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H.R. 5428

BIOMASS RESEARCH AND DEVELOPMENT ACT

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HEARING

BEFORE THE

SUBCOMMITTEE ON

ENERGY DEVELOPMENT AND APPLICATIONS

OF THE

COMMITTEE ON

SCIENCE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

NINETY-SIXTH CONGRESS

FIRST SESSION

NOVEMBER 15, 1979

[No. 63]

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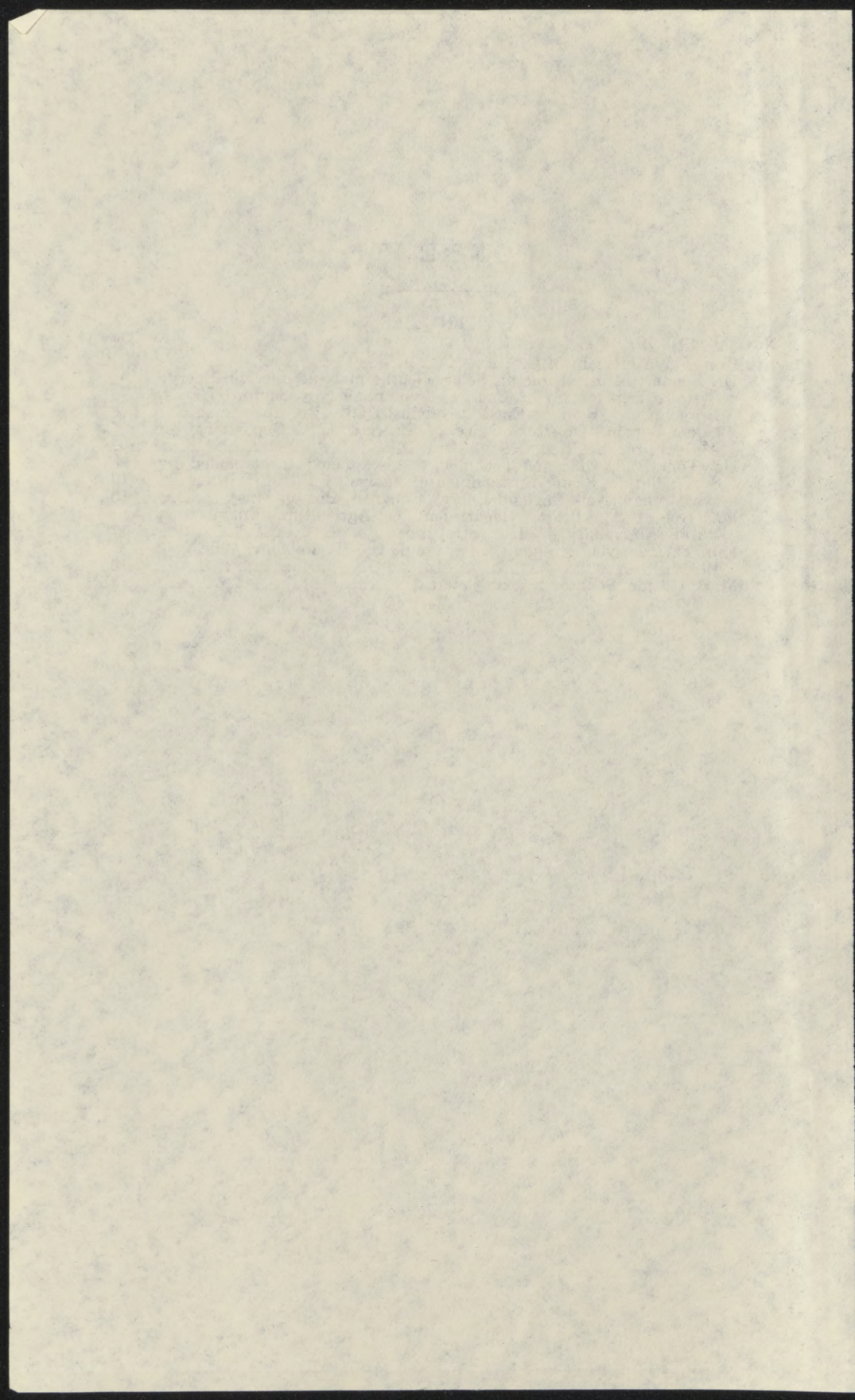
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H.R. 5428

BIOMASS RESEARCH AND DEVELOPMENT ACT

THURSDAY, NOVEMBER 15, 1979

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS,
Washington, D.C.

Mr. OTTINGER. The subcommittee will come to order.

Today the subcommittee has scheduled hearings on H.R. 5428, the Biomass Research and Development Act, which has been introduced by the gentleman from Indiana, Mr. Fithian. I would like to thank the gentleman from Indiana for his initiative, and look forward to hearing his testimony.

We adopted part of his program during the authorization bill and had made a commitment to him to have hearings on the remainder. I indicated my great interest and support for what he was trying to do, so I am pleased to be able to follow up on that today.

H.R. 5428 provides an additional \$75.6 million over the Science Committee's original authorization for biomass research and development activities in the Department of Energy for fiscal year 1980. These funds would be used to support activities for gasohol technology development, anaerobic digestic, basic research, integrated farm systems, advanced pyrolysis, agricultural and forest resource utilization, biomass power systems and commercialization efforts.

Several of these activities may be undertaken in cooperation with ongoing U.S. Department of Agriculture efforts.

Biomass is an important renewable energy resource that deserves the subcommittee's serious consideration. I hope that we will be able to review the Department's biomass programs today, and to look at the great potential offered by biomass, as well as the problems associated with the Department's present efforts to develop and commercialize biomass technologies.

Of particular interest to me is to learn how the Department of Energy and the Department of Agriculture are coordinating their efforts now, and what can be done in the future to help these departments accelerate the use of our Nation's biomass resources.

As I understand it, some of the programs that are included in Mr. Fithian's bill, H.R. 5428, were originally recommended by the Department of Energy and were cut at the instance of the Office of Management and Budget. I do think that, while we are going to hear from representatives of the Department of Energy and the Department of Agriculture today, we ought to have the OMB people up and see what is bothering them. Maybe the Department representatives here can give us some enlightenment in that regard.

We are going to have three panels today. The first panel is going to be Dr. Bennett Miller, the director of Solar, Geothermal and Electric Energy Systems, the Department of Energy, and Mr. Weldon Barton, director of the Office of Energy of the Department of Agriculture.

We are going to have the OTA with Dr. Thomas Bull and Mr. Mark Gibson from Senator Durkin's staff, who was formerly with the OTA.

The third panel will be Mr. Steve Morgan, New England Energy Congress, Dr. Robert M. Peart, Department of Agriculture Engineering of Purdue University, and Mr. Paul Tarman, vice president of the Institute of Gas Technology, Chicago.

I think we ought to have a good hearing and a thorough examination of these programs today.

Without further ado, let us hear from the author of the legislation, Mr. Fithian. Come up. We are very pleased to have you with us today, and thank you very much for your interest and your initiative. We will act as promptly as we can on your good work.

STATEMENT OF HON. FLOYD J. FITHIAN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF INDIANA

Mr. FITHIAN. First of all, I want to commend Chairman Ottinger and the members of the subcommittee for taking up the whole matter of biomass energy, and I want to thank you for accepting two of the programs in the authorization bill.

We are here today to talk about the general area of biomass and to argue the case for the other projects.

May I suggest, Mr. Chairman, that at the outset, I would like to make a part of the record here for the subcommittee a letter from Secretary Bergland, dated October 26, 1979, in response to this whole matter, and second, I would like to make available to the subcommittee as a part of the official record a September 1979 Station Bulletin No. 240 from the Department of Agriculture Economics Ag Experiment Station at Purdue University, A report entitled "Agricultural Energy Production Economic and Policy Issues."

[Material to be supplied follows:]



DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

OCT 26 1979

Honorable Floyd J. Fithian
House of Representatives
Washington, D.C. 20515

Dear Floyd:

Now that we have been able to review at some length your excellent suggestions to the President concerning USDA's role in expanding our fuel supplies, I am in a position to discuss your ideas in the context of current and contemplated USDA energy programs.

First, concerning the potential of our forests (public and privately owned) about 485 million dry tons of unused wood occurs annually due to logging and manufacturing waste, dead and cull trees, and other sources. Based on our assumption that up to half of this material might possibly be economically recovered and converted to energy, it could produce about 4.1 quads (quadrillion BTU's). This along with the 1.1 quads now being used, would provide us with about 7 percent of the nation's current energy needs.

The Forest Service is involved in research on various aspects of energy conservation and development of new energy sources applicable to forest lands and to processing and utilization of wood products. New and more efficient methods of wood utilization in housing construction is emphasized, as well as conversion of forest residues into alcohol and other energy sources. Recently, a Wood Utilization and Energy Application Program has been established to identify and promote promising demonstration projects dealing with the use of excess wood for energy. Current and future Forest Service efforts will be enhanced as a result of their recently developed long-range plan entitled "A National Energy Program for Forestry."

Secondly, the Science and Education Administration has significantly expanded energy research programs and extension educational efforts to promote energy conservation and increased use of renewable resources on farms and in rural areas. Current efforts and those planned for FY 1980 include:

- Establishment of two agricultural energy research and development centers - one for on-farm applications of solar, wind, and biomass energy including small-scale

fuel alcohol production - the other on the screening, evaluation and production of biomass feedstocks and on the improved conversion of feedstocks to alcohols and byproducts.

- Research and development projects are conducted at most State agricultural experiment stations and Federal research laboratories on improving the energy efficiency of agricultural production practices.
- Educational, training, and other assistance on energy conservation and on the use of renewable energy sources for rural residences and agricultural production are provided by State Cooperative Extension Services.
- DOE pass-through funds are used for research on agricultural applications of solar and wind energy and on-farm use of electric vehicles; demonstrations of on-farm solar application; and pilot energy extension activities.

Thirdly, the Commodity Credit Corporation with the assistance of the USDA Office of Energy has tentatively committed \$42.7 million of loan guarantees to finance four pilot projects under Section 1420 of the 1977 Food and Agriculture Act. These projects will use a combination of wood and agricultural materials to produce ethanol, wood pellets, a low BTU gas, and other renewable energy sources. However, the Commodity Credit Corporation has no specific authority to provide special subsidies for the production of alcohol for fuel, except that contained in the 1978 Emergency Act, an authority which has not yet been utilized for this purpose. New legislation would be required for the Commodity Credit Corporation to guarantee loans for the construction of distilling plants - or for any other purpose - since the authority under Section 1420 of the 1977 Act has been exhausted with the commitment to the four pilot projects previously referred to.

Fourth, the Rural Electrification Administration and the rural electric systems it finances are already engaged in many of the energy conservation activities noted in your telegram to the President. Continued financing of rural electric systems by the Rural Electrification Administration is contingent on their implementation of active energy conservation programs.

We are implementing the President's June 20 message to Congress on a national solar energy strategy directing the Rural Electrification Administration to provide short term insured and guaranteed loans to encourage energy conservation and the development of supplemental sources of energy. It is anticipated that criteria for these loan programs will be announced early in FY 1980 and that requests for financing will likely include solar heating and cooling equipment, solar crop drying, small wind generators, farm-based biomass generators and small hydroelectric facilities. Some Rural Electrification Administration borrowers are cooperating with the Department of Energy to test the effectiveness of solar and other facilities, such as the largest wind charger in the country and one of the largest solar heated and cooled office buildings.

Fifth, the Farmers Home Administration provides loans and loan guarantees for a variety of alternate energy purposes. For example:

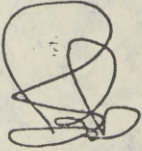
- Several recent rural housing and community facility loans have included funds for solar space and hot water heating equipment.
- A demonstration project is being conducted on a promising solar heating unit designed by the Farmers Home Administration. Six existing homes in different regions of the country were retrofitted with the unit and are being compared to similar homes with conventional heating systems to determine the cost-effectiveness of the solar unit.
- On farm energy-related projects are being financed under the Farm Ownership and Farm Operating programs. Also, Non-Farm Enterprise loans are available for projects involving off-farm sales. For example, ethanol distillation projects have been funded under this authority.
- Natural gas distribution systems in at least 30 areas have been financed under the Community Facilities program.
- Business and Industrial loan guarantees are available for energy related projects that are technologically and economically sound and meet Farmers Home Administration's other selective criteria. Recently funded projects have included coal mining, natural gas extraction, and explorations for oil off the Louisiana Coast.

- The Administration has supported pending congressional proposals to provide additional lending authority of \$100 million for each of Fiscal Years 1980 and 1981, to assist small-scale fuel ethanol distillation projects involving less than \$3 million per project of lending assistance.

In conclusion, the Department is currently involved in various efforts to conserve and produce energy, including some of the areas you have suggested. We will continue to evaluate areas where further work is needed.

We appreciate your interest in the Department's current and potential involvement in energy programs.

Sincerely,

A handwritten signature in dark ink, appearing to be "Bob Bergland". The signature is stylized with a large, looping "B" and a trailing flourish.

Bob Bergland
Secretary

**September 1979
Station Bulletin
No. 240**

AGRICULTURAL ENERGY PRODUCTION: ECONOMIC AND POLICY ISSUES

INDIANA AGRICULTURAL
EXPERIMENT STATION
1879-1979



100 YEARS OF SERVICE
PURDUE UNIVERSITY
WEST LAFAYETTE, IN

**Department of Agricultural Economics
Agricultural Experiment Station
Purdue University
West Lafayette, Indiana**

AGRICULTURAL ENERGY PRODUCTION: ECONOMIC AND POLICY ISSUES

by

Wallace E. Tyner and J. Carroll Bottum

It is the policy of the Agricultural Experiment Station of Purdue University that all persons shall have equal opportunity and access to its programs and facilities without regard to race, religion, color, sex or national origin.

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AGRICULTURAL ENERGY PRODUCTION: ECONOMIC AND POLICY ISSUES

by

Wallace E. Tyner and J. Carroll Bottum

Since 1974, our nation has become painfully aware of the domestic shortage of liquid energy sources. Currently, we are dependent on foreign sources for half the petroleum we consume in the United States. The so-called energy crisis is essentially a crisis of energy fluids and the national security problems associated with the high level of dependence on foreign sources of energy fluids. Once we recognize this, we naturally begin looking for alternative domestic sources.

The broad question facing the U.S. is which direction do we turn in our search for energy liquids and how do we reach our objectives. Coal, oil shale, enhanced oil recovery, and biomass all offer potential. It is our contention that all of these sources will be used to produce liquid energy in the future. No one source is free of problems and each offers advantages and disadvantages. To explore all the consequences of each source is beyond the scope of this paper. Rather, we are concentrating on one of the possible sources -- energy from agriculture. Production of alcohol (ethanol) from grain and agricultural by-products is being advocated as a viable alternative to imported petroleum. Ethanol can be burned directly for heat or motive power, blended with gasoline (this blend is known as gasohol), or used for industrial purposes.

In the 1920's, about 25 million horses were used to provide energy and power for agricultural production in the United States. A portion of our land and of our forage and grain crops was used to produce feed for the horses. So, one could say that agriculture was producing its own energy which was transformed into power by the horses and other draft animals to cultivate the fields and perform other on-farm work. During this period, agriculture was producing not only food but also the energy used in agricultural production. Through time the number of horses and other draft animals on U.S. farms declined, and farmers relied more on fossil fuel energy for power on farms. Today the agricultural sector has become dependent on fossil fuels, primarily petroleum, to supply much of the power for farm work.

Over the last half century, we have come full circle. In the 1920's we used a portion of our agricultural production to supply energy for power to perform farm work through horses and other draft animals. Today we are talking about using a portion of our agricultural production to produce alcohol to fuel not only farm machinery but also automobiles for the entire population of our country. We have come back to viewing agriculture not only as a source of food but also a source of energy.

In this paper we examine the potential of producing energy from agriculture, evaluate the economics of energy production from agri-

culture, and review some of the policy issues relevant to energy production from agriculture. Specifically, we discuss three types of agricultural energy stimulation policies: (1) Those aimed at the resource base, (2) Policies focused on the conversion process, and (3) Policies focused on the end use. Three basic types of resources for energy from agriculture are explored: crop residues, grains, and forage crops. The economics of energy from agriculture are evaluated for each of these resource materials and compared with other alternative synthetic fuels. The policy analysis first looks at the types of policies which are available and then evaluates some of the important alternatives to estimate the impacts of production of different levels of energy from agriculture.

Sources of Agricultural Energy^{1/}

Crop Residues

The procedure used for estimating crop residues considered both soil conservation and collectibility in arriving at the estimates for each crop. Total residue availability was estimated for each crop and region. The fraction of total acres which could be harvested for residue without causing excessive soil erosion was estimated for each crop and region. The fraction also was estimated for each land resource area and state. For those acres which could be harvested for residue, the amount of residue which needed to be left on the soil for conservation purposes was subtracted from the total amount available to get the usable residue for alcohol.

The crop residue resource estimates were calculated using a procedure which allowed residues to be removed from the soil only if soil quality would not be diminished by their removal. To the extent that this practice were followed, soil quality would not be affected by the limited residue removal. Long term studies have shown considerable changes in soil organic matter do not affect soil productivity. Also, the amount of residue which can be removed safely is a function of the crop rotation and tillage practices as well as soil type and slope. For example, under continuous corn, more residue can be removed with no-till than with chisel plow tillage. Residue removal would necessitate replacement of additional nitrogen, phosphorus, and potash. Some of the potash and phosphorus may be recycled. A modest increase in nitrogen fertilizer usage would come about if residues were removed.

In addition to deduction of residues for soil erosion control, any residue which could not be collected with current harvesting machinery

^{1/}This section is based on a comprehensive multi-disciplinary study performed by Purdue faculty in agricultural economics, agricultural engineering, and agronomy for the Office of Technology Assessment of the U.S. Congress. The study is titled, The Potential of Producing Energy from Agriculture and was completed in May 1979. The study was coordinated by Wallace E. Tyner.

was also deducted. For each crop, the total amount of residue that would be remaining on the soil after residue harvest was estimated. Deductions from this amount for erosion control and collectibility were made in arriving at the collectible surplus residue.

The total amount of residue produced each year in the United States was estimated at about 400 million tons. The total usable residue estimate is 78 million tons and is expected to range between 70 and 86 million tons per year. Table 1 summarizes the usable residue estimates by crop. Ninety percent of the usable crop residues come from corn and small grains. The majority of usable residue is concentrated in the Corn Belt and Great Plains states. The top five states--Minnesota, Illinois, Iowa, Indiana, and Ohio, contain half the total U.S. usable residues. Indiana produces 7 percent of the usable residues. Table 1 lists the usable residue in states having more than 1.5 million tons. Three-fourths of the total residues are concentrated in the top 13 states. Because of the concentration factors, it is not likely that residues would be used to a large extent in centralized conversion facilities in states other than the top 13. However, assuming two-thirds of the residues in these 13 states could be economically transported to a plant, 1.5 billion gallons (.13 quads)^{2/} of alcohol could be produced from residues each year. If three-fourths of the total usable residues in the U.S. could be economically transported to a plant, 2.3 billion gallons (.19 quads) of alcohol could be produced each year. We believe a realistic assessment of potential alcohol production from residues is in this range of 1.5 to 2.3 billion gallons per year. This assessment is purely on technical grounds and implies nothing about the economics of producing alcohol from crop residues.

If the crop residues were directly combusted in industrial or utility boilers, more energy could be produced. Using the same range of residue availability as above, 0.6 to 0.9 quads of energy could be provided from the nation's usable crop residues each year. However, direct combustion of residues likely would replace coal, a fuel that is in plentiful supply domestically.

Technology is available for harvesting residues. Experiments at Purdue and elsewhere indicate that residues such as corn stalks and wheat straw can be windrowed and collected in large bales or stacks. As would be expected, the cost of collecting, storing, and transporting residues to a central point depends on the concentration of residues in each area. In central Indiana the total delivered costs of corn residues amounts to about \$29 per dry ton. That figure includes labor, fuel, equipment, nutrient replacement, and a corn yield penalty that represents the foregone opportunity to do other tasks in the fall other than residue harvesting. Fall plowing in many areas enables the farmer to get into the field earlier the next spring for cultivation and planting which

^{2/} A quad is one quadrillion (1×10^{15}) BTU's. The crude oil in a quad is 182.7 million barrels or 7.67 billion gallons.

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TABLE 1
TOTAL USABLE CROP RESIDUE

Crop	Usable Residue (k tons)	Harvestable Acres (k acres)	Average Yield (t/acre)
Corn	37098	39122	.95
Small Grains	33623	36324	.93
Sorghum	1452	4100	.35
Rice	5457	2516	2.17
Sugarcane	590	331	1.78
Total	78220	82393	.95

TABLE 2
TOTAL USABLE RESIDUE BY STATE IN STATES HAVING MORE THAN 1.5
MILLION TONS OF USABLE RESIDUE

State	Total	Corn	S. Grain	Sorghum	Rice	Cumulative % of U.S. Total
	-----k tons-----					
Minnesota	10217	4150	6067			13
Illinois	8984	7956	1009	18	--	25
Iowa	8533	6930	1614	9	--	36
Indiana	6158	4564	1588	6	--	43
Ohio	3817	2556	1261	--	--	48
Wisconsin	3682	1716	1967	--	--	53
California	3274	250	1812	97	1115	57
Washington	2986	--	2986	--	--	61
Kansas	2526	269	1540	718	--	64
Nebraska	2357	1781	575	--	--	67
Texas	2348	582	547	--	1157	70
Arkansas	2327	10	408	55	1854	73
S. Dakota	2324	480	1844	--	--	76
Idaho	1994	21	1972	--	--	79
Michigan	1721	937	784	--	--	81
Missouri	1641	805	528	276	31	83

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increases corn yields. In some years, depending on the weather, residue harvest in the fall would limit the extent to which the fall plowing could be completed. Hence, residue harvest could result in a decrease in corn yield in some years. Our corn harvest simulation studies using actual weather data indicate that the corn yield penalty is about 1.6 bushels per acre per year on average.

