes will take the place of tenements. One could expand upon the benefits that would come to this land if a rounded program such as has been but skeletonized here could be carried out. I am convinced that within a generation it will be effected, because it will be necessary.

The simple steps now obviously needed are to pass those primary bills which are already before Congress or are here suggested. But beyond this there is imperative need that some one man (an assistant secretary in this department would serve)—some one man with a competent staff and commanding all the resources of this and other departments of the Government shall be given the task of taking a world view as well as a national view of this whole involved and growing problem, that he may recommend policies and induce activities and promote cooperative relationships which will effect the most economical production of light, heat, and power, which is more than the first among the immediate practical problems of

science, as Sir William Crookes said, for it is foremost among the immediate practical problems of national and international statesmanship.

LAND DEVELOPMENT.

I wish now to ask consideration for another matter of home concern to which I gave attention in my last report and as to which the intervening year has strengthened and perhaps broadened my ideas—the development of our unused lands.

It was never more vital to the welfare of our people that a creative and out-reaching plan of developing and utilizing our natural resources should go bravely forward than it is to-day. Ours is a growing country, and as its social and industrial superstructure expands its agricultural foundation must be broadened in proportion. The normal growth of the United States now requires an addition of 6,300,000 acres to its cultivable area each year, which means an average increase of 17,000 acres a day.

Fortunately, the opportunity for this essential expansion exists not only in the West, where much of the public domain is yet unoccupied, but in every part of the Republic. We have a great fund of natural resources in the very oldest States, from Maine to Louisiana, which invite and would richly reward the constructive genius of the Nation. It is claimed by those who have specialized for years on the subject of reclamation that the control and utilization of flood waters now wasted would produce within the next 10 years more wealth than the entire cost to the United States of the war with Germany.

After every other war in our history the work of internal development has gone forward by leaps and bounds, and our people have thus quickly made good the economic wastes of the conflict. The needs of to-day are different from those of the past and require different treatment, but they are by no means beyond the reach of enlightened thought and action.

More than a year ago we began an earnest discussion of reconstruction policies, particularly with respect to the land. But nothing has been done. Not one line of legislation, not one dollar of money has been provided except in the way of preliminary investigation. We stand voiceless in the presence of opportunity and idle in the face of urgent national need.

A PROGRAM OF PROGRESS.

The great work of material development accomplished in the past has been done very largely by private capital and enterprise. Doubtless this must be the chief reliance for progress in the future. We should realize, however, that this method has involved losses as well

as gains, for the Nation has sometimes been too prodigal in offering its natural resources as an inducement to private effort. Not only so, but with the exhaustion of the free public lands in our great central valleys—the most remarkable natural heritage that ever fell into the lap of a young nation—conditions of home making and settlement have radically changed.

There can be no doubt that there is an important sphere of action which the Government must occupy if we are to go steadily forward with the work of continental conquest, and all it implies to the future of the Nation, but in suggesting practicable steps of progress at this time I do not forget the burden of taxation which confronts our people nor the delicate and difficult task which Congress is called upon to perform in trying to keep the national outgo within the national income. Hence, I am now suggesting such constructive things as the Government may be able to do through the exercise of its powers of supervision and direction and with the smallest possible outlay of money.

Under this head I put, first, the matter of suburban homes for wage earners; second, reclamation of desert, overflow, and cut-over areas, together with improvement of abandoned farms, under a system of district organization which may be made to finance itself; third, cooperation with various States in the work of internal development.

GARDEN HOMES FOR THE PEOPLE.

There is no more baffling problem than that presented by the continued growth of great cities, but it is a problem with which we must sometime deal. It bears directly on the high cost of living and is, indeed, largely responsible for it. Rent is based on land values. Land values rise with increasing population. The price of food is closely related to the growing disproportion between consumers and producers, resulting from urban congestion.

Here is Washington, a city of some 400,000 people, doubtless destined steadily to grow until—a Member of Congress predicts—it may touch 2,000,000 twenty years hence. Already the housing problem is acute, as it is in almost every other large American city. It would be a pitiful thing if the provision of more housing facilities to meet the needs of growing population meant merely more congestion and higher rents, with an ever-decreasing degree of landed proprietorship and true individual independence. Such conditions, it seems to me, undermine the American hearthstone and carry a deep menace to the future of our institutions. I believe there must be a better way, and that the time has come when we should make an earnest effort to find it.