Cost studies in prime crop production areas in other regions indicate that residue costs range from \$27 to \$35 per delivered dry ton. Specific analyses were performed for corn and wheat residues in York county, Nebraska, rice residue in Colusa County, California, and small grains residue in Lincoln County, Washington. All of these areas are locations with high residue concentration. As the concentration of residues declines, the cost per delivered dry ton rises. In some areas delivered costs may be as high as \$50 or even \$60 per delivered dry ton. Because such a small percentage of the residues would be taken for energy, it is anticipated that it would not make a shortage of residues for other purposes.

Conventional Grain Crops

Our analysis of the potential of producing energy from conventional crops included corn, wheat, oats, barley, rye, grain sorghum, rice, sugarcane and sweet sorghum. To estimate the potential for expanding crop production for energy, we estimated the land which might be available for increased crop acreage. Many believe that land currently unutilized for crop production is free for increasing agricultural output. In fact, there are stringent limitations on bringing additional land into continuous crop production on an annual basis.

Land availability

One of the limiting factors on bringing new land into production is rainfall. We assume that if additional land were to be brought into production, it would have to be land that now receives adequate rainfall for crop production. We do not envision the improvement of arid lands by the addition of energy intensive irrigation in order to grow energy crops. The cost of irrigation, in economic and energy terms, is fast becoming too great to allow such a development.

The requirement for adequate rainfall limits one to the central and eastern half of the United States. By examining historical land use patterns, we estimated that about 40 million acres would be available for expanded crop production after accounting for land needed for food and feed production and exports. In addition to the historical perspective, we also examined recent work assessing potential cropland availability on the basis of land quality irrespective of historical use. A recent study by the Soil Conservation Service indicates that there would be 44 million acres in the adequate rainfall region of the country that is not now cropped which has what they consider a high probability of being converted if cropland were needed. Land was given a high probability of conversion to cropland when it was thought the land would normally be converted to cropland over the next 10 to 15 years on the basis of 1974 price/cost relationships which were the most favorable in the last decade and a half. Some of this land would come from forest and non-agricultural uses, but much of it would come

from land that is historically in the cropland pasture classification. Consequently, one cannot add the land that appears to be available on the basis of historical land use statistics to the land that is most easily converted on the basis of potential. Some of the land will be included in both categories and addition of the two totals would entail double counting.

Our best estimate is that somewhere from 30 to 50 million acres would be available for expanded crop production, and some of this is land which might alternatively provide forage production for biomass energy. Assuming corn yielding an average of 65 bushels per acre were grown, 1.95 to 3.25 billion bushels of corn could be grown on this land. Producing alcohol from this corn would also yield additional quantities of distillers grains to be absorbed into the feed supply.^{3/}

If on no other than an intuitive basis, one has to be skeptical of claims that there are 80, 100, or 150 million acres of cropland just waiting for biomass production. The production of biomass from current crops and cropping systems is not more profitable than cash grain production was in 1974-75. Why did we not see this land start to come into production in 1974-75? In fact, even less land came back into production in the mid 1970's than had been diverted in all the government programs in the 1960's. Also, we have seen the price of existing high quality farmland increase well above the rate of inflation. If there were good quality land readily available with minimal improvements required, one would expect that farmers would begin to purchase this land at lower cost and improve it rather than bid increasingly higher prices on existing developed cropland. While there has been much political attention paid to foreigners and large firms buying farmland, most recent studies conclude that the bulk of farmland purchases has been by other farmers, usually neighbors. One can only suspect from this behavior that the land suitable for conversion to cropland is somewhat limited and that its conversion cost is high enough, or its productivity is low enough, that farmers continue to intensify production on existing acres rather than go extensive. However, it also must be recognized that developed land was partly bid up as a hedge against inflation. The opportunity to get a more efficient sized unit was also an important factor.

One important factor to be remembered here is that other societal concerns act to inhibit conversion of lands that might be suitable for cropland. One of the major concerns is environmental quality in the form of 208 water quality regulations. Until very recently, when grain prices rose significantly, farmers would cultivate rolling land for row crops resulting in high levels of erosion. This was one way a farmer extended his cropland base during periods of high grain prices and then contracted it during periods of low grain prices. As 208 regulations are enforced, this practice will not be possible. The decision will have to be made either to leave the land in a forage or cover crop or to go to the capital expense to improve the land by terracing or other means so that crops can be grown on a regular basis while still meeting soil runoff standards.

^{3/} One of the big, as yet unsolved, questions regarding such large levels of alcohol production is the impact of distillers grains which are produced in the process. If the distillers grains are recycled as animal feed, the amount of alcohol production could be even greater. It is also possible the distillers grains could be exported.

Another important factor affecting the availability of land for energy crop production is the variability in world food supply and demand. Because of the wide fluctuations in grain supply and demand from year to year, the land available for energy production also is likely to vary from time to time. Research is needed to estimate the impacts of this variability on the economics of energy from agriculture.

Energy from set-aside acreage

We treat the potential energy production from set-aside acreage separately because of the important policy implications involved. In 1978, about 6.1 million acres of corn land and about 8.4 million acres of wheat land were in set-aside or diversion programs. The potential production from these set-aside lands was 370 million bushels of corn and 226 bushels of wheat. When alcohol is produced from grain, for every three pounds of grain used one pound of a by-product called distillers grain is produced. That distillers grain can be fed just as corn for beef cattle or it can be substituted for soybean meal in animal diets. Since this distillers grain is recycled, so to speak, back into the animal feed system, the 600 million bushels of potential production can be increased by another 300 million to account for the recycled grain. Hence, about 900 million bushels of grain could have been withdrawn from the agricultural sector as the result of using the grains from the set-aside land. About 2.5 billion gallons of alcohol could have been produced from the excess crop production capacity in 1978. The impact of the increase in distillers grain supply needs further study.

Forage Crops

Using 1974 data, we estimated that there are about 102 million acres of pasture and hayland in the Northeastern, Northcentral, and Southern states that could support increased yields for energy production. Through more intensive management (principally increased fertilization and more frequent cuttings), forage yields could be increased by one, two, or possibly even three tons (dry weight) per acre per year. A one ton yield increase corresponds to 102 million tons per year of cellulosic biomass which could be utilized for energy. This amount is greater than the total amount of usable crop residues for all crops in the United States. However, we estimate that the forage material could be produced for a price not less than \$40 per ton and perhaps higher. This compares with residue prices beginning around \$27 per dry ton.

To estimate a range of potential energy production from pasture and hayland acreage, we assume that the lower limit is two-thirds of the one ton per acre increment and the upper limit is three-fourths of the two ton per acre increment. The energy content which would be available for direct combustion ranges from 1.0 to 2.3 quads. Alcohol production would range from 2.7 to 6.0 billion gallons per year.

Summary of Resource Availability

Table 3 summarizes the potential resource availability for crop residues, conventional crops, and forage crops. The technical energy potential

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TABLE 3

SUMMARY OF RESOURCE AVAILABILITY

Source	Potential Production	Energy Production ^b	
		Direct Combustion (Quads)	Ethanol (Bil. gal.)
Crop residues	39.7 - 58.7 Mil. tons	.6 - .9	1.5 - 2.3
Crops			
1. From available cropland not now cropped ^a	1.95 - 3.25 Bil. bu.		5.2 - 8.7
2. From set-aside acres (1978)	596 Mil. bu.		1.6
Forage	68.2 - 153.3 Mil. tons	1.0 - 2.3	2.7 - 6.0
Totals		1.6 - 3.2 ^c	11.0 - 18.6 ^d

^a The figures shown for production from available cropland assume corn is grown on this acreage. The alcohol yield would be about the same, or possibly higher, if sweet sorghum were grown on this acreage.

^b These production figures reflect only technical potential and do not imply that energy production from any of the sources would be economic.

^c Assumes crops would not be used for direct combustion.

^d These totals are somewhat high because some of the land now used for pasture is counted in both the forage and crop categories. With the available statistics, it is impossible to separate clearly these categories.

for direct combustion ranges from 1.6 to 3.2 quads assuming that grains would not be grown for direct combustion. The technical potential for U.S. alcohol production ranges from 11.0 to 18.6 billion gallons per year. Using a base U.S. gasoline consumption of 120 billion gallons, the total alcohol production potential, if all used for gasohol, could yield a mixture ranging from 9 to 15 percent ethanol. It must be stressed that these numbers represent technical potential only.

Also, these estimates do not include the potential from other agricultural sources: Specifically, forestry residues, forestry plantations, animal wastes, and agricultural wastes are excluded.^{4/} If these resources were included, the potential energy would be much higher. For purposes of this study, however, we restricted ourselves to agricultural crops and residues.

^{4/} Agricultural wastes are defined as the by-product of processing collected agricultural materials. Examples include cotton gin trash, flour milling by-products, and sugarcane bagasse.

Cost of Energy from Agriculture

Direct Combustion

Crop residue is marginally economic for use in the Midwest in utility boilers (as a coal substitute) assuming the sulfur emission standards are enforced.^{5/} Up to one quad of energy could be produced from crop residues in this application.^{6/} Heating energy cost ranges from \$1.80 to about \$2.70 per million BTUs. However, a significant portion of the available residue is in areas which can use Western coal which is cheaper and lower in sulfur content. Hence, only a fraction of a quad would be economic in practice. Because of their higher cost, forage crops would not be economic as coal substitutes currently or in the near future.

Alcohol Production

Table 4 displays the conversion costs and factors which were used in the analysis of alcohol production costs. Table 5 displays alcohol cost for each raw material for a range of feedstock prices.

Industrial alcohol

We can use the data in Table 5 to determine the economic feasibility of producing industrial alcohol from agricultural products. The current wholesale cost of industrial alcohol is about \$1.20 per gallon. Clearly, production of industrial alcohol from corn would be economic so long as the corn price is below about \$2.60 per bushel. Conversion of residues to ethanol is not economic by the conventional process, but would be economic at the lower end of the residue cost range using the Tsao/Purdue process.^{7/} Industrial alcohol production from sugarcane also is economic at the lower end of the cane price range. These results indicate that it would be economic to manufacture industrial alcohol from agricultural products. About 300 million gallons of industrial alcohol are produced each year in the U.S. from petroleum sources. About 110 million bushels of corn or 7.7 million tons of residue would fully saturate the industrial alcohol market. This amount of corn could be grown on a fraction of the corn set-aside acreage. Ten percent of the total usable crop residue would be sufficient to produce this amount of alcohol. Hence, although agricultural products are competitive in the production of industrial alcohol, the current market is quite limited.

^{5/} Currently, sulfur emission standards are not being enforced. For a study which examines the potential of corn stover as a utility boiler fuel, see Abdallah, Mohammed Hamid, "Economics of Corn Stover as a Coal Supplement in Steam-Electric Power Plants in the North Central United States," unpublished Ph.D. dissertation, Ohio State University, 1978.

^{6/} A quad is 1 quadrillion BTUs and is a common unit for measuring energy consumption.

^{7/} The Tsao/Purdue process is in the experimental stage of development. The projected costs for the process presented here are speculative and further research and development will be needed to more accurately determine the costs.

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TABLE 4

ALCOHOL CONVERSION RATES AND COSTS

Feedstock	Conversion Rate (Lbs./gal.)	Conversion Cost ^{a/} (\$/gal.)	By-Product Rate (Lbs./gal.)
1. Grain	21 ^{b/}	0.56	6.75 ^{c/}
2. Residue-conventional process	51 ^{d/}	1.20	--
3. Residue-Tsao/Purdue solvent extraction process	40 ^{e/}	0.56	--
4. Sugarcane and sweet sorghum	122 ^{f/}	0.39	--

Source: All values except the conversion cost for the Tsao/Purdue solvent extraction process were obtained from the University of Pennsylvania study team of the Office of Technology Assessment project on Energy from Biomass. The Tsao/Purdue process cost was obtained from a report by Arthur McKee Company.

^{a/} Conversion costs are net of all by-product credits and feedstock costs except the grain cost which is net of all by-product credits other than that for distiller's grain. At current market prices this credit would amount to \$0.34 leaving a net conversion cost of \$0.22 per gallon.

^{b/} This rate assumes 15.5 percent moisture corn and 12 percent moisture for other grains. All grains were assumed to have the same conversion rate.

^{c/} Distillers grains.

^{d/} Dry weight residue.

^{e/} Preliminary estimate (dry weight residue). With success in the research at Purdue and elsewhere, this estimate could fall as low as 20 lbs./gal.

^{f/} Wet cane (13-15 percent sugar).

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TABLE 5

ALCOHOL COST BY FEEDSTOCK AND CONVERSION PROCESS

Feedstock and Process	Raw Material Cost	Feedstock	Alcohol
		Cost (\$/gal.)	Cost ^{a/} (\$/gal.)
1. Corn	\$2.00/bu.	0.75	0.97
	2.30/bu.	0.86	1.08
	3.00/bu.	1.13	1.35
2. Wheat	\$2.50/bu.	0.88	1.10
	3.00/bu.	1.05	1.27
	3.50/bu.	1.23	1.45
3. Residue or forage- conventional process	\$20/ton	0.51	1.71
	30/ton	0.77	1.97
	40/ton	1.02	2.22
4. Residue or forage- Tsao/Purdue process	\$20/ton	0.40	0.96
	30/ton	0.60	1.16
	40/ton	0.80	1.36
5. Sugarcane or sweet sorghum	\$10/ton	0.61	1.00
	15/ton	0.92	1.31
	20/ton	1.22	1.61

^{a/} Conversion costs of \$0.22 for grains, \$1.20 and \$0.56 for the conventional and Tsao/Purdue residue processes, respectively, and \$0.39 for sugarcane were assumed.

Gasohol

With respect to gasohol, a very different picture emerges. Our gasoline consumption is about 120 billion gallons annually. A 10 percent gasohol blend nationally would require 12 billion gallons of alcohol. Something close to this amount could be produced from agricultural products, but currently it is not economically feasible. The wholesale cost of gasoline is about \$0.75 per gallon, as of August 1979, exclusive of excise taxes. Even the cheapest alcohol costs shown in Table 5 are higher than gasoline. Currently then, gasohol is not economic on a minimum cost basis.^{8/} In the longer term, we would expect gasoline costs to rise in real terms. However, the real cost of producing alcohol from agriculture is expected to rise, although not as much as gasoline costs. Retail gasoline costs, which currently are about \$1.00 per gallon, probably will have to rise at least to \$1.50 per gallon before gasohol would compete on a cost basis with gasoline.

Synthetic Fuels Cost Comparison

Liquid fuels can be made from a variety of domestically available solid fuel sources. In this study we have concentrated on liquid fuels

^{8/} We assume here that gasoline and gasohol perform equally well. Most research results tend to indicate this is a reasonable assumption.

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from crops and crop residues. Other potential sources include liquid fuels from enhanced oil recovery, tar sands, coal, and oil shale.

Enhanced oil recovery includes several technologies for extracting additional oil from the reserves which already have been discovered. Water, steam, or chemicals are injected into the reservoir causing additional oil to flow to producing wells. Some of the enhanced oil recovery techniques are available today and some are still under development.

Oil from tar sands also offers some potential for the U.S. although most of the world's tar sands reserves are outside the U.S. A tar sands refinery is currently operating in Canada and further expansion is planned.

For both coal and oil shale there are several candidate conversion processes being considered. Coal can be converted to methanol which can be used as a fuel directly or blended with gasoline to form gasohol. There are some technical problems with using methanol for gasohol. In cold climates it tends to separate from the gasoline if there is any water present. In warm climates, vapor lock can occur with methanol blends. Also, methanol is somewhat more corrosive than ethanol. However, additional research and development could solve these problems and make methanol based gasohol a viable fuel.

Coal also can be converted to syncrude which is an oil-like product which can be refined like petroleum. Coal can be made directly into gasoline using the Fischer-Tropsch process. Alternatively, for the future, coal could be converted into electricity to power electric vehicles.

Oil shale can be made into syncrude using either in situ or above ground retorting. With the in situ process, the oil is extracted from the shale while it is still in the ground. For above ground retorting, the shale must be brought to the surface, the oil extracted, and the waste disposed of. The above ground process uses lots of water and the water is contaminated during refining.

In this paper, we will not supply a review of the literature and recent studies that have been done on the cost of liquid fuels from coal and oil shale. The estimates change from month to month and vary widely from one source to the next. Rather, we will provide a set of figures which represent our best judgement, as of today, as to what are the likely costs of the liquid fuel alternatives. Future technical change could reduce the cost using any of the energy resources. Also, the costs could fall with experience in production.

Table 6 provides a range of estimates for costs of liquid fuels from imported oil, enhanced oil recovery, coal, oil shale, grain, and crop residues. Liquid fuels from imported oil are the cheapest even at today's high oil prices. However, the basic motive behind the drive to develop alternative energy sources is to increase our national security by providing domestic sources of energy. We have abundant coal and oil shale resources in the U.S., and, clearly, liquid fuels from these sources will play an important role in our energy future.

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TABLE 6

COST OF ALTERNATIVE SYN-FUELS

Source	Range of Costs	
	\$/bbl.	\$/gal. ^{a/}
1. Imported crude	23	.88
2. Enhanced oil recovery	15 - 50	.57 - 1.90
3. Coal liquids	25 - 42	.95 - 1.60
4. Methanol from coal ^{b/}		.40 - .80
5. Oil shale	25 - 50	.95 - 1.90
6. Ethanol from grain ^{c/}		1.00 - 1.20
7. Ethanol from residue ^{c/, d/}		1.15 - 1.35

^{a/} The \$/gal. figures for oil products are calculated by multiplying the estimated \$/bbl. costs by a factor of 1.6 and dividing by 42 gallons per barrel. This factor was obtained from the Office of Technology Assessment, U.S. Congress.

^{b/} Methanol from coal is the cheapest of the sources on a per gallon basis, but it also contains the least energy per gallon. Methanol contains 63542 BTUs per gallon, ethanol 84861, and gasoline 127654.

^{c/} If the ethanol has to be transported any significant distance, there would be a transport or distribution charge which has been estimated at 20 cents per gallon for a 1,000 mile haul. However, offsetting that cost, ethanol has a value as an octane booster over and above its direct value as a fuel. This value has been estimated to range between 5 and 30 cents per gallon. Hence, these two factors may offset each other, and neither is included in these estimates.

^{d/} The residue costs are for the Tsao process or one of the other competing advanced processes. Conventional process costs would be considerably higher.

There are, however, environmental hazards associated with mining and processing coal and oil shale. Air and water pollution would be increased. Water requirements for processing are large. Much of the coal would be stripmined and land restoration will be expensive and in some areas extremely difficult. The environmental problems associated with above ground retorting of oil shale are quite severe. Disposal of the spent shale after the oil is extracted is a serious problem. The spent shale material has a greater volume than the original shale rock. It appears that energy and environmental tradeoffs will have to be made.

Any of the sources listed in Table 6 can and probably will be used as we make the transition from oil to a diversity of alternative sources of

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liquid energy. The cost ranges for most of the alternatives overlap. All of the coal and oil shale processes are in the development stage, and it will probably be ten years before significant amounts of liquid fuel can be obtained from these sources. The residue processes for alcohol also are being developed, and it will be at least five years before significant amounts of ethanol can be produced from cellulosic products. In the near term, enhanced oil recovery and production of ethanol from grains and sugar crops appear to be the most promising options. However, over the longer term, the total amounts of liquid fuels which potentially can be produced from these sources are much smaller than the potential of liquid fuels from coal or shale.

Policy Issues

In this section we describe current agricultural policy for grain crops, provide a framework for evaluating policy alternatives for production of energy from agriculture, and conclude with a general overview of impacts of the various policy alternatives. It is beyond the scope of this paper to provide a comprehensive analysis of all the possible policy options. Rather, we will present the major options and provide a framework for analysis of the options.

For readers not familiar with current agricultural policy, a brief summary has been included in an Appendix. This summary may be helpful to provide a basis for comparison of the energy stimulation alternatives.

Policy Alternatives for Developing Energy from Agriculture

Before embarking on a discussion of policy alternatives designed to stimulate production of energy from agriculture, we should make it clear that one of the options is to do nothing. Clearly, one future path is to continue agriculture programs as is or at least to keep energy and agricultural policy separate. This path might be chosen for several reasons. First, if we believe a world food crisis is imminent, we may want to keep idle capacity in agriculture. Second, if we believe because of cost or for other reasons that coal or oil shale are preferred alternatives, we may want to restrict ourselves to policies oriented towards those fuels. Third, if we believe that markets will produce a result superior to any outcome from government intervention, we could choose to do nothing. So as we review the set of options designed to stimulate production of energy from agriculture, we should remember that the stimulus set of alternatives is one route and the status quo is another.

For purposes of this discussion, we will divide the stimulus policy options into three categories: 1) policies to stimulate the supply of agricultural raw materials, 2) policies to subsidize the conversion process, and 3) policies to subsidize the end product. To date, legislation has been suggested, introduced, or passed in each of these areas. No doubt, our eventual policy mix will consist of policies in each category. Table 7 lists some of the important options which have been proposed or passed in recent years. The table lists six policies designed to stimulate production of raw materials, three policies designed to provide incentives for building processing facilities, and three policies designed to encourage consumption of the final product. Obviously, there are relationships between the various policy alternatives, but they are discussed separately in order to better describe each individual alternative.

TABLE 7

ENERGY FROM AGRICULTURE POLICY ALTERNATIVES

Raw material	Conversion processing	End product
1. Processors could purchase raw materials on the open market.	1. Tax advantages such as accelerated depreciation or increased investment tax credits for conversion facilities.	1. Gasohol tax exemption (4¢/gal.).
2. Eliminate the current set-aside program and provide price supports for major agricultural commodities. CCC acquired grain would be sold to processors at a subsidized rate.	2. Investment subsidies.	2. Direct per unit subsidies to the producer or marketer of alcohol or gasohol.
3. Contract with farmers to buy a certain fraction of their crop at the target price and then sell the crop at a subsidized rate. ^{a/}	3. Investment loan guarantees.	3. Tax credits for consumption of gasohol.
4. Continue existing farm policy but establish an additional policy to produce alcohol from corn.	4. Government owned alcohol plants.	4. Additional tax on non-gasohol fuel.
5. Policies designed to stimulate use of crop residues such as subsidies to processors who use residues.		
6. Policies designed to stimulate use of forage crops such as subsidies to processors who use forage crops.		

^{a/} This option is similar to the approach in H.R. 3905 introduced by Congressman Bedell of Iowa.

Raw material policies

The first raw material oriented policy is basically a market version where processors would purchase raw materials on the open market as needed for conversion to alcohol. This policy would be used primarily in conjunction with either end product subsidies or subsidies for the conversion process. If end product subsidies and conversion processing subsidies were considered adequate to stimulate production of alcohol from agricultural products, further policies to stimulate production of raw material might not be needed.

The second option provides for elimination of the current set-aside program and for the use of price supports to encourage production of crops on previously set-aside land and to maintain farm incomes. The CCC (Commodity Credit Corporation) would acquire any grains farmers chose to sell at the price support and would in turn sell the amounts of grain needed for conversion to alcohol to processors. This would require larger reserves to take care of our energy needs in unfavorable crop years. The sales to conversion processors would be at a subsidized rate. In essence, this policy attempts to transfer the current expenditures used to idle land into a subsidy for conversion of corn grown on that land into alcohol. Price supports would need to be established so as to maintain farm income stability and achieve production of grains from previous set-aside lands but not sufficiently high to bring in substantial quantities of marginal land into production.

The third option to stimulate production of raw materials is basically that proposed in H.R. 3905, the Bedell Amendments to the Farm Act in the current Congress. Farmers who agreed to participate in the agricultural program each year would be required to sell to the Secretary of Agriculture ten percent of their production at the target price. Currently, the target price is above the market price for major grains so there would be an incentive to join the program. In other years, the market price could rise above the target price and little or no grain would be acquired by the Secretary. In both this option and the previous one the Secretary would enter long term contracts with alcohol producers to sell them grains at a subsidized rate. The contracts probably should be written to provide for price escalation as the price of gasoline and alcohol rise through time.

A fourth option would be to continue existing commodity programs but to establish an additional demand for grains through a gasohol program. Under this policy option, crop support programs would be structured in basically the same way they are currently. In actual practice, however, the programs would operate quite differently because set-aside area probably would diminish as the demand for grains increased with the additional demand for alcohol.

The fifth and sixth options are designed to stimulate the use of crop residues and forage crops for alcohol production. These options could be used with or without excess production capacity conditions. The policies could be administered by providing a per unit subsidy to conversion processors who use residues or forage crops as input materials. For example, the federal government might announce a policy to provide a payment of \$5.00 per ton to producers who use crop residues or forage crops as input materials for a conversion facility. For forage crops, another option might be to establish a forage crop price support program somewhat similar to existing crop support programs or to the price support program outlined in option (2) above. We estimate that support prices for forage crops would need to be at least \$40 and perhaps \$50 per dry ton for the program to be effective. Support prices at this level would make alcohol production, even with advanced conversion technologies, quite expensive. In contrast, delivered residue costs may be around \$30 per dry ton in some areas.

Conversion subsidies

In this section we list three possible policy alternatives. The first is a package of possible tax advantages such as accelerated depreciation or increased investment tax credits for construction of alcohol conversion facilities. These tax incentives could operate much the same as the tax incentives built into the 1978 Energy Act. The second option is for direct investment subsidies. Under this option, the government would pay a percentage of the investment costs for new alcohol production facilities. The last option provided here is an investment loan guarantee. This option has already been implemented, and four investment loan guarantees have been provided.

End product subsidies

The first alternative in this approach, the gasohol tax exemption at the federal level, has already been passed by Congress and is being implemented. The option consists of exempting the four cent per gallon federal gasoline tax for sales of gasohol. This four cent per gallon subsidy amounts to a forty cent per gallon subsidy for alcohol because alcohol is only one-tenth of the product gasohol. Another means of subsidizing the end product would be to provide direct payments to alcohol producers for each gallon of alcohol or gasohol produced. Alternatively, tax credits could be provided for consumers who use gasohol. This could come in the form of an additional tax credit for gasohol consumption above and beyond the current gasoline tax credit or eliminating the current gasoline tax credit but retaining it for gasohol.

Impact of Policy Options

Table 8 provides a framework for evaluation of the impact of the alternative policy options briefly described above. The first column lists performance characteristics which could be used in evaluating the effectiveness of each of the types of policy alternatives. The remaining three columns provide the three categories of policy options reviewed in this paper. In any actual analysis one would want to list not only the categories of options but the actual specific options under consideration so that the columns under Raw Material would list all six options which were reviewed above. To perform an analysis of the policy options, we would want to examine the effectiveness of each of the options with respect to the performance characteristic described in the first column. For the purposes of this paper, we will merely point out some probable impacts and general indications of effectiveness in achieving the listed objectives. No attempt will be made to complete the matrix.

The first objective of increasing stability in quantity and price of raw materials is affected only by some of the raw material oriented policies. The processing and end-product subsidies would help provide an increased demand for agricultural commodities, but would not greatly diminish uncertainty in the price unless they caused such a huge change in demand that excess production capacity was eliminated. Because the availability and price of raw materials is considered to be such an important factor,

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TABLE 8

FRAMEWORK FOR IMPACT OF POLICY OPTIONS

Performance Characteristic	Raw Material	Processing	End Product
1. Stability in quantity and price of raw materials.			
2. Management efficiency.			
3. Administrative ease.			
4. Conversion flexibility.			
5. Level and stability of food and feed prices.			
6. Level and stability of agricultural exports.			
7. Government expenditures.			
8. Structure of agriculture.			
9. Economic efficiency in agriculture.			
10. Farm income.			

some sort of raw material oriented policy would have to be included in any viable package of policies to be used. Also, storage policies for raw material reserve may be required as a part of supply policy if sources are not diverse.

Management efficiency refers to the impact the policy has on the incentive for management (processors) to be efficient. Subsidies if not properly designed, may provide leeway for inefficient management or use of the subsidy for non-targeted program objectives.

Some of the policies are quite difficult to administer, and others would be quite simple. Ease of administration and enforcement should be considered in any evaluation of alternatives. For example, any policy which requires a separate stream of grain for alcohol conversion would be more difficult to administer than one which uses a common market for energy and food/feed.

Conversion flexibility refers to the ease of conversion to alternative (probably residue) feedstocks if grains become in short supply. For example, since grains are in excess supply now, the government could require that any plant constructed to use subsidized grains be built in such locations and with technical design characteristics that it could be converted to residues in the future.

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The level and stability of food and feed prices and exports are important performance characteristics of alternative programs. Programs that allocate large amounts of grain to alcohol production may adversely impact these performance characteristics. Also, the issue of the impact of conversion by-products needs to be better understood.

For any public policy, the level of government expenditures required to implement the policy is an important performance characteristic. The Federal treasury cost, as well as social cost of each alternative should be estimated.

Structure of agriculture refers to impacts on the family farm, land ownership, and land prices and other related factors. High levels of energy production from agriculture could cause significant changes in the structure of agriculture.

Some policies could distort production decisions and reduce economic efficiency in agriculture. Farm income as measured by gross intake, would probably be increased slightly by any of the subsidy proposals.

Combinations of Options

It is already quite clear that a combination of policy options likely will be used. The federal gasohol tax exemption has already been passed. Several states, including Indiana, have also passed exemptions. Investment loan guarantees have already been established. Variants of the raw material options have been proposed, introduced into legislation, or passed by Congress. It appears that Congress would like the policies to be oriented towards all three target areas: 1) raw material stimulation, 2) conversion processing, and 3) end-product.

Conclusions

Without an exhaustive analysis of the alternative options, singly and in combination, we cannot say which would be preferred or even what the precise impacts of the various options would be. However, we can make a few general statements about the viability of producing various levels of energy from agriculture.

First, we will focus on relatively low levels of energy from agriculture. Currently, the U.S. government is paying farmers to idle wheat and corn land. In fact, land "set-asides" have existed in one form or another for most of the past twenty years. Farmers participated in the set-aside program because they saw advantages in doing so. Some felt it would reduce supply and therefore was in their own interest and the interest of agriculture to do so. Some were wanting to cut back on their individual farm operation which set-aside allowed them to do more profitably. Some participated in the set-aside program because of the crop insurance features and still others because of the storage features of the program. A limited number set aside land because, with the anticipated prices, they believed it would make them a higher return from their crops. Therefore, producers participated for all of these reasons. Over the past seventeen

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years the direct payments to farmers for idling land have averaged \$1.6 billion per year. If we believe that excess capacity in agriculture is likely to continue to exist in the future, it appears reasonable to explore options which would make use of this land and reduce or eliminate the set-aside payments to farmers.

In a study recently completed at Purdue, two policy options were evaluated, both of which are designed to make use of the excess production capacity for corn.^{10/} The options were essentially the same as raw material options 2 and 4 from Table 7. One calls for an elimination of the set-aside program and substitution of price supports with no production controls. The second option essentially continued the current agricultural programs but with a demand for corn for alcohol stimulated by subsidies to alcohol producers. Interestingly, both options resulted in virtually no change in the performance characteristics of corn and soybean prices and export levels. Government expenditures were unchanged in the first option but increased slightly in the second option. These results held for alcohol production levels of 1 and 2 billion gallons per year.^{11/}

The importance of these results is that for low levels of alcohol production (around 2 billion gallons), it appears that the existing set-aside subsidy could be transferred effectively to a subsidy for alcohol production without creating adverse effects elsewhere in the economy. Essentially, this means that, if we choose, we could begin to produce alcohol from agriculture in substantial quantities relative to current alcohol production with little or no cost to the American people.

The analytical results were quite different for alcohol production levels significantly beyond the 2 billion gallon per year level. Results from two different studies have indicated that feed and food grain prices would increase and exports decrease at higher alcohol production levels.^{12/} While the models used in these studies may not be accurate for such large changes, they do indicate the possibility of larger energy production from agriculture causing severe dislocations elsewhere in the economy.^{13/}

^{10/} R. L. Meekhof, W. E. Tyner and F. D. Holland, "U.S. Agricultural Policy and Gasohol: Simulation of Some Policy Alternatives," Dept. of Agricultural Economics, Purdue University, June 1979.

^{11/} Gasoline consumption in the U.S. is about 120 billion gallons per year, so this production would amount to about 2 percent of total gasoline consumption.

^{12/} R. L. Meekhof, W. E. Tyner and F. D. Holland; and Tyner, et al., The Potential for Producing Energy from Agriculture.

^{13/} Alternatively, a long term commitment to energy production from agriculture could induce positive effects. A long term supply response, both in the U.S. and abroad, could provide a measure of stability in international markets not now present.

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However, any change in agricultural policy in the direction of using agriculture for food, feed, fiber, and energy would be implemented slowly. We would not move to producing 3 billion gallons of alcohol overnight. Therefore, it appears that we could begin to adopt policies which stimulate production of energy from agriculture with low cost to society and low risk. In the meantime, we certainly would want to continue to evaluate alternative policies and to review the situation as conditions change. If we wait until all the answers are in, we will have lost valuable time and resources in our struggle to produce more liquid energy at home.

APPENDIX

CURRENT AGRICULTURAL POLICY

The government in this century has been involved in agricultural policy since 1929 when the Federal Farm Board was formed. Various types of price supports and production controls have been utilized over the years with changes in farm legislation. The Food and Agriculture Act of 1977 is one of the most comprehensive pieces of farm legislation ever passed by the Congress. Together with minor changes contained in the Emergency Agricultural Act of 1978, the 1977 Act is the basis of current agricultural policy. This section contains a brief description of its key provisions and provides definitions of important terms.^{1/}

First, we define the terms that are important to understanding current policy provisions:

target price--The target price concept is used as a basis for making a direct income payment to farmers for certain crops. It provides a means for varying support payments to producers inversely with the market price. Target prices are adjusted annually based on USDA estimates of production costs excluding land and returns to management. The Secretary of Agriculture also has discretionary powers to adjust target prices in certain situations. If the market price falls below the target price, eligible farmers receive deficiency payments based on the difference between the target price and market price.

deficiency payments--Deficiency payments are made when the average market price received by farmers during the first five months of the marketing year is less than the target price. The payment is the smaller of two differences: (1) target price minus loan rate, or (2) target price minus average market price. Deficiency payments are made only on production from each farm's share of the "national program acreage."

disaster payments--Disaster payments are made for major commodities when natural disasters prevent normal planting operations or, after planting, if the crop harvested is less than 60 percent of normal production. The disaster payment rate is 50 percent of the target price for the deficit in production below the 60 percent level.

^{1/} This section draws heavily upon the following sources: J. B. Penn and W. H. Brown, "Target Price and Loan Rate Concepts for Agricultural Commodities," in Agriculture-Food Policy Review, ERS-USDA (1977); T. A. Stucker and W. T. Boehm, A Guide to Understanding the 1977 Food and Agricultural Legislation, ESCS-USDA Report No. 411 (1978); M. A. Martin, "Major Provisions of the 1979 Wheat and Feed Grain Programs," in The 1979 Farm Program, EC-484, CES Purdue University (1979); and Commodity Program Provisions Under the Food and Agriculture Act of 1977, AER No. 389, Economic Research Service, U.S. Department of Agriculture (1977).

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national program acreage--The national program acreage for wheat and feed grains is the estimated acreage required to meet domestic, export, and inventory adjustment needs for the crop year. The allocation factor is determined by dividing the "national program acreage" by the estimated national acreage harvested for each crop and is used to determine individual farm program acreage.

nonrecourse loans--With these loans the producer pledges specific amounts of his crop as collateral and the amount that can be borrowed is equal to the loan rate times the quantity put under loan. At the end of the loan period (nine to 12 months with extensions possible) the farmer may either repay the loan with interest or forfeit the stored grain as payment for the loan.

loan rate (support price)--The loan rate is the rate at which farmers can borrow on their crop production. The loan rate effectively serves as a commodity price support if there is adequate participation in the program.

set-aside--To be eligible for deficiency payments, nonrecourse loans, or disaster payments, farmers must participate in a government voluntary program of taking a fraction of their normal acreage out of production (the set-aside). For 1978 and 1979, wheat set-aside has been 20 percent and corn set-aside 10 percent.

cross-compliance--To be eligible for any program benefits, a farmer is required to meet set-aside requirements for all crops he plants. In other words, a farmer growing both wheat and corn must participate in both programs to receive benefits from either.

farmer-held reserve--The farmer held reserve program allows farmers to extend the nonrecourse loan on their grain plus receive a prepaid storage payment. Upon completion of the nonrecourse loan, an eligible producer can sign a three year contract to enter the farmer-held reserve. He agrees to hold the grain for that period or until the market price reaches the release level which is 140 percent of the loan rate for wheat and 125 percent of the loan rate for corn. The producer pays interest only during the first year of the three year period at seven percent per year. Farmers can release the grain earlier by paying a penalty.

Operation of the current farm price and income program is illustrated under three different sets of circumstances in Figure 1. In panel A the market price is above the target price and loan rate. In this situation, farmers would sell their crops in the market and no deficiency payments would be made nor loans requested. In panel B the market price is below the target price but above the loan rate. In this situation, farmers would not elect to take the non-recourse loan but would receive a deficiency payment equal to the difference between the target price and market price times the farmers' production from program acreage, $(P_t - P_m) * Q_a$, which is the hatched area in panel B. In panel C the market price is below both the target price and the loan rate. Farmers would be likely to take advantage of the nonrecourse loan program which would increase their revenue for the crop from $Q_b * P_m$ to $Q_b * P_l$ or by the amount $Q_b (P_l - P_m)$. In addition,

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farmers would receive an additional deficiency payment on their program acreage equal to $Q_a \cdot (P_t - P_l)$. In practice, the loan rate becomes an effective price floor below which market price is unlikely to fall.

The farm program really has two major effects. The deficiency payments are an income transfer from the general public to farmers, and have little effect on market prices. The loan program is, essentially, a price support which tends to increase prices to consumers up to the level of the loan rates and transfers income from consumers to farmers. The current program splits the incidence of income transfer between consumer payments (if farm price is below the loan rate) and general tax revenues (for deficiency payments).

This description of the current farm program is a gross simplification. Many complexities were omitted and some less important features were not described at all. Nonetheless, the background information may be useful for our discussion of policy alternatives.

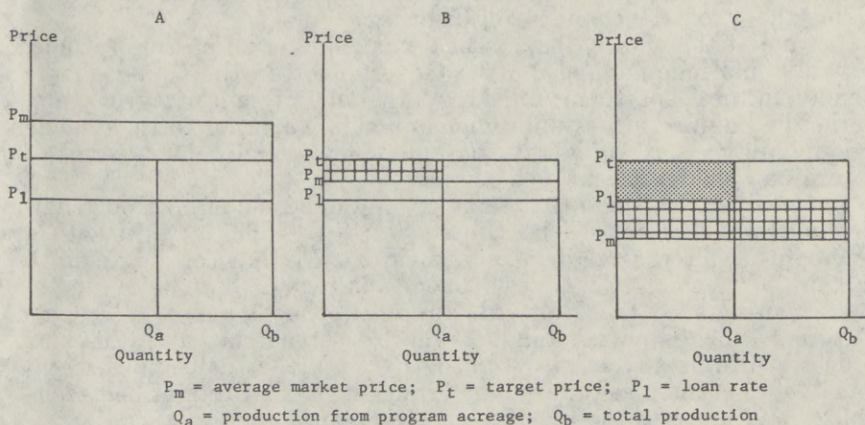


FIGURE 1. OPERATION OF THE CURRENT FARM PROGRAM

Let me also invite the chairman of the subcommittee and members to join with me in promoting a revolution.

I am talking about a revolution in our whole thinking on energy. A revolution the time of which has come, and perhaps is overdue, and let me suggest that the elements of the revolution, that is, things that we have to overcome, will first be ourselves as Members of the House on this matter, because we have had many pieces of legislation and we are, at the same time, dulled in our appreciation for energy change, and second, we are overpowered in some ways by other more powerful interests and powerful movements in energy, such as nuclear and synthetic fuels and others. So our first part of the revolution will be in the House.

The second part of the revolution will be to convince the agencies, namely the Department of Energy and the Department of Agriculture, to change their ways. In the case of the Agriculture Department, you are talking about an old institution that's been around for a very, very long time, and they have gotten involved in many, many things that do not involve or do not attend to bioenergy systems.

In the case of the Department of Energy, they are a newer agency, but they, too, have made it clear to all of us that bioenergy is the "orphan child" of the energy family, and they are under enormous pressure from the same kind of groups, whether it's the oil industry, the nuclear industry or the coal industry or others to shunt onto a siding the whole development of bioenergy.

Let me at the outset, then, issue a challenge to all of those people. I would challenge anybody in the Government, in the House, in the Senate, in the Department of Energy, the Department of Agriculture, or in the engineering establishment outside, to bring forth a single example in the field of energy that is one-half as efficient in terms of return on our investment as bioenergy.

Let me also challenge that same group, and include in it our engineering establishment in the United States to come forward with a single, other alternative development in energy that can be made to match the calendar for delivery time of bioenergy.

The authors of the Harvard Business School's report, "Energy Future," which is an outstanding work, observed that an ideal solar collector has already been designed. Requiring virtually no maintenance, it is economical and nonpolluting; it uses an established technology and it stores energy. It is called a plant.

When we talk of biomass conversion technology, we are really talking about ways of tapping the stored energy of plants. We can burn them directly for energy, we can let them decompose under controlled conditions to produce methane; we can heat them under pressure to produce oil and natural gas substitutes; or we can ferment their sugars to produce a premium liquid fuel, alcohol.

While they have never been fully inventoried, biomass resources around the world are huge. One expert recently estimated that 10 times as much energy as the world consumes every year is collected and stored by plants. But the real question is not, of course, how much plant matter there is, but rather, how much of it is economically available for energy without threatening its other important end uses, such as food, clothing, building material production, or damaging the long-term productivity of the soil.