Within a 10-mile circle drawn around the Capitol dome are thousands of acres of good agricultural land, of which the merest fraction has been reduced to intensive cultivation. Much of it is wastefully used, and much of it is not used at all. Conditions of soil, climate, and water supply are good and represent a fair average for the United States. Suburban transportation is a serious problem in some localities and less so in others, but tends to become more simple with the extension of good roads and increasing use of motor vehicles, including the auto bus.

Somewhere and sometime, it seems to me, a new system must be devised to disperse the people of great cities on the vacant lands surrounding them, to give the masses a real hold upon the soil, and to replace the apartment house with the home in a garden. Such a system should enable the ambitious and thrifty family not only to save the entire cost of rent, but possibly half the cost of food, while at the same time enhancing its standard of living socially and spiritually, as well as economically.

It has been suggested that there is no better place to demonstrate a new form of suburban life than here at the National Capital, where we may freely draw upon all the resources of the governmental departments for expert knowledge and advice and where the demonstration can readily command wide publicity and come under the observation of the Nation's lawmakers. And I am expecting that this experiment will be made. Such a plan of town or community life, rather than city life, should be extended to every other large city in the Nation. A simple act of legislation, accompanied by a moderate appropriation for organization and educational work, would enable the department to put its facilities at the service of local communities and of the industries throughout the United States. This form of national leadership would be of value both to investors in the local securities and to the home builders themselves. If the work of land acquisition and construction, together with the organization of community settlements resulting therefrom, were conducted under the supervision of the State or the Federal Government it would safeguard the character of the movement from every point of view.

Therefore, I put first among the constructive things which may be done by the exercise of the Government's power of supervision and direction, with the smallest outlay of money, this matter of providing suburban homes for our millions of wage earners.

RECLAMATION BY DISTRICT ORGANIZATION.

The provision of garden homes for millions of city workers will contribute largely to the Nation's food supply and become in time a most effective influence in reducing excessive cost of living for many

of our people. It will not, of course, solve the problem of increasing the number of farms and the area of cultivation to meet the needs of growing population. Neither will it enable us to expand our home market rapidly and largely enough to keep the country on an even keel of prosperity.

We must go forward with the development of natural resources as we have done for the past three centuries. And we must recognize at the outset that conditions have changed with the depletion of the public domain to the point where it offers comparatively little in the way of cultivable lands.

We have now to deal principally with lands in private ownership. This calls for a new point of view and for the application of a somewhat different principle than that which has governed our reclamation policy heretofore. Moreover, reclamation is no longer an affair of one section of the United States. The day has come when it must be nationalized and extended to all parts of the Republic.

To the deserts of the West we have brought the creative touch of water; and we must find a way to go on with this work. But it is of equal importance that we should liberate rich areas now held in bondage by the swamp, convert millions of acres of idle cut-over lands to profitable use, and raise from the dead the once vigorous agricultural life of our abandoned farms.

One more fundamental consideration—we have outlived our day of small things. Whether we would or not, we are compelled by the inexorable law of necessity arising out of existing physical conditions to cooperate, to work together, and to employ large-scale operations, and on this principle we should move: Not what the Government can do for the people, but what the people can do for themselves under the intelligent and kindly leadership of the Government.

We have an instrument at hand in the Reclamation Service which has dealt with every phase of the problem which now confronts us, and with such high average success as to command the entire confidence of Congress and the country. It has turned rivers out of their natural beds, reared the highest dams in existence, transported water long distances by every form of canal, conduit, and tunnel, installed electric power plants, cleared land, provided drainage systems, constructed highways and even railroads, platted townsites, and erected buildings of various sorts. In this experience, obtained under a variety of physical and climatic conditions, it has developed a body of trained men equal to any constructive task which may be assigned to it in connection with reclamation and settlement in any part of the country.

True economic reclamation is a process of converting liabilities into assets—of transforming dormant natural resources into agencies of living production. When such a process is intelligently applied

it should be able to pay its own bills without placing fresh burdens on the national treasury. It is in the confident belief that such is actually the case that I suggest the policy of reclamation by means of local districts, financed on the basis of their own credit but with the fullest measure of encouragement and moral support of the Government, practically expressed through the Reclamation Service.

In this connection it seems worth while to recall that with a net expenditure of \$119,000,000 the Reclamation Service has created taxable values of \$500,000,000 in the States where it has operated. The ratio is better than three to one, and that is a wider margin of security than is usually demanded by the most conservative banking methods. There is no reason to doubt that the overflow lands of the South, the cut-over areas of the Northwest, and the abandoned farm districts of New England and New York and other States would do quite as well as the deserts of the West if handled by such an organization.

What is the legitimate function of the Government in connection with reclamation districts to be financed entirely upon their own credits without the aid of national appropriations? I should say that the Government, with great advantage to the investor, the land-owner, the future settler, and the general public, might do these things:

1. Employ its trained, experienced engineers, attorneys, and economists in making a thorough investigation of all the factors involved in a given situation, to be followed by a thorough official report upon the district proposed to be formed.

2. Offer the district securities for public subscription in the open market. This, of course, would follow the actual organization of the district and the approval of its proceedings by the Government's legal experts.

3. Construct the works of reclamation with proceeds of district bond sales, and administer the system until it becomes a "going concern," when it may be safely confided to its local officers.

The most obvious advantage of Government cooperation is the fact that it would assure the service of a body of engineers, builders, and administrators trained in the actual work of reclamation. This advantage, as compared with the management that might be had in a sparsely settled local district, would often make all the difference between success and failure. Unquestionably it would materially reduce the interest rate on district bonds and greatly facilitate their sale in the open market.

There are other advantages less obvious but really more important. Experience has shown that great enterprises can best be handled under centralized control. This control, to be effective, must extend from the initiation to the completion of the project. There

can be no assurance of this when the management is left to the electorate of a local district, and without such assurance it is difficult to command the support, first, of the landowners whose consent is essential to the formation of the district; next, of the investors who must supply the money; finally, of the settlers who must purchase and develop the land in order that the object of the enterprise may be realized. The Government can give the assurance of precisely that quality of unified, centralized, permanent, and responsible control that is required to command the confidence of all the factors in the situation.

There is another advantage of Government cooperation that will inure greatly to the benefit of the settler. The Government may readily apply the policy it now uses in connection with privately owned lands within reclamation projects. It requires the owners to enter into a contract by which they agree to accept a certain maximum price for their land if sold within a given period of years. This price is based upon the value of the land before reclamation. There are many instances, particularly of swamp and cut-over areas, where land that may be bought for \$10 an acre and reclaimed at a cost of \$25 to \$50 per acre, has an actual market value of \$100 to \$200 per acre the moment it is put into shape for cultivation. If the Government, by means of a contract with the local district, undertakes the work of reclamation and settlement and does this work at actual cost, the settler will generally save enough to pay for all his improvements and equipment.

The crowning consideration is the fact that, because of all these advantages, the work of reclamation would actually be accomplished, while to-day it is not being done except in the far West, and accomplished without the aid of Government appropriations.

SOLDIER-SETTLEMENT LEGISLATION.

In the foregoing, attention has been called to those things which may be accomplished by the exercise of the Government's powers of supervision and direction with the smallest outlay of money. In all this I have been speaking of reclamation for the sake of reclamation.

The proposed soldier-settlement legislation stands on an entirely different footing. The primary object is not to reclaim land but to reward our returned soldiers with the opportunity to obtain employment and larger interest in the proprietorship of the country. The policy is based on a sense of gratitude for heroic service, not on economic considerations. This is the answer to those who have criticized it as class legislation or the proposal to grant special privileges to one element of our citizenship or as a plunge into

socialism. Frankly, we avow our purpose to do for the soldier what we would not think of doing for anybody else and what would not be justified solely as a matter of reclamation.

Many measures of soldier legislation have been introduced into Congress. Only one of these has been favorably reported. This was introduced by Representative Mondell, of Wyoming, on the first day of the present special session, embodying the plan of reclamation and community settlement brought forward by this department in the spring of 1918.