Three important major categories of resources which meet these criteria are: wood wastes, crop wastes, and municipal solid wastes.

The Department of Agriculture estimates that approximately 485 million dry tons of unused wood is left to rot in U.S. forests every year. Based upon the assumption that one-half of this could be recovered and economically converted to energy in an environmentally sound way, it could produce to 4.1 quads of energy per year, about 5.2 percent of our annual energy consumption.

I have provided the subcommittee with a copy of that USDA estimate for the record.

Purdue University, which has done a great deal of work in this area under the auspices of its renewable resources laboratory, estimates the total annual U.S. crop residue production at about 400 million tons. These are residues, mind you, not food. Usable residues, that is, those not required for soil enrichment and which can be economically collected, are estimated to range between 70 and 86 million tons per year.

If three-quarters of these usable residues were burned directly as a boiler fuel, they could produce between 0.6 and 0.9 quads per year. If the same residues were converted to alcohol, the contribution would be less, on the order of about 0.19 quads per year.

I have included with my written testimony a copy of the Purdue crop residues resource assessment that I have cited.

Finally, municipal solid waste could provide about 1.5 quads of energy per year, according to the Office of Technology Assessment report entitled "Materials and Energy from the Municipal Waste." The report, which focused on a broad range of issues associated with resource recovery and recycling of MSW—municipal solid waste—estimated that another 0.3 quads of energy could be saved in the process as a result of recycling metals and glass contained in the MSW.

OTA's report, like the others I have cited, makes realistic assumptions about the economic and environmental constraints on energy applications of biomass resources. I am aware that other more optimistic assessments are available, but I would like to keep our discussion on the topic as realistic as possible and, I might say, as conservative as possible, for even within the conservative constraints of all of the estimates, there is a tremendous opportunity in terms of biomass.

Even using these conservative figures, the total energy contribution biomass resources could make is staggering. The combined contribution of the three resources I have mentioned here today is between 6.2 and 6.8 quads of energy every year.

To put this into perspective for those among us who are not used to thinking in terms of quadrillion British thermal units, this amounts roughly to 8 percent of our total energy consumption last year; one-third of our entire imported oil; one-half again as much energy as the President's original synfuels bill and program; more than twice as much energy as all of the nuclear plants in the United States produced last year; or nearly three times as much energy as was produced on Alaska's North Slope in 1978.

So, as you can see, biomass is not a minor source of energy, but rather a major energy resource which we can no longer afford to ignore.

Our goals are simple. In July 1978, Agriculture Secretary Bergland outlined the first of the administration's bioenergy goals in testimony before the Senate Agriculture Committee. These goals included net energy self-sufficiency by 1990 in forestry production and processing under conditions that sustain forest productivity.

A more ambitious goal, that of achieving 20 percent of the country's energy needs from solar and renewable resources, including biomass, by the year 2000, was declared by President Carter in his June 20, 1979 message on solar energy.

These are ambitious, but achievable, goals; goals which have broad support among our people. The question we must ask ourselves as legislators is whether present policies and institutional arrangements in the agencies over which we have jurisdiction will allow us to achieve these goals.

My own evaluation is that we will miss the mark by a wide margin, unless we organize and energize these agencies to meet the challenge.

Despite the President's decision to establish ambitious goals for renewable energy resources—including biomass—the Federal biomass program receives relatively low priority in both the Department of Energy and the Department of Agriculture.

Only \$57.8 million—a 7.6 percent—of the total \$4.4 billion spent by the Federal Government this fiscal year on energy supply is devoted to biomass programs jointly administered by USDA and DOE. Of that relatively small amount, far too much is being spent on exotic 21st century concepts, such as kelp farming and energy plantations, rather than on short-term technologies with more immediate applications. Neither agency has used existing legal authority fully to develop the great potential of biomass energy.

There is, fortunately, a legislative solution to these problems. H.R. 5428 is a step in that direction.

Within DOE, the fuels from biomass program has been plagued by managerial and staffing problems since its inception, problems which are still adversely affecting the ability of program managers to perform their duties.

I will simply list these problems, rather than develop them today, but first is the rapid personnel turnover in key managerial positions in that division of DOE.

Second is the lack of any comprehensive plan to do the job. Third is serious, and I would say, systemic staffing problem. Fourth, there are excessive administrative demands on that staff that are not productive in terms of dealing with the problems of biomass. Fifth, the abdication of the monitoring responsibilities by that division.

While H.R. 5428 offers no solution to these administrative problems, this subcommittee can influence DOE's administrative procedures through congressional oversight procedures by the subcommittee, and I would urge that.

Because biomass energy development is intricately tied to agriculture and forestry policies, and because the food and fiber sectors of the economy affect the economics and availability of bioenergy, the Department of Energy and the Department of Agriculture have common areas of interest and responsibility, but despite overlapping jurisdictions and similar programs, virtually no substantive coordination or program planning has taken place between these two departments.

There are indications that DOE-USDA coordination and cooperation may improve in the future. However, recent interagency agreements and those forthcoming set forth a more explicit biomass development role for both. I am pleased to see this development.

USDA, for example, is expected to receive a portion of the DOE biomass budget, fuels from biomass program via pass-through funding, for the purpose of administering some biomass development projects.

H.R. 5428, my Biomass Research and Development Act, makes more extensive use of this action-forcing mechanism for USDA and DOE cooperation and coordination. Nevertheless, the dissimilarities between the functions of these agencies can make effective coordination exceedingly difficult, a factor which we must constantly bear in mind when we legislate in this area.

The need for cooperation between USDA-DOE in developing the potential of biomass energy is, in part, a reflection of the need for a systemic approach to biomass research and development. Most biomass conversion technologies are highly source-specific. In other words, the local conditions such as long-term availability of biomass and raw material transportation and storage costs, are just as important as the hardware involved.

At some point in the development of biomass technologies, the emphasis must shift from solving strictly hardware problems to solving the practical problem facing people—mainly people in rural areas—who will run the hardware. Integrating proposed bioenergy systems is not an easy task when the two Federal agencies with the responsibility for biomass split precisely along these lines. Integrating bioenergy systems—putting all the pieces together—is so crucial to the success of biomass that Congress should specifically require it in authorizing legislation.

H.R. 5428 does that.

In closing, I would like to raise several questions I really didn't specifically touch upon.

First is the question of whether or not some of the activities I am proposing are really research and development, that is, things under this committee's jurisdiction.

Let me suggest that there might have been a question when Henry Ford brought together the elements—a gasoline engine invented by someone else, wheels already developed long since, clutches and all the other pieces—as to whether or not that is really research; but surely, when he came out with an end product that was a car, we could at least argue the case that it was development. So, while many of these things are out there, the program of pulling them together into a systems approach is, I would argue, a bona fide item under the jurisdiction of this subcommittee.

Second, I would like to suggest that the Department of Energy's solar programs, including biomass, are currently undergoing some real reorganization. As you know, the goal of reorganization is to consolidate, and hopefully speed the development of solar and other renewable technologies.

It seems to me that the subcommittee has an opportunity to exercise effective oversight during the reorganization.

When I last checked, Mr. Chairman, there were 11 separate programs in the Department having some jurisdiction over bioenergy programs. It might be appropriate to request consolidation, or at least a better coordination mechanism between these programs.

Another two areas the subcommittee may wish to explore: First—with the appropriate DOE officials—the reasons why the fuels from biomass program has been unable to obtain the level of staffing recommended by the Congress in the past fiscal year and supported by this subcommittee, and why excessive administrative demands continue to be placed on that staff.

Finally, the subcommittee may wish to look into several State and regional initiatives on biomass which seem to be progressing smoothly and rapidly. Some of them actually appear to be achieving more on their rather meager resources than we at the Federal level are.

The TVA effort, for example, is a good one, on wood pyrolysis, the work of the Purdue University Renewable Resources Laboratory is another, the Iowa Development Commission, are efforts you may wish to explore. I suspect that you will find a link between the success of these groups and their ability to cut through institutional barriers.

The CHAIRMAN. Thank you very much for your testimony.

You touch in here on some of the shortcomings of the Department of Energy in staffing and commitment in achieving these goals. You are on the Agriculture Committee, I believe, and you didn't have much to say about the Department of Agriculture.

Mr. FITHIAN. I said all that this morning, Mr. Chairman, before the Forestry Subcommittee, but I would be glad to repeat some of it here.

The CHAIRMAN. I think it would be useful, just from the point of view of our knowledge, because we don't have that contact as a rule. Mr. Bedell had a proposal in that we should eliminate the subsidies for the set-aside program and use those subsidies instead for subsidizing distilleries for alcohol.

I wonder where the Department of Agriculture is on that and other aspects of the biomass program.

Mr. FITHIAN. The Department of Agriculture has under its jurisdiction a number of agencies which really ought to be pressed into service. The rural electrification program, the entire rural electrification program, comes under the Department in a way. The Forestry Service is under the Department. The set-aside program to which you refer, of course, is under the Department, and many, many others.

As I see it, the energy division, the energy section, within the Department doesn't, in any way, have the clout that the older, more established parts of the Department have.

Let's take as an example the Cooperative Extension Service; it has an agent in every county in the United States, and we really ought not to embark upon the Department of Energy creating a second layer of that kind of energy extension.

What we ought to do is mandate in the most blunt way that that will be a priority function of the Department of Agriculture. Now, to do that, you have to overcome some very well entrenched schools of agriculture, the agricultural establishment in the country. When I said earlier it's going to be difficult to untrack some of the Federal agencies and get them focused on the new problem of energy, I was referring specifically to the 200-year-old or so Department of Agriculture as one of those areas in which we are going to have to have that change.

I will say that it is my judgment in the past 6 months that both departments have made some healthy strides, and I commend them for that. We had Assistant Secretary Culter this morning before the Agriculture Committee and Dr. Weldon Barton who will be here this afternoon, and their report was hopeful, was promising, that at least certain steps along the lines of bioenergy are really underway now.

But it's still a very poor cousin down there, just as it is over in the the Department of Energy, so we have a long way to go, and the

Agriculture Committee—of which Mr. Glickman and I are members—have our work cut out for us, just as those of you who have jurisdiction over the Department of Energy have.

The CHAIRMAN. You argue very strongly for a need for better coordination between the two departments. You said your bill addresses that. How would we best go about that? We can do it through oversight, as we are going in part today, on a continuing basis.

Mr. FITHIAN. Generally speaking, departments can kind of go their separate ways as long as their funding is not entangled with each other, and there will be, from time to time, great battles over jurisdiction in turf, but the action-forcing mechanism of our bill is the pass-through funding.

If you are going to have pass-through funding, that is, granted, the Department of Energy has to be the lead agency, and that has to be the focal point, but if you are going to use the resources—the Department of Agriculture in biomass—then you appropriate the sum of money to the Department of Energy, but require that it be passed through.

Just in the process of passing through and making sure that the money is used, and on the receiving end, making sure that they have people in place to utilize it, requires a degree of cooperation that independent or individual funding, us to Agriculture, you to Department of Energy, doesn't require. So, in the very process of pass-through funding is an action-forcing mechanism.

It doesn't really, Dick, go to the whole problem. I wouldn't make that case at all.

The CHAIRMAN. Is the staffing of the Department of Agriculture adequate to handle the—

Mr. FITHIAN. I think not in the area of the forestry, because that's such a tremendous opportunity for immediate development. I think there ought to be—they have qualified foresters and they have highly qualified and experienced people and I am not knocking that. I am simply saying that if they are going to go out and really work with State forest agents and so on, they are going to have to get through OMB a larger budget than they have.

In the Department of Energy's section on biomass, they are going to have to come in for more funding than they now have if they are really going to hold up their end of the bargain.

The CHAIRMAN. I assume that you are working on that in the Agriculture Committee.

I saw in the letter from Secretary Bergland to you that there is an "economic real potential for 4.1 quads" just in forest products alone, which, together with "1.1 quads now being used," he said "would provide us with 7 percent of the Nation's current energy needs * * *"

Mr. FITHIAN. You know, one of the great problems in that area, Mr. Chairman, is when you go to talking to the engineering establishment—I don't care what university or what private industry—and you start talking about wood as a resource for energy. It's hard for them to restrain a chuckle, because they think of wood as being back in the 1920's or back in the 1890's or whatever, and yet, just enormous waste is taking place in that whole industry.

The Swedes are really quite out in front of us in terms of technology, but even in terms of our own technology, even if we didn't turn to Sweden for some help, there are some very exciting prospects for wood

in terms of short-term energy turnaround. I am talking about under 5 years.

The CHAIRMAN. I would like to hear more from you, but let me recognize my colleagues at this point.

Mr. Fish?

Mr. FISH. Thank you, Mr. Chairman. I hope to elicit more from our colleague.

Congressman Fithian, I appreciate your being here because you are getting into an area that we don't normally—I would like to pick the point on the forestry issue.

This 4.1 quad of energy from dry tons of unused wood left to rot in U.S. forests, this is, I understand it, the official Department of Agriculture figure?

Mr. FITHIAN. I believe so, yes.

Mr. FISH. And no argument there from the forestry people that you you ought to leave this rotten wood in the forest where it fell?

Mr. FITHIAN. No; in fact, the Forest Service would argue that a coordinated program of getting the dead wood out and the scrub timber out, and so forth, would actually improve their program, both in terms of environmentally speaking and in terms of productivity of the forests.

So we are not talking—and I want to be very specific on this—about going out and cutting down all the trees in the United States and forgetting the housing industry and forgotten the future when you are talking about wood resource. And the Forest Service is really supportive of this.

Now they will go a little slower than I would like to go, to be candid about it. What they do have, as announced this morning in the testimony, are four or five rather major demonstration projects underway in four different regions of the country: One in the South, one in New England, one in Oregon, and so on, to demonstrate the usefulness of wood energy.

Mr. FISH. Do you know of any conflict between the Environmental Protection Agency and the Forestry Service?

I guess what I am trying to develop is—I happen to be interested in forestry myself in a very amateurish way, and I have two stepsons who are loggers, work in logging camps, and I can see the value of cutting down a tree that's too near another tree to allow one of them to mature and not two of them to be stunted, but I always understood that the rotten stuff on the ground was valuable to the soil and the rotten stuff standing was a home for some animal or bird.

I just wonder if there is any environmental clash with the Forestry position on this.

Mr. FITHIAN. I am not in a very good position, I would say to my colleague from New York, to answer the question.

I know of no ongoing clash between the Forest Service and USDA with the exception of the use of certain kinds of insecticides, and on that you can get some pretty good arguments.

The CHAIRMAN. Would the gentleman yield?

Mr. FISH. Surely.

The CHAIRMAN. I thought that the forestry industry, which I have been very closely connected with, and the Department were supportive of a concept of clearcutting. To the extent that's done, doesn't that interfere with the use of your surplus wood for bioenergy purposes?

Mr. FITHIAN. Well, yes, but according to the Forest Subcommittee's questions and testimony this morning, the slash and the deadwood problem really would remain, as I understand it.

Now, I am not a forester. I am not even as close to it as Mr. Fish, but would remain whether you are doing a clearcutting or an alternate—

The CHAIRMAN. It would in the areas that are not clearcut.

If you have ever seen a clearcut area, it is the most complete wasteland you have ever seen. You come from an area in the middle of the forest and suddenly you find a stark nakedness with just stumps left standing. It's kind of like the moonscape. A pretty terrible looking thing.

The argument is made that that regenerates itself in due course. It is, of course, a very controversial issue.

Mr. FITHIAN. There are two kinds of resources we are really talking about. One is the deadwood, the slash, the waste, that's in the timber. The other is that portion of the tree which never finds its way into lumber, even the harvested tree.

I am a little hesitant to quote this figure, but as I understand it, if you cut down 100 million tons, 10 of it actually end up in hardwood lumber, and the other 90 go into either kinds of usage or are wasted. There is a tremendous opportunity to generate electricity, electric power, to pelletize, to do those things that can be done with that which is not used.

Now some part—I would have to go back and check my figures—something like 15 million of that 100 million tons, or 15 percent, would go into pressed wood kind of products. Another portion of it would be used at the mill to generate certain kinds of power, but there is a real need to develop the additional recovery of resources, which we are not doing now.

Mr. FISH. Just an aside here. You know, you go to any mill today, any lumber mill, and you see just mounds of sawdust type of waste, and yet, my understanding is the Department of Energy today has no program to facilitate the people to change over in the drying process of the lumber from oil to burning the waste wood that they have right there.

Mr. FITHIAN. There certainly needs to be a great deal more emphasis and stress placed on that and, additionally, according to the testimony this morning in the Agriculture Committee, there is also a tremendous opportunity for actually using that to generate electricity. But then you run into the opposition of the power companies in the area who either want no competition, or don't want to fiddle around with a small input. That's true even within the rural electric.

Mr. FISH. Let me get on to a couple of the other issues here.

I think it is very significant, you add up to a minimum of 6.2 quads as against what I understand—today's contributions—about 1.5.

Now, I don't see any timeframe in your analysis in the beginning of your testimony about wood wastes, crop wastes, municipal solid wastes, when we can get up to this figure of 6.2 quads to 6.8 quads.

Are you talking about the next 10 years, or are you talking about a shorter timeframe?

Mr. FITHIAN. That is the potential resource of recoverable bio-energy resources. If we are talking about the seven specific projects that my bill encompasses, then we are talking about a relatively

short timeframe. In the main, most of these will be paying off in less than 5 years.

Some of them will stretch out to the 10-year period, but in no case are we talking about down beyond the year 2000 type energy resource.

Mr. FISH. Well, if a major effort was made to reach your goal here—and it doesn't seem to me we are talking about any new technology; just talking more of a concerted drive—do you see this contribution in the next decade?

Mr. FITHIAN. Yes; definitely.

Mr. FISH. Now, your bill provides for an additional \$75 million for biomass work within the Department, and I understand there are six professionals here at this point. Do you think they can handle an additional \$75 million?

Mr. FITHIAN. A significant portion of that is going to have to be passed through if you are getting to the biomass resource managers, the foresters, the people who are engaged, or could be engaged, in collecting agricultural residues and the like.

No; in no way could the now limited number of people at the Department of Energy administer or supervise a program of that dimension if there were not the passthrough mechanism. The 25 people, as I understand it, in that department now, even there, are not really full time directing their activities to bioenergy despite the directives of Congress, so that it is simply still being treated as a kind of a poor cousin down there.

I think that this committee and the Agriculture Committee over there and others who have jurisdiction are going to have to elevate its stature. We are going to have to do that by budget, personnel, and nudging, pushing, directing, oversight, whatever we can do.

Otherwise, it will never be on anything like a competitive basis with nuclear and coal and oil and the big brothers. It will always be starved out.

Mr. FISH. Finally, we are talking here about either direct combustion or an end product of methane or a premium liquid fuel alcohol.

In view of the fact that transportation fuels are our most immediate problem, do you think that this should be emphasized? That the emphasis should be laid on alcohol fuels as distinct from other byproducts?

Mr. FITHIAN. Well, that has been the thing that I worked on first and foremost for a couple of years, was pressing forward that program, and am still strongly in support of it. I strongly support the cellulosic conversion process that is being developed, whether through distillation or membrane technology. All of those things are available to us, and I would put that at a very high priority.

I don't know that I would put it really that far ahead of generating some electricity and substituting wood pellets for imported oil. Seems to me that you are talking about the same kind of energy.

Some of the other energy uses of this might be a little less in immediate demand, but that's the way I see the priorities.

The CHAIRMAN. Mr. Glickman?

Mr. GLICKMAN. Thank you, Mr. Chairman. It's a pleasure to have you here, Floyd. I serve with you on both committees and, as you know, we share an interest in this area.

As a member of the National Alcohol Fuels Commission, which was set up last year under the Surface Transportation Act, we have set out

trying to make rhyme or reason out of alcohol fuel as part of biomass, and I applaud your efforts in this bill.

One of the things that has come to my attention from the Commission is the fact that there still is relative lipservice paid to this technology in both departments. I might add that there are other departments of this Government. HUD is now becoming more involved, and the Commerce Department is becoming more involved.

Some are in commercialization and some are in research and development, but I would ask the following questions.

In your bill, as you point out in your statement, you primarily talk—you create this additional emphasis in biomass by, as you say, “requiring specific expenditures to be made in certain designated subject areas in order to mandate that they be spent there,” as opposed to other larger areas.

How do we deal with the basic issue, which is a lack of commitment on the part of the Assistant Secretaries in Agriculture, Energy, Commerce, HUD, or wherever else, who just don’t seem to care about the technology, regardless of how much money we put in?

Mr. FITHIAN. Well, in short, I think probably we in the Congress do our poorest job in oversight—a rigorous oversight—to see what expenditures and emphasis have been placed on a program, and whether their being carried out could be a great net return to the American taxpayer.

If that oversight took place just timely, just before the next round of appropriations bills came though, I think they would have some fairly substantial effect. But it’s not going to be an easy battle.

Mr. GLICKMAN. What about—maybe form over substance doesn’t make too much difference—but what about changing the way that biomass programs are administered within the departments themselves? Perhaps give more status to a person, particularly at the Department of Energy, but at USDA—both—who has the responsibility for this area?

Mr. FITHIAN. I would certainly favor it. I think that would be helpful if you up the ante, the title, the size of the desk, or whatever it is that gets things done down there.