The measure has been much misunderstood and sometimes deliberately misrepresented. In the first place, it was not put forward as the complete solution of the soldier problem. It was at no time supposed or expected that all of the 4,800,000 men and women engaged in the war with Germany would or could take advantage of its provisions. It fortunately happens that the vast majority quickly found their places in the national life. Of the remainder, a very large proportion may be classified as "city minded." They have no taste for farm life but would be better served by vocational training and opportunities to enter upon remunerative trades or professions. There is an element of "country minded," and of these some 150,000 have made application for opportunities of employment and home-making under the terms of this bill. Largely they are men who have had agricultural experience but who can not obtain farms of their own without very considerable cash advances and other assistance which the Government could render. It is for this element that the policy is designed.

It has often been said that the plan would be applied only in the West and South. The truth is that it has been the purpose from the first to extend it to every State where feasible projects could be found, and that our preliminary investigations lead us to believe this will include every State in the Union.

The wide discussion of the measure has been highly educational to the country, and some of the criticism is of constructive character. For example, attention has been sharply called to the fact that in certain localities there are individual farms well suited to our purpose which may often be had at a price representing rather less than the value of their improvements. These are the so-called "abandoned farms" so numerous in the Northeastern States. In some cases they are interspersed with land now cultivated, so situated that it is not possible to bring together a large number of contiguous farms as the basis of a Government project.

In New England and elsewhere public sentiment strongly favors a modification of the pending measure which will enable the purchase of individual farms rather than community settlement. This would

be practicable only in localities where a sufficient number of farms, even if not contiguous, could be had to make possible the necessary supervision and instruction, together with cooperative organization for the purchase of supplies and sale of products. Without these advantages the plan of soldier settlement would fail in many instances. My information is that these conditions could be met. Not only so, but it is urged that existing farm communities would be inspired by the presence of soldier settlers and benefited by the presence of soldier settlers by their cooperative buying and selling agencies.

Another criticism of the pending measure is directed to the amount of the first payment the soldier settler is required to make. As the bill now stands it calls for 5 per cent on the land, 25 per cent on improvements and live stock, and 40 per cent on implements and other equipment. It has been urged by some friends of soldier settlement that no first payment should be required, but that the Government should make advances of 100 per cent in view of the soldiers' peculiar claim upon national consideration. It might be feasible to do this in the case of community settlements. But it could not be done in the case of scattered and individual farms, at least without abandoning the principles of sound business.

In the case of community settlement the soldier literally "gets in on the ground floor." Starting with a territory that is entirely blank so far as homes and improvements are concerned, he finds himself in a place where community values remain to be created. When he buys an improved farm in a settled neighborhood the situation is precisely reversed. In both cases there is or will be "unearned increment," or society-created values; but in the one case he *gets* the increment, while in the other case he *pays* it. Obviously, a larger advance would be justified in one case than in the other.

ALASKA.

One of the first recommendations made by me in my report of seven years ago was that the Government build a railroad from Seward to Fairbanks in Alaska. Five years ago you intrusted to me the direction of this work. The road is now more than two-thirds built, and Congress at this session, after exhaustively examining into the work, has authorized an additional appropriation sufficient for its completion. The showing made before Congress was that the road had been built without graft: every dollar has gone into actual work or material. It has been built without giving profits to any large contractors, for it has been constructed entirely by small contractors or by day's labor. It has been built without touch of politics: every man on the road has been chosen exclusively for abil-

ity and experience. It has been well and solidly built as a permanent road, not an exploiting road. It has been built for as little money as private parties could have built it, as all competent independent engineers who have seen the road advise.

Edwin F. Wendt, of the Interstate Commerce Commission, in charge of valuation of the railroads of the United States from Pittsburgh to Boston, after an investigation into the manner in which the Alaskan Railroad was constructed and its cost, reported to me as follows:

In concluding, it is not amiss to again state that after the full study which was given to the property during our trip, we are satisfied that the project is being executed rapidly and efficiently by men of experience and ability. It is believed that it is being handled as cheaply as private contractors could handle it under the circumstances.

The road has not been built as soon as expected because each year we have exhausted our appropriation before the work contemplated had been done. We could not say in October of one year what the cost of anything a year or more later would be, and we ran out of money earlier than anticipated. It has not been built as cheaply as expected because it has been built on a rising market for everything that went into its construction—from labor, lumber, food supplies, machinery, and steel to rail and ocean transportation. I believe, however, it can safely be said that no other piece of Government construction or private construction done during the war will show a less percentage of increase over a cost that was estimated more than four years ago.