Mr. GLICKMAN. See, I am told, for example, the Department of Energy—and I now work with some of those people who now work for the National Alcohol Fuels Commission—they tell me that—when I talk about lipservice, I am giving it the benefit of the doubt, and, as a matter of fact, that even today, the people left in that particular area dealing with alcohol fuels either have virtually no experience in the area, or really don’t care anything about it.

While I applaud the idea of allocating specific funds, which hopefully maybe universities and other private institutions carry forward, what really disturbs me is the lack of any change of attitude.

I don’t know how—I realize that we are talking about something that there is no answer to right here, but that attitude determines how these moneys are spent. That attitude determines what sort of internal oversight is given.

I just—well, your bill may be a place to start with it.

Mr. FITHIAN. I hope so. Fortunately, if this is any consolation, in many areas, the people of the United States are simply not waiting for the Department of Energy; they are not waiting for the Department of Agriculture; they are acting on their own. To the extent that

we can help augment that speed of conversion and change, which may take place anyway once the private sector overcomes the engineering establishment who doesn't believe in some of these things, it is beginning to happen.

Farmers, for example, are turning to alcohol fuels, and they will make it with or without the Department of Agriculture.

Mr. GLICKMAN. What about the issue—you touched on the issue of commercialization versus the issue of research and development. In the areas that you touch on in your bill, are any of these areas ready for commercialization; that is, besides alcohol technology itself?

Mr. FITHIAN. Well, I think the thrust of the bill is to try to pull together these systems. Yes; certain segments of the system are ready to go. But the development aspect of it, I was trying—Chairman Ottinger and I have tried to sort out those things which are rather specifically under the category of research and development, which is his jurisdiction, from those which are the commercialization phase, which, as I understand it, is John Dingel's subcommittee's jurisdiction.

So this bill, these projects, are geared to research and development in the more comprehensive definition of that term; that is, the development of actually putting the pieces together, even though some of it is not pure research.

Mr. GLICKMAN. Is there something dealing with commercialization?

Mr. FITHIAN. Well, some parts of this, and some parts of a much larger bill introduced and now passed—introduced by Senator Talmadge on the Senate side and now passed by the Senate—that we are wrestling with in four different committees of the House, have a fair degree of commercialization aspect to them.

The CHAIRMAN. Well, if there is any way that we can help you on Mr. Dingel's subcommittee—I am the ranking Democrat on that committee—we will be pleased to do so, and this committee has had the closest cooperation with them, so if it is a question of putting in two titles, we could put on the second title of this bill and arrange for hearings on energy and power on it if that is something that you and Mr. Glickman and others—

Mr. FITHIAN. I thank the chairman. We certainly will want to work with you.

Let me here, in public testimony, commend these two subcommittees for very close cooperation. It was true when the authorization bill was up. I think that has been a very healthy development in the House in the last 2 years, and you are to be commended.

Mr. GLICKMAN. I just want to ask one other question, the old legal principle of including some and excluding others.

There are areas of biomass followup that may not specifically relate to this that don't get any attention from the Department of Energy.

For example, the use of alcohol as a blending agent; octane improvement. All sorts of things that are more involved in the commercializing end, but still R. & D. oriented. You don't see this as any way competing against the type of thing, do you?

Mr. FITHIAN. No; I don't. This would simply supplement that. That is needed, too.

Mr. GLICKMAN. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Gore, I think is also on the Alcohol Fuels Commission and very active on the subcommittee on this subject.

Mr. GORE. Thank you, Mr. Chairman.

The CHAIRMAN. You want more? I'll be glad to give more.
[Laughter.]

Mr. GORE. Well, I was waiting to hear the conclusion. Thank you for that flowery acknowledgement, Mr. Chairman.

Like the chairman, I also serve on the Energy and Power Subcommittee, and with him, I have been an enthusiastic supporter of this technology, and I would like to acknowledge and express thanks for your leadership in this area. It is a terrifically important area, and one where the people are really a long ways ahead of the Government.

The Government could be helping out a lot more than it is, but as you mentioned, farmers are going to do this with or without Government programs, and it is just a matter of whether we are going to maximize the potential there, or whether we are just going to let it slide along.

My concern in this whole energy production area is that we have had just a selective sense of urgency. We identify the problem, and then somebody proposes one solution that seems to have the chance to help solve the problem, and it's like we have blinders on; we all head in that direction and say, "Synthetic fuels is the way to go," and synthetic fuels is a way to go, but this problem is so immense and so threatening to the country, that we can't afford merely a selective sense of urgency.

We ought to feel a broad sense of urgency and apply it to every potential source of energy that has great promise, and this is one of those areas. Indeed, one of the most promising. So, I congratulate you for the leadership you have provided on this issue, and I look forward to working with you to see that this bill passes, and on this subcommittee and on the Energy and Power Subcommittee.

I wanted to ask you whether or not you are familiar with the recent work that's been done at Oak Ridge, Tenn., on the anaerobic process.

Mr. FITHIAN. Yes, in a general way. I don't have the specific details on it, but there is some very good work being done there. There is good work being done in the Tennessee Valley with the wood project and the like.

Mr. GORE. We just had a briefing on the Energy and Power Subcommittee on the latest developments that Oak Ridge National Laboratory has come up with, and they have tripled the efficiency of anaerobic conversion—of conventional conversion with this process, and there are really no significant economies of scale. It can be used at any scale. It can even replace an individual septic tank and provide methane gas for homes. It can replace sewage plants the size of a plant serving Washington, D.C., and provide energy instead of consuming energy, and yet, we are spending taxpayers' money to build plants that burn natural gas in order to consume biomass classified as "waste."

Instead, we ought to have a massive program to recover the energy in biomass instead of using energy to dispose of it in an idiotic fashion. Yet, when we put money in the bill last year for this purpose, we couldn't get it through.

The Department of Energy is not to be blamed solely on this. They recommended—the Division recommended—\$30 million for commercialization of this particular waste conversion technique, which I am well aware is only one part of your bill, but the Office of Management and Budget, exercising that selective sense of urgency I referred to, in its wisdom, deleted every last cent from that program, and decided,

instead, to continue spending Federal money to build plants that will consume natural gas to get rid of it.

Mr. FITHIAN. A good example of what you are saying in terms of "selective" priorities, out of the nearly \$58 million that we've spent in 1980—excuse me, out of the \$4.4 billion that we spent in 1980 on research and development of the energy supply budget, only \$57.8 million was spent in the whole field of biomass. That represents 7 percent of the total, despite of its potential.

Mr. GORE. Well, this is really our "hole" card in this country, because our greatest resource is arable land, and we had better start using it. This bill provides us an opportunity to start using it, and I thank you for it and look forward to working with you on it.

I yield back the balance of my time, Mr. Chairman.

The CHAIRMAN. Mr. Anthony?

Mr. ANTHONY. Thank you, Mr. Chairman.

I just had an opportunity to hurriedly go through the text of the bill, and was unfortunately held up and could not hear all of the previous testimony. So bear with me if what I ask is repetitious to that extent.

I am really interested in how this bill may impact on some things that are going on in the State of Arkansas.

Gulf Oil has donated their laboratories, their patents, and processes for biomass conversion to the University of Arkansas, and they are in the process of working with the Department of Energy to secure funds to build a commercial plant in Arkansas utilizing municipal wastes, paper sludge from the papermills, and potentially, the left-over wood fiber after logging operations—after normal logging operations.

I just wondered if you could tell me how this bill would impact on a program like that.

Mr. FITHIAN. I am not entirely familiar with the process you are talking about, but there is a stress in the bill and money in the bill for cellulosic conversion and cellulosic conversion is that conversion to alcohol or otherwise of any cellulose which would include food wastes, sewage, plant residues, and the like.

So, to the extent that what you are doing in Arkansas deals with that particular part of the bioenergy sphere, it seems that this would augment what you are trying to do there.

Mr. ANTHONY. In my district alone, we have approximately six papermills, and I have been told that the greatest amount of waste product that has the potential for having biomass conversion is the sludge that's left over after those operations.

I just make you knowledgeable about that, so as this bill does go through its hearing process and markup process, if you would keep that in mind, I will analyze it closer myself to see how it may function. Because right now, they are talking about a demonstration project because of the high cost of a commercial project, although they are totally satisfied in their own minds that the process will work right now.

Mr. FITHIAN. I would just call attention to my friend from Arkansas and others on the committee that we are in a rather unusual position right now in a parliamentary sense. The Talmadge bill, which is a "granddaddy bill" compared to this one, has passed on the Senate side.

We now have various bills in various states on the House side which could conceivably match up in a conference situation. Congressman

Bedell sponsored a bill which we worked on in the Agriculture Department, which would certainly match up.

Congressman Weaver is working on a wood waste bill which would match up. This bill would match up to a part of that, and some of the things that the gentleman is interested in would certainly be covered by that, and if we can figure out the committee structure whereby we get all of the pieces passed through the various committees in the House, I think that we are close up to being really able to put in place some major new initiatives.

Mr. ANTHONY. I agree with you, and I am on the subcommittee that is dealing with Mr. Weaver's wood utilization bill. As you well know, we both serve on Agriculture together, and we have had some bills that have gone through there where we attempted to have that bill tied to and it just—parliamentary wise—would not work out.

This bill—what would this bill do over and above what is already in the system, and what moneys have already been appropriated for DOE and USDA?

What is your stated need for this bill that is not now being accomplished?

Mr. FITHIAN. Perhaps it is best to describe it in just two breakdowns, rather than to take the seven projects themselves.

It would put to the Department of Energy, in conservation and solar, \$19.8 million, and energy technology, \$30.4 million; \$25.4 million would be passed through to the Department of Agriculture for parts of this bill.

Let me perhaps step back a ways and tell you where these projects came from.

Originally, as Mr. Ottinger and I discussed this, we talked with the Office of Technology Assessment, talked to people in DOE and USDA, and we were trying to do some things in biomass energy and push forward legislatively.

We discovered nine programs which had made it all the way through working levels in those departments. Well thoughtout—we thought—programs which were offered. They were offered and they were either cut off at the Secretary's level—the Secretary or the Deputy Secretary—trying to match up an OMB figure with the departmental requirements, or they were cut out at the OMB level itself.

Now, that was prior to the big turnaround in Congress in which these nine programs—relatively small by comparison, \$75 million—were dropped out, even though they had great potential and were well developed in the various departments. They were dropped out for budgetary considerations.

Then, things happened in this country, and we turned around and passed—a what? \$80 billion, the figure varies—synthetic fuels bill, and that wasn't in the budget either.

What we have done is simply take those nine programs and pull them together in a bill. Then in discussion with Mr. Ottinger and Mr. Dingel, it was discovered—and I defer to their judgment—that two of the programs could be implemented. The mechanism was in place and we really didn't have to have hearings on them, so that took two of the programs, and Mr. Ottinger's substitute was accepted on the floor, and two of them then went into the Department of Energy authorization bill.

The other seven, it was his judgment, ought to come back in the form of a separate piece of legislation and be heard in this committee and be heard in the Agriculture Committee, and that is really what today's proceedings are all about.

Mr. ANTHONY. Thank you.

I yield back the balance of my time.

The CHAIRMAN. Mr. Hance?

Mr. HANCE. I just have one quick question.

What would be the total cost if you had full authorization under all your programs that you mentioned?

Mr. FITHIAN. Under these programs, \$75.6 million.

Mr. HANCE. Per year?

Mr. FITHIAN. For these programs, yes.

Mr. HANCE. Thank you.

Mr. FITHIAN. Yes, fiscal 1980.

The CHAIRMAN. Mr. Royer?

Mr. ROYER. Mr. Chairman, staff has indicated to me that most of the questions that we had in mind have already been asked and responded to.

I would like to commend the gentleman for his leadership role, and also indicate, as Mr. Gore and other members have, that I certainly intend to support your efforts.

Just the one question, and maybe it's a technical one that you can answer for me.

In section 108 on page 6 of the bill, it is in reference to the pass-through and the indication that the Secretary of Energy "shall make at least \$4 million available to the Secretary of Agriculture."

Is that an absolute mandate? That if it wasn't spent on something—

Mr. FITHIAN. Well, yes. That is part of what I have described as a kind of an action-forcing mechanism whereby you appropriate the money, recognizing the Department of Energy, the lead agency. You mandate that they pass through to the Department of Agriculture that amount of money, which means, then, that the Department of Agriculture—and they do have the capacity to actually use that money wisely—have to coordinate with the Department of Energy to get it in the first place, and the Department of Energy has a more-than-passing interest in working with the Department of Agriculture.

So we have thought in the past that we haven't had enough cooperation between the two departments, and this is what we have called a sort of an "action-forcing" mechanism, but it is an absolute unless the Committee should change it.

Mr. ROYER. I think the idea of the passthrough and the encouragement, the incentive, is good. I just question the idea of making a mandate of a certain number of dollars, whether that's appropriate.

Mr. FITHIAN. I guess the rationale for it, in addition to the action-forcing nature of it, is this. We are in a very difficult fight for energy priorities in the country and I do not oppose the development of any form of energy. I think we ought to have all the forms of energy.

That's where I'm "coming from" philosophically.

But I do know that biomass is the closest in; it is the closest, quickest turnaround; it will double anything else if you are talking about a 5-year or 10-year period. It will double any other source of energy that we know in terms of cost benefit, but it is a very, very weak cousin when it comes to vying for attention of the Department of Energy,

wrapped up as it is with nuclear, wrapped up in oil, wrapped up in coal. Biomass simply gets no attention, and that's why this may seem a bit strident to you, but it is sort of a recognition over the last several years that at both the Department of Agriculture and the Department of Energy there is simply not enough attention, even so that the managers of this division can hold their own or hold up their head, so to speak, when it comes budget time.

It is my theory, at least, that the weakness of those divisions were the reasons that these programs were dropped out at budget time. That's where these programs came from. They were dropped out at budget time, and had this been a program for nuclear or for oil or whatever, the only criticism would have been that it was so small.

The amounts are so small they would have whipped them through like "petty cash" in those other divisions, and that's kind of the relative weight that's being given to this in the departments.

Mr. ROYER. I guess the other comment that I would like to make—and I again commend you for it—I do know that in our particular area, for example, and I know in many other areas, the local communities have taken on these projects, and I think there have been significant success stories in many of the areas, and there is no reason why it shouldn't be pursued.

I know that in our area there have been different projects going on for a long period of time that have proven successful, and I think we ought to take advantage.

Mr. FITHIAN. I thank the gentleman for his question.

My final comment, Mr. Chairman, is that I have just been informed that Senator Durkin has expressed some interest in sponsoring this bill on the Senate side if we are unable to match it up with the Talmadge bill, which I presume will be the outcome, and I understand also that Mark Gibson, a representative from Senator Durkin, is testifying later this afternoon. But I just wanted to publicly thank the Senator here for his expressed interest.

The CHAIRMAN. Very good.

Mr. ROYER. I yield back the balance of my time, Mr. Chairman.

The CHAIRMAN. Mr. Davis?

Mr. DAVIS. I have no questions at this time, Mr. Chairman.

The CHAIRMAN. Since we are transferring \$25 million under this bill to the Department of Agriculture, I assume the Agriculture Committee will have to act on this bill, too. Is that your understanding?

Mr. FITHIAN. Yes, that is my understanding, and that is why we had asked Chairman Weaver of the Forestry Subcommittee to hold hearings, which he was good enough to do this morning for this on a bill that he has and for the Talmadge bill.

The CHAIRMAN. Have we scheduled hearings on this in the Interstate and Foreign Commerce Committee, to your knowledge?

Mr. FITHIAN. No; they have not been yet scheduled.

The CHAIRMAN. All right. Well, that's something that we'll have to do.

Subsequent to your introduction of the bill, I wonder if there are any other areas that have come to your attention, as long as we are going to pass legislation on this subject, that we ought to consider.

Mr. FITHIAN. We have some areas in what is now the Talmadge bill, and we have some other areas we are working on that I would be glad to supply to you and your staff.

I thought it of a different category. That is, these are programs that were already developed in the departments and they were geared to do something with them, but if it is your judgment that we should make it somewhat broader, I would be glad to participate in that.

The CHAIRMAN. I would like to indicate to the gentleman that if there are additional areas that we can take advantage of without undue delay, we would be glad to do that, and the sooner we can have information on that, it would be helpful to have the other witnesses address themselves to any additions that we might want to put in here. I would be pleased to receive them.

Mr. FITHIAN. It's possible—although I'm not sure you would want to make it a part of this bill—we are concerned, really very concerned, as I expressed earlier—it really wasn't an integral part of the testimony about the reorganization that is taking place in the Department of Energy right now, whether you would deem it possible to use this bill as a vehicle to mandate a little bit more action and attention and importance to biomass would be your judgment, but I would certainly support you if you decided to do that.

The CHAIRMAN. That will be an area where I'll certainly explore.

I want to thank you very much, indeed, for your help. We do have a rather full pallet this afternoon, so we should get on.

Mr. FITHIAN. Thank you, Mr. Chairman. I really didn't intend to take this much of the committee's time, but I appreciate your generosity.

The CHAIRMAN. As you can see, there is tremendous interest on the committee. I don't anticipate there is going to be any difficulty in getting legislation out.

Mr. FITHIAN. Thank you.

The CHAIRMAN. The committee will next hear from Mr. Bennett Miller from the Department of Energy, accompanied by Mr. Sandorf Harris; and Mr. Weldon Barton, the Director of the Office of Energy of the Department of Agriculture. I don't know if he's accompanied by anybody or not.

Mr. BARTON. No.

The CHAIRMAN. All by your lonesome?

I have expressed a preference to the Department of Energy, not just applying to this program, but to all programs. We had some difficulty in the wind area a couple of weeks ago to provide the person who is directly affecting the person who is actually handling the program within the Department, for testimony.

You get into a peculiar balancing act with the policymaking arm where the Department is represented and has to have whispered the answers in his ear to be able to reply to the questions on the programs themselves.

We would be glad to hear from you, Mr. Miller, on the policy area, but we would like to have Mr. Harris available to us, and we are glad that he is with us to answer specific questions about the program.

Mr. MILLER. Thank you, Mr. Chairman.

I indeed will turn the floor over to Mr. Harris after a very brief introductory comment.

[The biographical sketch and prepared statement of Dr. Miller follows:]

BIOGRAPHICAL SKETCH

Bennett Miller

EDUCATION

- Columbia College, A.B. (1959) in Physics
- Columbia University, M.A. (1961) in Physics
- Columbia University, Ph.D. (1965) in Physics
- (Speciality: Plasma Physics and Nuclear Fusion Research)

PROFESSIONAL EXPERIENCE

- 3/78 to PRESENT: Department of Energy
Program Director for Solar, Geothermal, Electric and Storage Systems
- 10/77 - 3/78 : Department of Energy
Deputy Program Director for Solar, Geothermal, Electric and Storage Systems
- 4/76 - 10/77 : Energy Research and Development Administration
Director, Office of Plans, Budgets and Program Implementation; Office of the Asst. Administrator for Solar, Geothermal, and Advanced Energy Systems (ASGA)
- 1/75 - 4/76 : Energy Research and Development Administration
Assistant Director for Research, Division of Magnetic Fusion Energy, ASGA
- 6/74 - 1/75 : Atomic Energy Commission
Deputy Assistant Director for Research, Division of Magnetic Fusion Energy, ASGA
- 1/74 - 6/74 : Atomic Energy Commission
Chief, Experimental Plasma Research Branch, Division of Magnetic Fusion Energy, ASGA
- 4/70 - 1/74 : Atomic Energy Commission
Physicist; Division of Magnetic Fusion Energy, ASGA
- 7/69 - 4/70 : Ohio State University
Asst. Professor of Nuclear Engineering

AWARDS, HONORS, PROFESSIONAL SOCIETIES, ETC.

American Physical Society; American Association for the Advancement of Science; International Solar Energy Society; Phi Beta Kappa, 1958; Eugene Higgins Fellow in Physics, '60; Honorary Woodrow Wilson Fellow, '60; White House Fellows Finalist, '66; AEC Special Achievement Award, '72.

STATEMENT OF DR. BENNETT MILLER
PROGRAM DIRECTOR FOR SOLAR, GEOTHERMAL,
ELECTRIC AND STORAGE SYSTEMS

AND

MR. SANFORD HARRIS
BRANCH CHIEF FOR BIOMASS ENERGY SYSTEMS
UNITED STATES DEPARTMENT OF ENERGY

BEFORE THE
HOUSE SCIENCE AND TECHNOLOGY COMMITTEE

SUBCOMMITTEE ON ENERGY
DEVELOPMENT AND APPLICATIONS

UNITED STATES HOUSE OF REPRESENTATIVES

ON

BIOMASS ENERGY DEVELOPMENT

NOVEMBER 15, 1979

Dr. Miller

Mr. Chairman and Members of the Subcommittee:

I am pleased to appear before you today to discuss the Department of Energy's biomass program and to offer some comments on recent questions you have addressed us. I am accompanied by Mr. Sanford Harris who is Chief of the Biomass Energy Systems Branch, and who will provide more detailed information regarding the program that the committee may request.

I have been in charge of the solar research and development programs, including the biomass technology development efforts, for almost two years now and I believe that energy derived from biomass not only offers a significant long-term energy resource for the nation, but also some near-term relief to our liquid fuel supply problems. The President's Domestic Policy Review identified biomass as having the largest impact

on energy supplies by the year 2000 among the solar technologies. Other studies performed within the Department support this and further show that wood combustion has the greatest potential of any of the biomass options. Wood already provides a significant fraction of local residential heating requirements in areas such as northern New England. Gasohol use has been spreading from the Midwest to the rest of the country as the price of gasoline has risen. Over the past year it has become clear that these and other technologies offer an especially significant potential for helping the American farmer by providing him with an assured source of fuel to assure production of food crops, and with new market opportunities for crops which can be used as biomass feedstocks. Farmers and others who grow biomass resources possess the best opportunities and capabilities to adopt these technologies in the near-term.

I believe that the biomass program we have developed in DOE reflects these perceptions of the near- and long-term potential for biomass energy and I would like now to have Mr. Harris review this program for your information. Then, I would like to return to discuss H.R. 5428.

Mr. Harris

One of our basic thrusts in the near-term is the promotion of direct combustion of wood. Wood is already the major source of biomass energy. We already have technology for using it. In certain parts of the country wood is becoming a major local energy source. Vermont is a good example: over 50 percent of the residences use wood as a major heating source; and, in Burlington, the feasibility of commercial generation of electric power

using wood has been demonstrated. As a result planning is underway in other areas for plants up to 50 MW capacity. An important DOE role in this area is to improve the safety and reliability of wood-fueled systems. We are supporting the design of new residential heaters, definition of health and safety requirements for stoves, consumer education, and improvements to the collection, harvesting, and distribution systems.

In this near-term work we believe it is very important to work through state and regional groups which have direct contact with the consuming public.

As an example of this work, we are starting demonstration of small-scale systems to turn wood into a low-Btu gas. In cooperation with the Northeast Solar Energy Center we are planning to install an improved travelling grate conversion system to gasify wood, thereby replacing a conventional oil-fired system. The plant where this will be demonstrated is located in New Hampshire. If the demonstration shows it to be commercially feasible, this particular system will be ready to enter the marketplace.

Direct combustion and low-Btu gasification of wood are not the only near-term conversion technologies. We are doing research to improve the efficiency of fermentation plants used for ethanol production. We are moving actively into small-scale applications of fermentation and anaerobic digestion on farms and with rural cooperatives. These technologies are already here, but there is still room for improvement. This year we plan to move into the marketplace, in cooperation with the Department of Agriculture (USDA), by promoting demonstrations and helping suppliers to develop equipment ready for the commercial market.

Our mid-term research and development program is aimed at developing new sources of inexpensive raw materials and corresponding technologies for conversion. With few exceptions, the cost of raw materials is a major part--up to 90 percent--of the cost of the alternate fuel produced from most biomass technologies. The cost of raw materials can be reduced by increasing the productivity per unit of land and by lowering the costs of harvesting, collection, and preparation. The program addresses both approaches. Some specific elements include cultivation of new crops for fuel conversion (sweet sorghum, for example), development of tree farms which will yield larger tonnages of wood per acre per year through species selection, and development of new collection and harvesting methods. Because trees take some time to grow, that program cannot provide conclusive results before the late 1980's. However, early results have enabled us to refine the program, eliminate the less promising projects, and concentrate on the concepts which offer the greatest opportunity. We are also working on better conversion methods for all biomass resources. These include thermochemical conversion and large-scale fermentation of cellulosic feedstocks to alcohol. We plan to choose the best conversion concepts to move to process demonstration units by 1982 and to build pilot plants by the mid 80's. By 1990 we expect to produce ethanol using low-cost cellulosic feedstocks and highly efficient plants. We expect to produce methanol and synthetic oil from wood. We also plan to demonstrate the technical feasibility of large-scale gasification plants to produce medium-Btu gas which can be converted to liquid fuels or sold directly to gas customers.

We are conducting research in a number of long-term areas. Two that relate to feedstock production are exotic species development and aquaculture. The base of available knowledge in each of these is small, but the promise is large. Certain plants produce hydrocarbon latexes which can be converted to high grade fuels. We are investigating the cultivation of these plants on a commercially viable basis, and developing collection techniques for the latexes. Our work in marine and aquatic biomass is proceeding along the same lines. Experimental results on raising microalgae in salt-water ponds have shown a potential for raising very large tonnages per acre per year on marginal land. Similarly, ocean algae may also be able to provide huge quantities of raw materials, without competing with traditional land use for food supplies. In this area, we are cooperating with the Gas Research Institute in developing methods to raise kelp.

Other long-term basic research in biomass includes work on biophotolysis, mainly directed at hydrogen production, and on photosynthesis. A greater understanding of photosynthesis will assist in the search for improved species of plants which will produce biomass feedstocks more efficiently.

Finally, we are also intensifying our effort to find biomass-derived chemical products which can be substituted for energy-intensive petrochemicals. This program will tie directly into gasification and other wood conversion programs as well as the program for conversion of agricultural residues. The ultimate effect of this program will be relatively small compared to developing the potential market for biomass-derived fuels. However, biomass-derived chemicals will be

important in specialized applications, and plants could be built within agricultural areas to convert agricultural residues and wastes into fertilizers and chemicals for local use.

I would like to turn to some other areas of interest to the Subcommittee. We have become increasingly aware of the need and opportunities to move our near-term technologies into commercialization. We are already making significant efforts to improve the transition, and our current merger with the Office of Conservation and Solar Applications will lead to increased emphasis on this issue. In FY 80, the Biomass Energy Systems Branch will support on-farm application of small-scale anaerobic digesters producing medium Btu gas and small-scale stills to produce alcohol fuels. On a larger scale we are conducting a demonstration project in anaerobic digestion at a cattle feedlot in Bartow, Florida, which produces enough methane for on-site needs, and generates 450 kW electric power for sale to the electric grid. Other planned activities will promote low Btu gasifiers for industrial applications and expand public information services. The key to these commercial activities in our minds, however, is the necessity of working through local and regional offices such as the Regional Solar Energy Centers and the DOE Regional Offices to provide technologies in response to regional needs. The technologies will be transferred through federal, state and local offices in response to user requests. Another important part of the commercialization activities is the active solicitation of industrial involvement and cost-sharing to enhance and accelerate technology transfer.

Loan guarantees for biomass conversion facilities producing alternative fuels have been authorized through the Department of Energy Act of 1978 (PL 95-238), and draft regulations under this act have been issued by the Department. To date, however, there have been no appropriations for these activities. Another alternative, which is already starting to occur, is the use of existing loan programs at other agencies to introduce these technologies into the marketplace. Loan programs at EDA, CSA, SBA and the USDA are already starting to be used to support the construction of fermentation and anaerobic digestion plants.

The development of biomass energy is a responsibility of many offices throughout the government. In order to carry out this extensive energy development program for biomass, DOE has decentralized responsibility for specific program elements to other organizations. The main focus of activity remains the Biomass Energy Systems Branch in DOE Headquarters, which is responsible for the research, development and demonstration activities necessary to make biomass systems commercially feasible. These activities, as described in the previous sections of this testimony, are currently supervised at Headquarters by a staff of five professionals. We are actively recruiting for three additional professionals and two positions in the support staff. In addition to the Branch, one professional in the Division of Distributed Solar Technology is assigned to support

activities in alcohol fuels production, and two professionals in the Office of Solar, Geothermal, Storage and Electrical Energy Systems are assigned to support the Branch and oversee biomass activities for the Program Director.

Operations in DOE are increasingly being decentralized to field organizations. The Biomass Branch has assigned lead technical responsibility for specific components of the program to offices and laboratories in which there are experts in particular fields. These include the Solar Energy Research Institute, which manages the advanced R&D components of the program, the Department of Agriculture's Forest Service and Science and Education Administration which manages the production and supply components, DOE operation offices, and several other small programs. By the middle of FY 80, about 90 percent of the technical program management will be decentralized, although Headquarters will maintain control over general program direction and policies, as have been outlined in specific memoranda of understanding.

The Solar Applications Office, which like our program, is now part of the combined Office of Conservation and Solar Energy, has been active in the application of proven wood combustion technology. They have worked in close liaison with the Biomass Energy Systems Branch, which provides technical support and assistance. The Industrial Applications Program of the Solar Applications Office has managed residential and industrial wood combustion projects for the Branch. A Wood Resource Manager has been appointed to promote rapid commercialization of systems

using the direct combustion of wood. The Branch is supporting this effort by committing \$2 million in FY 80 to fund demonstration projects in the fields of residential heating, wood stove design, development of safety and health standards, and utilization of industrial wastes for direct combustion. These cooperative efforts will be facilitated by the recent reorganization which puts all solar technology development and commercialization under the Assistant Secretary for Conservation and Solar Energy. Significant improvements in the coordination and the efficiency of the efforts are expected to result. In addition, a single office will provide for better communication with the Office of Energy Research which is pursuing basic research in support of the biomass effort. Their work centers on hydrogen and other chemical production. The new structure will also provide for an orderly and timely progression of biomass technologies through the development process from research to final commercial implementation.

Another area in which close coordination and cooperation must continue is in the biomass work being performed jointly by DOE and the Department of Agriculture. A Memorandum of Understanding (MOU) describing how the Departments will work together was signed October 30, 1978. Over the last year we have been working under this Departmental MOU which requires a specific Program MOU delineating the areas of cooperation and responsibilities of each Department for "Biomass as an Energy Source." The draft biomass memorandum being developed by the two departments stipulates that

the Department of Agriculture will provide field management for the production and supply efforts of the DOE biomass program, and will provide project development and management for the small-scale technology development program for on-farm uses of anaerobic digestion and alcohol production. DOE retains the responsibility for the overall program guidance and policy, and establishes objectives and criteria which are to be jointly accomplished. It is expected that a final biomass memorandum will be signed by the end of this calendar year. The total budget for this effort to be managed by USDA in FY 80 will be about \$12 million.

I hope that this brief review has answered most of your questions and has conveyed some of the sense of optimism we feel about biomass as a renewable energy resource, and some of the sense of progress we feel concerning the management of the government's biomass programs. At this time I will return the microphone to Dr. Miller to discuss the proposed legislation.

Dr. Miller

I would like to comment on H.R. 5428, the proposed "Biomass Research and Development Authorization Act of 1979." We welcome the support and interest in renewable energy that has been expressed by the Congress and the general public, especially in the area of near-term technologies. This bill would add significant amounts of money to specific elements of our FY 80 biomass program. We believe that the budget that was proposed by the Administration, reviewed and passed by Congress, and enacted by the President as PL 96-69 provides for a balanced research and development

effort on biomass energy systems. We believe that the pace of these efforts is consistent with the stage of development of the technologies and products being developed.

We at DOE, like the nation as a whole, are acutely aware of the need to reduce our dependence on imported oil. We are, therefore, looking carefully at a variety of options to use biomass to provide liquid fuels or to otherwise displace current oil usage. We are, for example, currently reviewing our effort in alcohol fuels to determine what steps may be taken to accelerate the availability of alcohol for the industrial and transportation sectors.

This ends my prepared statement. I appreciate having the opportunity to present an overview of our biomass energy programs and some of our current activities. If you or the other subcommittee members have any questions, we will be happy to answer them.

Thank you.

STATEMENTS OF DR. BENNET MILLER, PROGRAM DIRECTOR FOR SOLAR, GEOTHERMAL, ELECTRIC, AND STORAGE SYSTEMS, DEPARTMENT OF ENERGY, AND SANFORD HARRIS, BRANCH CHIEF, BIOMASS ENERGY SYSTEMS

Dr. MILLER. As always, I am pleased to appear before you today to discuss the Department of Energy's biomass program and to offer some comments later on on the legislation and some of the questions that you have addressed to us.

As you know, I am accompanied by Mr. Sanford Harris, Chief of our Biomass Energy System Branch, who will provide you more in the way of detailed information on the biomass program.

I have been in charge of the solar research and development programs, including the biomass technology development efforts, for almost 2 years now, and I personally believe that energy derived from biomass offers not only a significant long-term energy resource for the Nation, but also some near-term relief to our liquid fuel supply problems.

The President's Domestic Policy Review identified biomass clearly as having the largest impact on energy supplies by the year 2000 among all the solar technologies.

Other studies performed within the Department support this and further show that wood combustion has the greatest potential of any of the biomass options.

Wood already provides a significant fraction of local residential heating requirements in areas such as northern New England. Gasohol use has been spreading from the Midwest to the rest of the country as the price of gasoline has risen.

Over the past year, it has become clear that these and other technologies offer an especially significant potential for helping the American farmer by providing him with an assured source of fuel to assure production of food crops, and with new market opportunities for crops which can be used as biomass feedstocks.

Farmers and others who grow biomass resources possess the best opportunities and capabilities to adopt these technologies in the near term.

I believe that the biomass program we have developed in DOE reflects these perceptions of the near- and long-term potential for biomass energy.

Now, with your permission, Mr. Chairman, I would like to have Mr. Harris review this program for you. At the conclusion of his statement, I would like the opportunity to complete my testimony with a very brief discussion of H.R. 5428.

The CHAIRMAN. Mr. Harris?

Mr. HARRIS. Mr. Chairman, one of our basic thrusts in the near term is the promotion of direct combustion of wood. It is already the major source of biomass energy as used in the country today.

We have the technology for using it, and in certain parts of the country, wood is becoming a major local source of energy.

For example, the State of Vermont where something like 50 percent of the residents use wood as a major source of heating, and in Burlington, Vt., the feasibility of commercial generation of electric power using wood has been fully demonstrated.

As a result, planning is underway in many other areas for plants up to 50-megawatt capacity. An important DOE role in this area is to improve the safety and reliability of wood-fueled systems so that we are supporting the design of new residential heaters, definition of health and safety requirements for stoves, consumer education, and improvements to the collecting, harvesting, and distribution systems.

In this near-term work, we believe it is very important to work through State and regional groups which have direct contact with the consuming public.

As an example of this, we are starting demonstration of small-scale systems to turn wood into low-Btu gas. In cooperation with the Northeast Solar Energy Center, for example, we are funding the installation of an improved traveling grate conversion system to gasify wood, thereby replacing a conventional oil-fired system.

The plant where this will be demonstrated is located in New Hampshire. If the demonstration shows it to be completely commercially feasible, this particular system will be ready to enter the marketplace.

Direct combustion and low-Btu gasification of wood are not the only near-term conversion technologies. We are concentrating extensive efforts in the research to improve the efficiency of fermentation plants for ethanol production, and to seek new technologies to expand alcohol production.

We are moving actively into small-scale applications of fermentation and anaerobic digestion on farms and with rural cooperatives. These technologies are already here, but there is still room for improvement.

This year we plan to move into the marketplace, in cooperation with the Department of Agriculture, by promoting demonstrations and helping suppliers to develop equipment ready for the commercial market.

To assist in the use of agriculture residues, we are planning this year the development of improved harvest and collection techniques to reduce cost and improve efficiency.

Our midterm research and development program is aimed at developing new sources of inexpensive raw materials and corresponding technologies for conversion. With few exceptions, the cost of raw materials is a major part—up to 90 percent—of the cost of the alternate fuel produced for most biomass technologies.

The cost of raw materials can be reduced by increasing the productivity per unit of land and by lowering the costs of harvesting, collection, and preparation.

The program addresses both approaches. Some specific elements include: Cultivation of new crops for fuel conversion—sweet sorghum, for example—development of tree farms which will yield larger tonnages of wood per acre per year through species selection, and development of new collection and harvesting methods.

Because trees take some time to grow, the program cannot provide conclusive results before the late 1980's. However, early results have enabled us to refine the program, eliminate the less-promising projects, and concentrate on the concepts which offer the greatest opportunity.

We are also working on better conversion methods for all biomass resources. These include thermochemical conversion and large-scale fermentation of cellulosic feedstocks to alcohol.

We plan to choose the best conversion concepts to move the process demonstration units by 1982 and to build pilot plants by the mid-

1980's. Before 1990, we expect to product ethanol using low-cost cellulosic feedstocks in highly efficient plants.

We expect to product methanol and synthetic oil from wood. We also plan to demonstrate the technical feasibility of large-scale—for biomass—gasification plants to produce medium-Btu gas which can be converted to liquid fuels, or sold directly to gas customers.

We are conducting research in several long-term areas. Two that relate to raw material production are exotic species development and aquaculture. The base of available knowledge in each of these is very small, but the promise is large.

Certain plants produce hydrocarbon latexes which can be converted to high-grade fuels. We are investigating the cultivation of these plants on a commercially viable basis, and developing collection techniques for the latexes.

Our work in marine and aquatic biomass is proceeding along the same lines. Experimental results in raising microalgae in saltwater ponds have shown a potential for raising very large tonnages per acre per year on marginal land.

Similarly, ocean algae may also be able to produce huge quantities of raw materials without competing with traditional land use for food supplies. In this area, we are cooperating with the Gas Research Institute in developing methods to raise giant kelp.

Other long-term basic research in biomass includes work on biophotolysis, mainly directed at hydrogen production, and on photosynthesis. A greater understanding of photosynthesis will assist in the search for improved species of plants which will produce biomass raw materials more efficiently.

Finally, we are also intensifying our effort to find biomass-derived chemical products which can be substituted for energy-intensive petrochemicals. This program will tie directly into gasification and other wood conversion programs, as well as the program for conversion of agricultural residues. The ultimate effect of the program will be relatively small compared to developing the potential market for biomass-derived fuels.

However, biomass-derived chemicals will be important in spealized applications, and plants, for example, could be built within agricultural areas to convert agricultural residues and wastes into fertilizers and chemicals for local use.

I would like to turn to some other areas of interest to the subcommittee. We have become increasingly aware of the need and opportunities to move our near-term technologies into commercialization.

We are already making significant efforts to improve the transition, and our current merger with the Office of Conservation and Solar Applications will lead to increased emphasis on this issue.

In fiscal year 1980, the Biomass Energy Systems Branch will support on-farm application of small-scale anaerobic digesters producing medium-Btu gas and small-scale stills to produce alcohol fuels.

On a larger scale, we are conducting a demonstration project in anaerobic digestion at the cattle feedlot in Bartow, Fla., which is designed to produce enough methane for on-site needs and to generate about 500 kilowatts of electric power for sale to the electric grid.

Other planned activities will promote low-Btu gasifiers for industrial applications and expand public information services. The key to these commercial activities in our minds, however, is the necessity of working through local and regional offices such as the

Regional Energy Solar Energy Centers and the DOE regional offices to provide technologies in response to regional needs.

The technologies will be transferred through Federal, State, and local offices in response to user requests. Another important part of the commercialization activities is the active solicitation of industrial involvement and cost-sharing to enhance and accelerate technology transfer.

Loan guarantees for biomass conversion facilities producing alternate fuels have been authorized through the Department of Energy Act of 1978, Public Law 95-238, and draft regulations under this act have been issued by the Department.

To date, however, there have been no appropriations for these activities. Another alternative, which is already starting to occur, is the use of existing loan programs at other agencies to introduce these technologies into the marketplace. Loan programs at EDA, CSA, SBA, and the U.S. Department of Agriculture are already starting to be used to support the construction of fermentation and anaerobic digestion plants.

The development of biomass energy is a responsibility of many offices throughout the Government. In order to carry out this extensive energy development program for biomass, DOE has assigned responsibility for specific program elements to other organizations.

The main focus of activity remains the Biomass Energy Systems Branch in DOE headquarters, which is responsible for the research, development, and demonstration activities necessary to make biomass systems commercially feasible.

These activities, as described in the previous section of this testimony, are currently supervised at headquarters by a staff of five professionals. We are actively recruiting for three additional professionals and two positions in the support staff.

In addition to the Branch, one professional in the Division of distributed Solar Technology is assigned to support activities in alcohol fuels production, and two professionals in the Office of Solar, Geothermal, Storage, and Electrical Energy Systems are assigned to support the Branch and oversee biomass activities for the program director.

Operations in DOE are increasingly being decentralized to field organizations. The Biomass Branch has assigned lead technical responsibility for specific components of the program to offices and laboratories in which there are experts in particular fields. These include the Solar Energy Research Institute, which manages the advanced R. & D. components of the program as well as fermentation and anaerobic digestion.

We look upon our forthcoming agreement with the Department of Agriculture to manage the production and supply components as well as the small-scale components of the program. DOE operations offices, which handle the thermochemical program and several other small programs, are handled at national labs.

By the middle of fiscal 1980, about 90 percent of the technical program management will be assigned, although headquarters will maintain control over general program direction and policies, as have been outlined in specific memoranda of understanding.

The Solar Applications Office, which, like our program, is now part of the combined Office of Conservation and Solar Energy, has been

active in the application of proven wood combustion technology. They work in close liaison with the Biomass Energy Systems Branch, which provides technical support and assistance.

The industrial applications program of the Solar Applications Office manages residential and industrial wood combustion projects for the Branch. A wood resource manager has been appointed to promote rapid commercialization of systems using the direct combustion of wood.

The Branch is supporting this effort by committing \$2 million in fiscal year 1980 to fund demonstration projects in the field of residential heating, wood stove design, development of safety and health standards, and use of industrial wastes for direct combustion.

These cooperative efforts will be facilitated by the recent reorganization which puts all solar technology development and commercialization under the Assistant Secretary for Conservation and Solar Energy.

Significant improvements in the coordination and the efficiency of the efforts are expected to result. In addition, a single office will provide for better communication with the Office of Energy Research which is pursuing basic research in support of the biomass effort. Their work centers on hydrogen and other chemical production. The new structure will also provide for an orderly and timely progression of biomass technologies through the development process from research to final commercial implementation.