The men have been well housed and well fed. Their wages have been good and promptly paid; there has been but one strike, and that was four years ago and was settled by Department of Labor experts fixing the scale of wages. The men have had the benefit of a system of compensation for damages like that in the Reclamation Service and Panama Canal. They have had excellent hospital service, and our camps and towns have been free of typhoid fever and malaria. That the men like the work is testified by the fact that hundreds who "came out" the past two years, attracted by the high wages of war industries, are now anxious to return to Alaska.

There has been but one setback in the construction, and that was the washing out of 12 miles of tracks along the Nenana River. This is a glacial stream which, when the snows melt, comes down at times with irresistible force. In this instance it abandoned its long accustomed way and cut into a new bed and through trees that had been standing for several generations, tearing out part of the track which had been laid.

The work of locating and constructing the road has been left in the hands of the engineers appointed by yourself. The only instruction

which they received from me was that they should build the road as if they were working for a private concern, selecting the best men for the work irrespective of politics or pressure of any kind. As a result, we have a force that has been gathered from the construction camps of the western railroads, made up of men of experience and proved capacity. That they have done their work efficiently, honestly, and at reasonable cost is my belief.

It is not possible during the construction of a railroad to tell what it costs per mile because all the foundation work, the construction of bases from which to work, the equipment for construction, and much of the material is a charge which must be spread over the entire completed line. The best estimate that can be made to-day as to the newly constructed road is that it has cost between \$70,000 and \$80,000 per main-line mile, or between \$60,000 and \$70,000 per mile of track.

This cost per mile includes the building of the most difficult and expensive stretch of line along the entire route from Seward to Fairbanks—that running along Turnagain Arm, which is sheer rock rising precipitously from the sea for nearly 30 miles. There are miles of this road which have cost \$200,000 per mile. Even to blast a mule trail in one portion of this route cost \$25,000 a mile.

The only Government-built railroad—that across the Isthmus of Panama—cost \$221,052 per mile. The only two recently built railroads in the United States are (1) the Virginian, built by H. H. Rogers, which cost exclusive of equipment \$151,000 per mile, with labor at from \$1.35 to \$1.75 per day and all machinery, fuel, rails, and supplies at its door, and (2) the Milwaukee line to Puget Sound, which is estimated as having cost \$130,000 per mile exclusive of equipment.

The work has been conducted with its main base at Anchorage, which is at the head of Cook Inlet. The point was chosen as the nearest point from which to construct a railroad into the Matanuska coal fields. That was the primary objective of the railroad, to get at the Matanuska coal. From Anchorage it was also intended to drive farther north through the Susitna Valley and across Broad Pass, and to the south along Turnagain Arm toward the Alaska Northern track. To secure coal for Alaska was the first need. So in addition to Anchorage as a base, one was also started at Nenana, on the Tanana River, from which to reach the Nenana coal fields lying to the south. If these two fields were open, one would supply the coast of Alaska and one the interior. This program has been acted upon, with the result that the Matanuska field is open to tidewater with a down-grade road all the way. The Nenana road has been pushed far enough south to touch a coal mine near the track, which may obviate the immediate necessity for reaching into the Nenana field proper.

There is an open stretch across Broad Pass to connect the Susitna Valley with the road coming down from Nenana. This gap closed, there will be through connection between Seward and Fairbanks.

MATANUSKA COAL.

By decisions of the Commissioner of the Land Office all of the claims in the Matanuska coal field were set aside, and by act of Congress a leasing bill was put into effect over the entire field. Under this law a number of claims must be reserved to the Government. The field was surveyed, and some of the most promising portions of the field have been so reserved.

Two leases have been entered into by the Government, one with Lars Netland, a miner, who has a backer, Mr. Fontana, a business man of San Francisco, and the other with Oliver La Duke and associates. There are many thousands of acres in this field which are open for lease and which will be leased to any responsible parties who will undertake their development. Government experts who have examined this field do not promise without further exploring a larger output of coal from this field than 150,000 tons a year.