Another area in which close coordination and cooperation must continue is in the biomass effort being performed jointly by DOE and the Department of Agriculture. A memorandum of understanding—MOU—describing how the departments will work together was signed October 30, 1978. Over the last year, we have been working under this departmental MOU, which requires a specific program MOU delineating the areas of cooperation and responsibilities of each department for biomass as an energy source.

The draft biomass memorandum being developed by the two departments stipulates that the Department of Agriculture will provide field management for the production and supply efforts of the DOE biomass program, and will provide project development and management for the small-scale technology development program for on-farm uses of anaerobic digestion and alcohol production.

DOE retains the responsibility for the overall program guidance and policy, and establishes objectives and criteria which are to be jointly accomplished. It is expected that a final biomass memorandum will be signed by the end of this calendar year, and the total budget for this effort to be managed by USDA in fiscal 1980 will be about \$12 million.

I hope that this brief review has answered many of our questions and has conveyed some of the sense of optimism we feel about biomass as a renewable energy source, and some of the sense of progress we feel concerning the management of the Government's biomass programs.

At this time, I will return the microphone to Dr. Miller to discuss the proposed legislation.

Thank you.

Dr. MILLER. With your permission, Mr. Chairman, I will complete our testimony. It will only take me a minute or two.

I would like to comment on H.R. 5428, the proposed "Biomass and Development Authorization Act of 1979."

We welcome the support and interest in renewable energy that has been expressed by the Congress and the general public, especially in the area of near-term technologies.

This bill would add significant amounts of money to specific elements of our fiscal year 1980 biomass program.

We believe that the budget that was proposed by the administration, reviewed and passed by Congress, and enacted by the President as Public Law 96-69, provides for a balanced research and development effort on biomass energy systems. We believe that the pace of these efforts is consistent with the stage of development of the technologies and products being developed.

We at DOE, like the Nation as a whole, are acutely aware of the need to reduce our dependence on imported oil. We are, therefore, looking carefully at a variety of options to use biomass to provide liquid fuels or to otherwise displace current oil usage.

We are, for example, currently reviewing our effort in alcohol fuels to determine just what steps may be taken to accelerate the availability of alcohol for the industrial and transportation sectors.

This, Mr. Chairman, ends our prepared statements. I appreciate having the opportunity to present an overview of our biomass energy programs and some of our current activities.

We will, of course, be pleased to answer any questions. Thank you.

The CHAIRMAN. I think we will hear from Mr. Barton first, and then we'll have questions.

We are pleased to have you with us. We had the Secretary here earlier in the year. I believe you accompanied him at that time.

I hope we have been able to persuade the Secretary to have a little more optimism on these programs than he indicated at that time.

Mr. BARTON. Thank you very much, Mr. Chairman. It was a pleasure for the Secretary to appear. I believe that was on May 5 when the Secretary appeared before your committee the previous time, and it is a pleasure for me to appear back before the committee today.

I would like to apologize to the subcommittee in the beginning. The statement that I have and that you have before you is an abbreviated statement that really is not as broad as we might intend it. This is actually essentially the statement that was given to the Weaver subcommittee this morning that Congressman Fithian testified and referred to.

We just frankly ran out of time in getting the full clearances and so on on the broader statement, and so this statement deals essentially with wood biomass and wood energy.

What I would like to do, Mr. Chairman, is file this statement for the record, summarize it, and with your permission, we might submit some additional materials on some of the other activities beyond that, and, of course, respond to questions that you and the subcommittee might have.

The CHAIRMAN. Without objection, your full statement will appear in the record. We would be delighted to have a summary of it—

Mr. BARTON. Thank you.

The CHAIRMAN. And we would also be pleased—if you are in a position to do it—if you would make some comments on the legislation before us, H.R. 5428.

Mr. BARTON. Yes, I can do that, Mr. Chairman.

[The biographical sketch and prepared statement of Mr. Barton follow:]

PERSONAL DATA SHEET

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Present Professional Position

Special Assistant to the Secretary, Office of the Secretary, U.S.
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Formal Education

B.A., political science, Southwest Texas State University, 1962;
M.A., political science, Florida State University, 1963;
Ph.D., political science, Florida State University, 1965

Professional Background

Assistant Professor of Political Science, Southwest Texas State
University and Texas Technological University, 1965-1969

APSA Congressional Fellow, Offices of Senator Joseph Montoya and
Congressman Thomas Foley, 1969-1970

Assistant Director of Legislative Services, National Farmers Union,
Washington, D.C., 1970-1975

Staff Consultant, Committee on Agriculture, U.S. House of Representatives,
1975-1976

Special Assistant to the Secretary, Office of the Secretary, U.S.
Department of Agriculture, January 1977-present

Publications on Agricultural Policy and Organization

Barton, "Coalition-Building in the United States House of Representatives:
Agricultural Legislation in 1973," in James E. Anderson (ed.), Cases
in Public Policy-Making (New York: Praeger, 1976), pp. 141-161.

Barton, "Food, Agriculture, and Administration Adaptation to Political
Change," in Weldon V. Barton (ed.), "A Symposium: Food and Agricultural
Policy Administration," Public Administration Review, March/April, 1976,
pp. 137-142.

Barton, "Administrative Reorganization by Presidential Plan," Rocky
Mountain Social Science Journal, April 1970, pp. 119-129.

Statement of Weldon V. Barton
Director, Office of Energy
U.S. Department of Agriculture

before the

House Committee on Science and Technology
Subcommittee on Energy Development and Applications
Honorable Richard Ottinger, Chairman

Concerning Biomass Energy Development

November 15, 1979

MR. CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

It is a pleasure to appear before the Subcommittee today to discuss developments in biomass energy and the pending bill, H.R. 5428. The Subcommittee has asked for an update on the Department of Agriculture's activities relating to biomass as an energy source.

The Administration has established a goal of reducing U.S. dependence on foreign oil by the equivalency of 4.5 million barrels per day by 1990, through a combination of energy conservation and production of new domestic energy supplies.

In support of the President's goals, Secretary Bergland has proposed the following goal for the agricultural and forestry sectors for the year 1990:

Agricultural production and forestry production and processing: net energy self-sufficiency, under conditions that sustain productivity and maintain other objectives in both of these sectors.

This calls for, by 1990, the production of enough energy from agricultural and woody biomass materials so that, together with measures to conserve energy in agriculture and forestry, these sectors are contributing as much biomass energy to the general U.S. economy as they are taking in petroleum and other energy from the general economy. Thus, agriculture and forestry would be self sufficient on a net accounting basis.

Presently, agricultural production and forestry production and processing together consume about 6.7 percent of total U.S. energy usage, or 5.2 quadrillion BTU's (quads). Wood and wood residues are now providing about 1.3 quads of energy. To reach the net energy self sufficiency goal based on biomass sources alone, we estimate that an additional 4 quads of energy would have to be produced from all agricultural and forestry biomass sources.

A number of existing authorities will be used by USDA, in coordination with the Department of Energy and other agencies, to pursue the energy self-sufficiency goal. These include: (1) extensive technology transfer programs; (2) pilot projects and programs; (3) contracting authorities and other quasi-regulatory measures; and (4) financial incentives to foster adoption.

We are not certain what mix of authorities will be most effective in pursuing the goal and we recognize that economics and market forces—much of which remains uncertain at the present time—will have a primary influence on how the goal is realized. Nevertheless, given the present economics of energy and biomass sources, it does not seem imprudent to seek net energy self-sufficiency in agriculture and forestry by 1990—and to adapt and use existing authorities so that economics and market forces are assisted in exerting the maximum influence in achieving the goal.

Clearly, woody biomass will serve as a primary raw material source in meeting the 1990 goal. Wood and wood residues are already providing the equivalency of about 46 percent of the energy used in forestry production, transport and processing (about 1.3 of 2.8 quads) and the Department of Energy has identified wood combustion as an area particularly ready for further commercial application.

The USDA is currently analyzing our on-going and projected wood energy activities and initiatives of the Forest Service and other USDA agencies. This is being done within the context of USDA's current and projected energy conservation activities and initiatives, and of energy production activities involving other USDA units and other biomass feedstock materials. The analysis is designed to develop balanced and coordinated usage of authorities in pursuing the 1990 goal.

With respect to wood energy, we have tentatively identified three alternative levels of activity, and mixes of authorities. These are estimated by 1990 to yield increments of additional forest sector energy production of 1.0, 2.0, and 4.1 quads, respectively. When these production levels are related to projected total purchased energy usage by the forestry sector in 1990 (including production, transport and processing of forestry products), the three options range from leaving the sector energy-deficient by 1.8 quads to achieving a net energy "surplus" of 2.0 quads.

We plan to complete our overall analysis by the end of this year, in order to provide an improved basis for determining how the production of energy from wood and other biomass materials and the conservation of energy in agriculture and forestry can best contribute to the President's overall energy goals.

Population of the United States is projected to increase to 245 million people by 1990 (Census Series II projections), and food and fiber production needs would increase by 20 percent to account for population growth and continued export of 20 percent of our food and fiber output. A preliminary analysis indicates that without conservation efforts agricultural production energy requirements would increase from 2.0 quads to about 2.4 quads of energy. However, our research agencies indicate that by 1990 energy conservation efforts can reduce our agricultural production energy needs to less than 2 percent greater than in 1974--2.044 quads of energy.

The possible "surplus" of up to 2.0 quads of additional biomass energy from forestry activities suggests that only minor contributions of biomass energy from the agricultural production sector would be required to meet the net energy self-sufficiency goal. However, there are over 600 million tons of biomass residues produced annually from our farms and it is expected that significant amounts of energy will be produced from the farm residues and from use of some commodities. Furthermore, we do not know at this time what is the best balance among forestry and agricultural materials as sources of energy related to the 1990 goal.

In considering present and projected use of wood and other agricultural materials for energy and USDA activities in this area, the following are important considerations: (1) USDA activities are often designed to protect related objectives (such as soil conservation; protection of different types of wood for their highest-value use, maintenance of adequate food production to meet domestic and export needs and commitments, etc.), while allowing economics to pull agricultural and forestry biomass materials into energy uses; (2) wood will often be most economically used when burned as a solid fuel where it backs out the use of liquid or gaseous fuels; (3) increased wood utilization per se, regardless of whether directly for fuel or for chemical, construction, or alternate uses, tends to serve energy conservation goals—since wood is generally less energy intensive to produce than steel or aluminum for construction and for other end uses.

The USDA, while continuing its surveys of potential wood availability for energy purposes and related research and development work, is expanding its activities in pilot and demonstration projects and programs designed to encourage commercial utilization of wood materials under proper conditions. The following are examples of these efforts:

- USDA is establishing demonstration projects for use of wood as as fossil fuel substitute. These demonstrations are encompassing a variety of uses of wood energy, including space heating for homes and buildings, industrial uses, and electric generation and co-generation. They are being carefully selected for potential economic feasibility.

One such wood-energy demonstration project is now in place in Oregon, where large volumes of timber have been killed by insects. Energy

products are being given a high priority during the salvage of this dead timber, resulting in wood chips being marketed to local industries for boiler fuel. The USDA and DOE are cooperating on this project.

- A wood-energy pilot project involving ASCS and the Forest Service was begun in April 1979 in three counties in each of four New England States, and on October 17 was expanded to include the six-state New England area. The project pays for all costs to private woodlot owners for the technical assistance needed to develop 10-year forest management plans and for marking the existing stand of timber for selective cutting for fuel use. Seventy-five percent of the cost of building access roads, where necessary, is also provided. The expanded pilot project will result in the cutting of about 259,000 cords of fuel wood, will cost about \$1.4 million, and should replace about 777,300 barrels of home heating oil at a current value of \$11.2 million.

The primary long-term purpose of this fuel wood pilot project is the protection of the residual stands of timber on the acreage harvested for fuel wood, and the management of the remaining stands on a sustained-yield basis over the 10-year period of the management plan and beyond. Information from the pilot project will be disseminated so that the private sector is encouraged to assume responsibility for similar practices in other areas.

- A pilot project has been tentatively approved by USDA for a loan guarantee of some \$6.9 million to Enerco, Inc., Langhorne, Pennsylvania, to manufacture and place at diverse locations, mobile units designed to convert forest and agricultural residues into gas, oil and charcoal for fuel and other uses. Each of these mobile pyrolysis units is expected to produce 60 tons a day of gas, oil and charcoal, with an

energy content of 1 billion BTU's. Total annual energy production is estimated at 13.5 trillion BTU's. The TVA has purchased one of these units for testing purposes, and final approval of the USDA loan guarantee for commercial reproduction of the unit is contingent on the satisfaction performance of the TVA unit on a continuous basis.

- Another pilot project tentatively approved by USDA for a loan guarantee would support the construction by Guarantee Fuels, Inc., of two plants in North Carolina to refine forestry and agricultural residues into fuel pellets for direct burning in industrial boilers. The project is designed to convert daily 1,200 tons of wet agricultural and forestry residues into 600 tons (9.7 billion BTU's) of homogeneous, transportable, storable fuel pellets for direct combustion. The project includes provision for a burner mechanism to be installed at textile mills, brick manufacturing plants, or other industrial applications which will enable the conversion of plants from oil or gas to the wood pellets with little difficulty. The technology of this project has the potential for widespread applicability, where a clean-burning fuel is desired as a substitute for oil or gas. The loan guarantee will be approximately \$5.85 million for the Guarantee Fuels project.

There are other projects concerning wood energy in progress or being planned, involving the joint efforts of the Forest Service, Farmers Home Administration, Rural Electrification Administration, Science and Education Administration, and other USDA agencies. As the USDA seeks to expand wood energy utilization toward reaching the overall goal for 1990, we will attempt wherever possible to take advantage of, and build upon, the existing

forestry management and assistance programs of the Forest Service and other USDA agencies. A pilot program involving use of future timber sales contracts for removal of wood volumes in addition to the primary products, as provided in H.R. 5220, is the type of approach that must be employed if the USDA is to make a direct contribution to expanded use of wood for energy purposes on a sustained basis. We have provided our specific views on this type of approach in the context of our report on H.R. 5220.

With regard to H.R. 5428, the "Biomass Research and Development Authorization Act of 1979" which is pending before this Subcommittee, the Department of Agriculture fully supports the concept of expanded research and development on biomass energy as evidenced by the joint efforts of the Department of Energy and the Department of Agriculture. The USDA is currently working with DOE to finalize a program memorandum on biomass energy under which the USDA will provide management for the production and supply efforts of the DOE biomass program, and will provide project development and management for the small-scale technology development program for on-farm uses of anaerobic digestion and alcohol production. This funding pass-through program from DOE to USDA will include an emphasis upon forestry biomass, will involve about \$12 million, and will be signed by the end of this calendar year. We are convinced that joint efforts of DOE and USDA in the biomass area which draw upon the combined strengths of both agencies are most productive, and do not believe that the enactment of legislation is necessary at this time.

**STATEMENT OF WELDON V. BARTON, DIRECTOR, OFFICE OF
ENERGY, U.S. DEPARTMENT OF AGRICULTURE**

Mr. BARTON. Mr. Chairman, we view our biomass energy programs in the Department of Agriculture as an integral part and supportive of the President's overall energy programs, including the President's goal of developing through a combination of conservation and new production the equivalency of some 4.5 million barrels of oil—of additional fuel—by 1990.

In support of the President's goal, Secretary Bergland has proposed the following goals for the agriculture and forestry sectors for the year 1990:

We propose that in agricultural production and forestry production and processing, we aim at achieving net energy self-sufficiency by the year 1990, under conditions that will sustain productivity in those sectors and, in addition, maintain other objectives of feed production, food production, and forestry production for lumber, et cetera.

Presently, we are using in the two sectors—in the forestry sector and the agricultural sector—some 6.7 percent of total energy usage. That represents about 5.2 quads of energy.

We are producing from wood materials and from wood residues about 1.3 quads of energy now, and if you take into consideration projections of additional usage and conservation considerations until 1990, we estimate that we would have to produce about an additional 4 quads of energy from agricultural and forestry materials to reach that target that we have proposed for the year 1990.

In attempting to reach such a target, we would place emphasis upon existing programs and existing authorities of the Department of Agriculture, and these include the extensive technology transfer programs of the Department, pilot projects and programs, contracting authorities and other quasi-regulatory measures, and direct financial incentives, loans, loan guarantees and other direct financial incentives to foster adoption of new technologies.

We don't know, Mr. Chairman, at this point, what will be the appropriate balance of residue materials, woody biomass materials, and agricultural commodities and materials that will have to be used for energy in meeting those 1990 goals.

We have some additional analysis underway in the Department in collaboration with the Department of Energy and the remainder of the administration, and we hope by the end of the year that we will have a somewhat better fix on the balance of use of different types of raw materials looking toward that net energy self-sufficiency goal by 1990.

We recognize, at the same time, that in the final analysis, economics will determine how and to what extent we can reach that type of goal, and that our programs have limited leverage. We can only support those types of goals rather than in any sense assure their realization.

I am moving over to page 5 of the statement—the middle of the page.

The USDA is continuing its surveys of potential wood availability and other biomass availability for energy purposes and is conducting related research and development work. At the same time it is expanding its activities in pilot and demonstration projects and pro-

grams designed to encourage commercial utilization of wood materials and other biomass materials under proper conditions.

For example, the USDA—primarily through the Forest Service—is establishing demonstration projects for use of wood as fossil fuel substitutes. These demonstrations are encompassing a variety of uses of wood energy, including space heating for homes and buildings, industrial uses, and electrical generation and cogeneration. The demonstration projects are being carefully selected for their potential economic feasibility.

One such wood energy demonstration project is now in place in Oregon, where large volumes of timber have been killed by insects in the Blue Mountain area. Energy products are being given a high priority during the salvage of this dead timber, resulting in wood chips being marketed to local industries for boiler fuel.

This is a joint effort in the Blue Mountain area between the USDA and the Department of Energy.

Mr. Chairman, with your permission and the subcommittee's permission, I would like to provide for the record the complete list of those demonstration projects as they are being developed by the Forest Service.

[Material to be supplied follows:]

Enclosure 3

STATUS REPORT - WOOD UTILIZATION AND ENERGY APPLICATION PROGRAM

PROJECT & SOURCE	DESCRIPTION	STATUS
1. Hybrid Geothermal-wood generation R-5, California Water Board and Geo-Products	Project will use geothermal water as feed-stock and for drying wood chips. Wood to heat water to 9000 for generating electricity. Spent water may be used for greenhouses. California Water Board will purchase 75% of electricity to pump water to lower California. Rest will be sold in Susanville area. Lassen NF will be main wood supplier. Addition to Lab will use wood fired heat pump unit.	Funds for feasibility study - FS-\$300,000 committed; State-\$150,000 committed; DOE-\$800,000 committed I/; Geo-Products \$750,000 committed. Call for bids on resource feasibility study being prepared for early issuance I/ \$200M FY 79, \$225 in FY 80 \$400M FY 81
2. Wood heating and cooling Berea Lab Forest Service Research		Approved for inclusion in request for bids. Contract award by September 1, 1979. May request DOE funds to study and monitor operation.
3. Wood Power Generation M Wolverine Electric & Consumers Power Company, Michigan, R-9	Electric Company plan to install a series of 25 Mwt. plants in Michigan. First plant scheduled for operation 1982. A market for 285,000 cds. each plant. NFS State and Private lands will benefit. Long term contract may become an issue.	Hersey is site for first plant. FS-State environmental assessment underway. Morbark Forester now working for CPC. Expect early action to develop wood procurement strategy. Environmental group has issued negative assessment report.
4. Pilot Study use of Forest Residues for fuel. R-2, RMS	Proposal to convert South Dakota School of Mines boiler to wood from forest residues and gather cost and operational data as well as demonstrate use of wood. Potential use - 20-30,000 tons per year. Possible wood-coal combination system.	Proposal calls for investment of FR-\$2 million; SDSM-\$1 million over 5-year period. Stimmering while other alternatives are investigated.

Status Report - WUEAP Projects

5. Utilization of wood for heat and power generation in Vermont. FS, State of Vermont, Burlington Electric Company Demonstrate Cable Logging Systems Vermont State of Vermont	FS proposes study to determine effect of strong energy wood demand on environment, economy, wood & soil resource, and existing markets. Study will also verify logging costs. State wishes to test Cable Systems for small timber on steep terrain. Has selected scottish made system for 1st test. Seeks \$89,000 for training crews, renting equipment and operating sales. To improve utilization and management and reduce hazard and damage. State has initiated program to pay operator to haul to concentration area near good road where people can cut to stove length. Rotating fund pays operator and is replenished by purchaser payments. Legislature appropriated \$175,000 for fund. Similar approach to above Vermont project	DOE approved, then withheld, funding. Still hopeful
6. Fuelwood Concentration Yards State of Vermont		We have proposal. Will take to DOE by September 7.
7. Fuelwood Concentration Yards State of Vermont		Two yards operating. Several more selected and advertised for bids. Wood being cut on Forest, Recreation, and Fish and Game Lands. Costs to consumer \$20-\$40/cord which covers all State costs.
8. Fuelwood Concentration Yards New York		Proposal being prepared by State.
9. Logging Systems for small timber U. Syracuse, NY Energy Office	Proposal will study, test and demonstrate fuelwood systems on small forest holdings. Performance and cost will be documented. Power company proposes to salvage beach logs and trees for chipping and electric generation in Alaska. Millions of tons of this material lies along the shore and is a hazard and eyesore. Other uses are impractical.	Proposal reviewed by FS and submitted by NY Energy office to DOE for funding.
10. Power generation for driftwood in Alaska. Private.		Dropped
11. Power generation and home heat from agricultural clearing. FS, State of Alaska	Many acres are being cleared in Alaska to make farmland. Wood could be used for both electric generation and heating in small Alaska communities. Both oil and electricity high priced to natives.	DOE financed study by Battelle Institute underway. FS providing input to study.