The population of Alaska has fallen off during the war. She sent, I am told, 5,000 men into the Army, the largest proportion to population sent by any part of the United States. The high cost of labor and materials closed some of the gold mines, and the attractive wages offered by war industries drew labor from Alaska to the mainland. All prospecting practically closed. But with the return of peace there is evidence of a new movement toward that Territory which should be given added confidence in its future by the completion of the Alaskan Railroad. There is enough arable land in Alaska to maintain a population the equal of all those now living in Norway, Sweden, and Finland, and all that can be produced in those countries can be produced in Alaska. The great need is a market, and this will be found only as the mining and fishing industries of the country develop.

SAVE AND DEVELOP AMERICANS.

When the whole story is told of American achievement and the picture is painted of our material resources, we come back to the plain but all-significant fact that far beyond all our possessions in land and coal and waters and oil and industries is the American man. To him, to his spirit and to his character, to his skill and to his intelligence is due all the credit for the land in which we live. And that resource we are neglecting. He may be the best nurtured and the best clothed and the best housed of all men on this great globe. He may have more chances to become independent and even rich. He may have opportunities for schooling nowhere else afforded.

He may have a freedom to speak and to worship and to exercise his judgment over the affairs of the Nation. And yet he is the most neglected of our resources because he does not know how rich he is, how rich beyond all other men he is. Not rich in money—I do not speak of that—but rich in the endowment of powers and possibilities no other man ever was given.

Twenty-five per cent of the 1,600,000 men between 21 and 31 years of age who were first drafted into our Army could not read nor write our language, and tens of thousands could not speak it nor understand it. To them the daily paper telling what Von Hindenberg was doing was a blur. To them the appeals of Hoover came by word of mouth, if at all. To them the messages of their commander in chief were as so much blank paper. To them the word of mother or sweetheart came filtering in through other eyes that had to read their letters.

Now this is wrong. There is something lacking in the sense of a society that would permit it in a land of public schools that assumes leadership in the world.

Here is raw material truly, of the most important kind and the greatest possibility for good as well as for ill.

Save! Save! Save! This has been the mandate for the past two years. It is a word with which this report is replete. But we have been talking of food and land and oil while the boys and young men that are about us who carry the fortune of the democracy in their hands are without a primary knowledge of our institutions, our history, our wars and what we have fought for, our men and what they have stood for, our country and what its place in the world is.

The marvelous force of public opinion and the rare absorbing quality of the American mind never was shown more clearly than by the fact that out of these men came a loyalty and a stern devotion to America when the day of test came. Had Germany known what we know now, it would have been beyond her to believe that America could draft an army to adventure into war in Europe. There should not be a man who was in our Army or our Navy who has the ambition for an education who should not be given that opportunity—indeed, induced to take it—not merely out of appreciation but out of the greater value to the Nation that he would be if the tools of life were put into his hand. There is no word to say upon this theme of Americanization that has not been said, and Congress, it is now hoped, will believe those figures which, when presented nearly two years ago, were flouted as untrue. The Nation is humiliated at its own indifference, and action must be the result.

To save and to develop, I have said, were equally the expression of a true conservation. What is true as to material things is true

as to human beings. And once given a foundation of health there is no other course by which this policy may be effected than to place at the command of every one the means of acquiring knowledge. The whole people must turn in that direction. We should enable all, without distinction, to have that training for which they are fitted by their own natural endowment. Then we can draw out of hiding the talents that have been hidden. The school will yet come to be the first institution of our land, in acknowledged preeminence in the making of Americans who understand why they are Americans and why to be one is worth while.¹

¹ Assistant Secretary Herbert Kaufman before the Senate Committee on Education presented facts and figures which accentuate the seriousness of the national situation. Among other things he said:

"The South leads in illiteracy, but the North leads in non-English speaking. Over 17 per cent of the persons in the east-south Central States have never been to school. Approximately 16 per cent of the people of Passaic, N. J., must deal with their fellow workers and employers through interpreters. And 13 per cent of the folk in Lawrence and Fall River, Mass., are utter strangers in a strange land.

"The extent to which our industries are dependent upon this labor is perilous to all standards of efficiency. Their ignorance not only retards production and confuses administration, but constantly piles up a junk heap of broken humans and damaged machines which cost the Nation incalculably.

"It is our duty to interpret America to all potential Americans in terms of protection as well as of opportunity; and neither the opportunities of this continent nor that humanity which is the genius of American democracy can be rendered intelligible to these 8,000,000 until they can talk and read and write our language.

"Steel and iron manufacturers employ 58 per cent of foreign-born helpers; the slaughtering and meat-packing trades, 61 per cent; bituminous coal mining, 62 per cent; the silk and dye trade, 34 per cent; glass-making enterprises, 38 per cent; woolen mills, 62 per cent; cotton factories, 69 per cent; the clothing business, 72 per cent; boot and shoe manufacturers, 27 per cent; leather tanners, 57 per cent; furniture factories, 59 per cent; glove manufacturers, 33 per cent; cigar and tobacco trades, 33 per cent; oil refiners, 67 per cent; and sugar refiners, 85 per cent.

"You will agree with me that future security compels attention to such concentrations of unread, unsocialized masses thus conveniently and perilously grouped for misguidance.

"They live in America, but America does not live in them. How can all be 'free and equal' until they have free access to the same sources of self-help and an equal chance to secure them?

"Illiteracy is a pick-and-shovel estate, a life sentence to meniality. Democracy may not have fixed classes and survive. The first duty of Congress is to preserve opportunity for the whole people, and opportunity can not exist where there is no means of information.

"It is a shabby economy, an ungrateful economy that withholds funds for their betterment. The fields of France cry shame upon those who are content to abandon them to their handicap.

"The loyal service of immigrant soldiers and sailors commit us to instruct and nationalize their brothers in breed.

"The spirit in which these United States were conceived insists that the Republic remove the cruel disadvantage under which so many native borns despairingly carry on.

"How may they reason soundly or plan sagely? The man who knows nothing of the past can find little in the future. The less he has gleaned from human experience the more he may be expected to duplicate its signal errors. No argument is too ridiculous for acceptance; no sophistry can seem far-fetched to a person without the sense to confound it.

"Anarchy shall never wait for mobs while the uninformed are left at the mercy of false prophets. Those who have no way to estimate the worth of America are unlikely to value its institutions fairly. Blind to facts, the wildest one-eyed argument can sway them.

"Not until we can teach our illiterate millions the truths about the land to which they have come and in which they were born shall its spirit reach them—not until they can read can we set them right and empower them to inherit their estate.

"If we continue to neglect them, there are influences at work that will sooner or later convince them who now fail to appreciate the worth of our Government that the Government itself has failed—crowd the melting pot with class hates and violence and befoul its yield.

"We must not be tried by inquest. We demand the right to vindicate the merit of our systems wherever their integrity is questioned or maligned.

"We demand the right to regulate the cheating scales upon which the Republic is weighed by its ill-wishers.

"We demand the right to protect unintelligence from Esau bargains with hucksters of traitorous creeds.

"We demand the right to present our case and our cause to the unlettered mass, whose benightedness and ready prejudices continually invite exploitation.

"We demand the right to vaccinate credulous inexperience against Bolshevism and kindred plagues.

"We demand the right to render all whose kind we deem fit to fight for our flag fit to vote and prosper under its folds.

"We demand the right to bring the American language to every American, to qualify each inhabitant of these United States for self-determination, self-uplift, and self-defense."

Dr. Phillander P. Claxton, Commissioner of Education, in his analysis of the illiteracy figures of the census, said:

"Illiteracy is not confined to any one race or class or section. Of the 5,500,000 illiterates as reported by the census of 1910, nearly 3,225,000 were whites, and more than 1,500,000 were native-born whites.

"That illiteracy is not a problem of any one section alone is shown by the fact that in 1910 Massachusetts had 7,469 more illiterate men of voting age than Arkansas; Michigan, 2,663 more than West Virginia; Maryland, 2,352 more than Florida; Ohio, more than twice as many as New Mexico and Arizona combined; Pennsylvania, 5,689 more than Tennessee and Kentucky combined. Boston had more illiterates than Baltimore, Pittsburgh more than New Orleans, Fall River more than Birmingham, Providence nearly twice as many as Nashville, and the city of Washington 5,000 more than the city of Memphis.

"It is especially significant that of the 1,534,272 native-born white illiterates reported in the 1910 census 1,342,372, about 87.5 per cent, were in the open country and small towns, and only 191,900, or 12.5 per cent, were in cities having a population of 2,500 and over. Of the 2,227,731 illiterate negroes 1,834,458, or 82.3 per cent, were in the country, and only 393,273, or 17.7 per cent, were in the cities."

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