Status Report - WUEAP Projects

12. FS Greenhouse, Petersburg, Alaska, FS	R-10 proposes installing wood boiler in nursery and using existing oil system as back-up. Petersburg sawmill only 5 miles away may supply fuel and itself by a candidate for cogeneration.	Ready for detailed feasibility analysis.
13. Cogeneration, Alaska Timber Corp, Klawock, ATC, State, FS	Alaska timber proposes generating electricity from residue using waste steam for drying. Can generate enough for itself and towns of Klawock and Craig. Local REA will buy electricity as will Klawock	Referred to FmHA for guaranteed loan. Talks underway. ATC has purchased boilers and generators. Need building and conveyor--about \$1 million. Should be resolved first quarter of FY 1980.
14. Production of stove logs from mill and forest Residues. Jim Burton Associates, State of Wyoming	Company proposed expanding production of stove logs from 50 to 100 tons day using mill residues. FS and State will test systems for producing and delivering logging residues as part of input.	Proposal being prepared
15. Residue removal Credits. FS	Forest Service will test use of Residue Removal Credit System similar to road construction credits to have logging residues brought to concentration area where fuelwood can be cut by public.	Test will be initiated in FY 1980
16. Cogeneration Hulett, Wyoming Five County RC&D, State, FS, and Mills	Hulett has 4 wood processing plants producing 500 tons of residues per/day which could convert to 14 megawatts of electricity. Process steam could be used in dryers, and to heat the high school and part of the town residences. Mills use about 2 mgwt.	Proposal presented to DOE 8/29 for feasibility study to determine what size generation facility should be built. FmHA interested in guaranteed loan potential. REA will buy excess but price may be low.
17. Ethanol Plants - Honey Lake and Burney, California Geo-Products, State FS	Proposed two 8500 gal/day plants using mill and forest residues. As a by-product 3 mgwts of electricity will be generated	Proposal submitted to DOE by Geo-Products.
18. Economic Analysis model	Pacific Southwest station plans to make economic analysis of harvesting wood for power generation which can be developed as a model for future analyses.	Study plan is being developed.

Status Report - WUEAP Projects

19. Fuelwood distribution project - Bangor, Maine Area. State, FS	Using labor from manpower and youth programs fuel wood would be cut and removed from the forest to be sold in the urban area. Recipients would be the elderly and the handicapped. Cost to individuals will be on an ability to pay basis. 1,000 cords of Gypsy moth killed oak will be cut on State Lands, trucked, and piled at the Harrisburg State Fair site. Estimated cost delivered to Harrisburg is \$65-\$70/cd. Wood will be resold for \$75-\$80/cd. 500 cds will be available to dealers for resale.	Currently the group is seeking funds for this project. Believe funds will come from HUD through Community Service Program.
20. Pennsylvania - Fire wood pilot project - Harrisburg Area. State	Add forest residue to mill reside in cogeneration plant already operating on campus. Unit currently provides 60% of electrical needs plus heating and cooling buildings. Project will determine collection and conversion costs plus volumes available.	State expects to break even on this project. Some legal problems. Wood dealers say it is hurting their business.
21. Wood residue cogeneration facility, University of Oregon Eugene Water & Electric Board (EWEB) and FS	EWEB seeks to secure needed wood additions to its mill residue sources from logging residues. In addition, it is considering an additional generating facility using logging residues. Electricity would be sold to California grid replacing oil generation until EWEB needs power in 1980's.	EWEB & FS each contributing \$10,000 to Project Development DOE cooperation and support expected.
22. EWEB electric generation and industry cogeneration.	DOE has funded study to grow hardwoods on power company ROW and test silvicultural and fertilization practices to maximize energy wood production. Will establish feasibility and practical procedures for growing energy biomass.	EWEB now obtaining 20% of needs from forest residues. Has option on unused Hines Lumber Co. generator. If forest residues are cheap enough will generate electricity for sale.
23. Seattle City Light Silviculture Project		PNW prepared the plans and will oversee the operations. Planting in 1979 and 1980 cost about \$1MM. over 5 years.

Status Report - WUEAP Projects

24. Additional wood generation or cogeneration plants:	Most will use processing residues.	Some FS involvement.
Kinzua Hepner, Hepner Ore., Tacoma, Washington; SDS Lumber Co., Bey Wa.; Klickitat PUD Bey Wa.; Coos-Curry Elect. Coop., Coos Bay, Ore.; Brooks-Scanlon Lbr. Co., Bend, Ore.; Simpson Lbr. Co., Shelton, Wa.		Study completed. Being studied for funding.
25. Hanford Tree Farm	Test of farm crops & trees irrigated with warm waste water from nuclear plant. Hybrid poplar looks best but many species will be tested.	6 acres planted to trees using well water as control. When nuclear plant is completed in 1982 warm water will be substituted to compare.
26. Dow-Corning Direct Combustion- Michigan	New construction will use wood boiler for steam and heat. Will use \$150,000 cords/yr.	Resource study complete. Expect this plant will be built sometime in the next 2 years.
27. North Star Electric Cooperative- Minnesota	Propose series of wood biomass generation facilities along 165 miles of the Canadian Border. Will sort for logs. Chips will be processed to methanol for storage and use during peaking periods.	Conceptual stage looking for help in preparing formal proposal.
28. Vaagan Lbr. Co., Coleville, Wa.	Cogeneration using processing waste. Will produce 4000 KW.	Begin operation this fall. Co. has 15 year contract with Power Co. to sell excess electricity.
29. Battelle Lab. Gasification Study	Convert forest residues to pipelines grades Methane for use in making urea fertilizer. Also will test production of other gases.	Funded by DOE. Success to date, beyond expectations. Study done 1980.
30. Morton-Randall, Lewis County, Washington	Municipal waste, forest and mill residue power plant.	Feasibility study underway.

Status Report - WUEAP Projects

31. Washington Power Company	Forty mgwt. power plant using 500,000 ton/year mill and forest residue.	Plant being designed scheduled to operate 1982.
32. Twin Timber Sale-Willamette NF	Willamette has offered and sold this sale which consist of two clearcut blocks--one requiring removal of all material 3" and larger--the other 11" and larger. Residue will be sold to EWEB (Eugene Water and Electric Board) for cogeneration plant. EWEB & FS will be collecting cost data for future sales and possible expansion.	Sale was bought in August '79. Operation soon.

In addition, a wood energy pilot project involving ASCS and the Forest Service was begun in April 1979 in three counties in each of four New England States, and last month, October 17, Secretary Bergland expanded this fuel wood program to include almost all of the counties in that six-State New England area.

This project pays the entire cost to private woodlot owners for the technical assistance needed to develop a 10-year forest management plan, and for marking the existing stand of timber for selective cutting for fuel use.

In addition, the project pays 75 percent of the cost of roads, if necessary, to bring the wood for fuel out of the forest area. The expanded pilot project—as expanded last month—will result, we estimate, in the cutting of about 259,000 cords of fuelwood, will cost about \$1.4 million of Agricultural conservation program money—existing moneys of the Department of Agriculture—and should replace enough home heating oil that would have a value of a total of some \$11.2 million.

The primary long-term purpose of this fuel wood pilot project is the protection of the residual stands of timber on the acreage harvested for fuelwood, and the management of the remaining stands on a sustained-yield basis over the 10-year period of the management plan, and beyond that.

Information from the pilot project will be disseminated so that the private sector hopefully is encouraged to assume responsibility for similar practices in other areas.

In addition, a pilot project has been tentatively approved by USDA for a loan guarantee of some \$6.9 million to Enerco, Inc., a small firm in Langhorne, Pa., to manufacture and place at diverse locations, mobile units designed to convert forest and agricultural residues into gas, oil, and charcoal for fuel and other uses.

Each of these mobile pyrolysis units is expected to produce 60 tons a day of gas, oil and charcoal, with an energy content of 1 billion Btu's.

The TVA has purchased the first of these units from Enerco, Inc. They are presently doing further development work and adaptations for that unit. When they get the problems out of that unit and it is ready for reproduction, the USDA loan guarantee will come into place and we will guarantee loans for reproduction of that unit and placement in various locations across the United States.

Another pilot project tentatively approved by USDA for a loan guarantee would support the construction by Guarantee Fuels, Inc., of two plants in North Carolina to refine forestry and agricultural residues into fuel pellets for direct burning in industrial boilers.

The project is designed to convert daily about 1,200 tons of wet agricultural and forestry residues into 600 tons of homogeneous, transportable, storable fuel pellets for direct combustion. The project includes provision for a burner mechanism to be installed at textile mills, brick manufacturing plants, or other industrial applications which will enable the conversion of plants from oil or gas to the wood pellets with little difficulty.

The technology, Mr. Chairman, of this project has the potential, we think, for widespread application, where a clean-burning fuel is desired as a substitute for oil or gas. The loan guarantee that we would make for this one would be just under \$6 million.

Let me emphasize that, with these projects and for other activities designed to move toward this goal of net energy self-sufficiency by

1990, we expect to rely upon our existing agencies and primarily upon the existing authorities of those agencies: The Forest Service, the Farmers Home Administration, REA, Science, and Education Administration, and so on.

An example of reliance upon our existing agencies—which we gave to the Agriculture Committee this morning—is a proposed pilot program which is included in pending legislation, which would give the Forest Service the authority to reimburse timber purchasers for removal of residues to a place where they can be utilized for energy. This is the type approach that we think must be employed if the USDA is to make a direct contribution to expanded use of wood for energy purposes on a sustainable basis.

Now, Mr. Chairman, with regard to H.R. 5428, Congressman Fithian's legislation which is pending before this subcommittee and was pending before the Agriculture Subcommittee, the Department of Agriculture fully supports the concept of expanded research and development on biomass energy, as evidenced by the joint efforts of the Department of Energy and the Department of Agriculture.

The USDA is currently working with DOE—as Sandy Harris has outlined to you—to finalize a program memorandum on biomass energy under which the Department of Agriculture will provide management for a large portion of DOE's biomass program, to include biomass production and project development and management for small-scale technology for on-farm uses of anaerobic digestion and alcohol.

This funding passthrough program from DOE to the Department of Agriculture will include an emphasis upon forestry as well as other types of biomass, and will involve about approximately \$12 million of passthrough moneys. We fully expect it to be signed and in place by the end of the year.

We are convinced that joint efforts of DOE and the Department of Agriculture in the biomass area, which draw upon the combined strengths of both agencies, are most productive, and that this is the most productive way to proceed. We do not think, at this point, that the enactment of additional legislation is required in this area.

Mr. Chairman, this concludes my statement. I will be pleased to respond to questions.

The CHAIRMAN. If I could have my colleagues' indulgence, I would like to ask a few just base questions, and I will recognize them for questions.

How much did the Department of Agriculture request of the administration in the biomass area, and how much did you get?

Mr. BARTON. You are talking about the fiscal year 1980 budget?

The CHAIRMAN. Fiscal year 1980.

Mr. BARTON. I don't think I am going to be able to tell you exactly what we requested in this area. We did secure a separate package of energy funding in the fiscal year 1980—the President's budget for fiscal year 1980—of some \$7.5 million, as I recall, and a large portion of that, probably around \$6 million, is designed to go directly into the biomass area.

I think the way this is turning out in the congressional action on the fiscal year 1980 budget, is that we are coming out with about \$6.2 million of that money, and roughly \$5 million of it we would expect to go into the biomass area.

The CHAIRMAN. And that's the total program in USDA for biomass? That would be \$5 million?

Mr. BARTON. That's the total explicit biomass effort within the——

The CHAIRMAN. Separate from the loan guarantees that you talked about?

Mr. BARTON. Yes, it is. And this is just within the Science and Education Administration.

Now, there is certain research and development related to biomass being conducted by the Forest Service, primarily in the Madison, Wis., laboratory of the Forest Service. This also, of course, does not include, as you indicate, activities of the Farmers Home Administration with loans and loan guarantees, and activities——

The CHAIRMAN. Well, can you bring us for the record what your present program is with some detail, and then what your request of the administration for fiscal 1980 was? Get us the same figures, if they are public at this point, for fiscal 1981?

Mr. BARTON. We will certainly submit what we have available in that regard, Mr. Chairman.

[NOTE: Fiscal year 1980 program follows. Fiscal year 1981 administration request will be in President's budget in January 1980.]

ANALYSIS OF USDA BIOMASS ENERGY PROJECTS

Biomass projects are listed in the following categories:

- Research and Development
- Demonstration and Education
- Loans and Loan Guarantees
- New Pass-Through Funds from DOE

Participating USDA agencies include:

- Science and Education Administration (SEA)
 - ARS - Agricultural Research
 - CR - Cooperative Research, including the State Agricultural Experiment Stations (SAES)
- Forest Service (FS)
- Economics, Statistics, and Cooperatives Service (ESCS)
- Farmers Home Administration (FmHA)
- Commodity Credit Corporation (CCC)

Most of the projects are on-going, based on data drawn from a 1977 inventory. Many of these are energy-related, and the data show the percentage attributable to energy. Recent projects have been added to the list. The only new funds appropriated in FY 1980 specifically for energy projects include:

SEA - On-farm generation and use of energy	\$1,775,000
Alcohol and production of biomass feedstocks	3,250,000
FS - Forest utilization	425,000
DOE - Biomass pass-through funds	12,000,000

ANALYSIS OF USDA BIOMASS ENERGY PROJECTS

RESEARCH & DEVELOPMENT Brief Descriptive Title of Project	PERFORMING ORGANIZATION AND LOCATION	ENERGY COMPONENT OF PROJECT			
		Funds, \$1000			
		%	1/ TOTAL	Pass 2/ TROUGH	3/ SY's
1. <u>Agricultural Products and Residues</u>					
Energy and the food-fiber sector (also IAI, ID1, ID2, IIB1)	SAES Columbia MO	10	2	-	.03
Criteria for utilization of animal wastes (also IBI)	SAES Tifton GA	15	3	-	.09
Production of sugarcane and tropical grasses as a renewable energy source (also IIA3)	SAES Rio Piedras PR	30	18	-	2.40
Expansion of the saccharum genetic base with growth regulatory chemicals (also IIA3)	SAES Rio Piedras PR	30	3	-	.24
Nutritional quality of crops in response to organic and inorganic fertilization	SAES Berkeley CA	100	28	-	.70
Utilization of animal, crop and processing residues (also IIA2)	SAES Davis CA	50	60	-	.60
Soil management systems for horticultural crops using organic wastes	SAES Davis CA	10	1	-	.01
Pyrolytic utilization of organic residues--forest and agriculture--for energy and product recovery (also IIA2)	SAES Berkeley CA	20	9	-	.10
Alternative energy sources for agricultural applications (also IIB1)	SAES Ft. Collins CO	20	7	-	.10

RESEARCH & DEVELOPMENT	PERFORMING ORGANIZATION AND LOCATION	ENERGY COMPONENT OF PROJECT			
		Funds, \$1000			
		%	1/	2/	5/
Brief Descriptive Title of Project			TOTAL	Pass TEROUGE	
Animal waste treatment systems for the 1980's	SAES Ft. Collins CO	100	53	-	1.10
Biomass production of sugarcane	SAES Gainesville FL	100	35	-	.50
Resource recovery	SAES Tifton GA	50	18	-	.20
Design parameters and equation for anaerobic biococonversion of organic wastes	SAES Honolulu HI	50	8	-	.10
Methane and protein from dairy waste	SAES Urbana IL	100	140	-	.60
Microbiology of thermophilic methanogenesis in cattle waste	SAES Urbana IL	30	52	-	.18
Animal waste management systems for 1980's	SAES Ames IA	40	31	-	.20
Beef production using manure and crop residues for major feed sources and methane production	SAES Ames IA	20	6	-	.04
Livestock waste disposal system	SAES Columbia MO	25	31	-	.20
Isotope studies on soils and the soil-plant relationship (also IIIA)	SAES Columbia MO	25	14	-	.15
Aerobic treatment of animal wastes to retain maximum nutrient content	SAES Bozeman MT	67	10	-	.38
Evaluation of crop residues and other low quality feedstuffs for beef cattle and sheep	SAES Raleigh NC	50	17	-	.20
Eurasian water-milfoil in Currituck Sound: its control and potential use	SAES Raleigh NC	20	2	-	.02
Bioconversion of animal wastes to methane	SAES Univ. Park PA	100	52	-	1.00

RESEARCH & DEVELOPMENT	PERFORMING ORGANIZATION AND LOCATION	ENERGY COMPONENT OF PROJECT			
		Funds, \$1000			3/ St's
		1/ TOTAL	2/ THROUGH	2/ THROUGH	
Brief Descriptive Title of Project		%			
Education of disposal-recycle scheme for agricultural solid wastes (biogas research project)	1690 College Nashville TN	100	83	-	.50
Manure disposal by land application	SAES Burlington VT	100	7	-	.20
Heavy clay soils for waste disposal	SAES Burlington VT	50	3	-	.05
Alternate methods for manure handling	SAES Burlington VT	50	4	-	.18
Land disposal of sludge from rural small towns	SAES Burlington VT	80	54	-	.16
Farm animal waste disposal	SAES St. Paul MN	40	14	-	.20
Energy related technological development	SAES Manhattan KS	100	102	-	4.00
Use of municipal waste-water and dried sewage sludge for crop plants (effects of treated municipal wastewater on crop production)	SAES Tucson AZ	20	4	-	.10
Use of municipal wastewater and dried sewage sludge for crop plants (treated municipal wastewater use in soil and the effect)	SAES Tucson AZ	20	4	-	.10
Animal waste treatment and recycling system (for feed)	SAES Lexington KY	25	20	-	.25
Investigations on the utilization of peanut hulls in feed and non-feed products	ARS Athens GA	10	4	-	.06
Anaerobic fermentation of livestock and crop residues	ARS Clay Center NE	100	54	DOE 33	.20
Close spacing of sugarcane as an energy crop	ARS Houma LA	100	40	DOE 40	.40
		56-765	143		

RESEARCH & DEVELOPMENT	PERFORMING ORGANIZATION AND LOCATION	ENERGY COMPONENT OF PROJECT			
		Funds, \$1000			
		%	TOTAL	1/ PASS THROUGH	2/ SY'S
Alcohol and production of biomass feedstocks					
In-house research	ARS				
More efficient preparation of the substrate	Peoria, IL	100	500		
Innovative fermentation practices					
Multi-use energy crops					
Better use of protein by-products					
University research	CR	100	500		
Ethanol for Fuel-Production by <i>Zmomonas</i>	Rutgers U.				
Energy Efficient Production of Anhydrous Alcohol	Purdue U.				
Hyperfiltration and Reverse Osmosis in Continuous Fermentation	U. of Ga.				
Time-Temperature Relations of the Enzymatic Conversion of Complex Polysaccharides to Sugars in Sweet Potato Roots	U. of Md.				
Alcohol Production from Agricultural By-Products	Cornell U.				
Production of Alcohol and Other Products from Ligno-Cellulistic Bio-mass Through the Use of a New Method of Chemical Pre-Treatment	Auburn U.				

RESEARCH & DEVELOPMENT	PERFORMING ORGANIZATION AND LOCATION	ENERGY COMPONENT OF PROJECT			
		Funds, \$1000			
		1/		2/	
Brief Descriptive Title of Project		TOTAL	PASS THROUGH	Per- sonnel	
On-farm generation and use of energy	SEA	100	\$1,775,000		20
Integration of components and proof of system effectiveness for the follow- ing energy applications. Includes R&D and Extension.			(New funding in FY 1980)		
1. Anaerobic digestion					
2. Alcohol					
3. Gasification					
4. Direct combustion					
5. Pyrolysis					
Alcohol and production of biomass feed- stocks	SEA	100	3,250,000		32
Development of science and technology for the large-scale production and conversion of biomass to fuels and chemical feedstocks. Included will be:			(New funding in FY 1980)		
1. Production research					
Screening - selection					
Agronomic systems					
Collection systems					
Environmental studies					
Computerized information system					
2. Processing R&D					
Fermentation and chemical conversion					
On-site alcohol production					
3. Extension					
Assessment of technical feasibility of new fer- mentation and techniques and transfer technology to users.					

RESEARCH & DEVELOPMENT	PERFORMING ORGANIZATION AND LOCATION	ENERGY COMPONENT OF PROJECT			
		Funds, \$1000			
		%	1/ TOTAL	Pass 2/ THROUGH	3/ ST'S
Brief Descriptive Title of Project					
2. Forest Products and Residues					
Utilization of animal, crop, and processing residues (also IIAL)	SAES Davis CA	50	60	-	.60
Pyrolytic utilization of organic residue—forest and agriculture—for energy and product recovery (also IIAL)	SAES Berkeley CA	80	34	-	.40
Investigation of unconventional sources of energy	SAES Moscow ID	100	32	-	.80
Selection of intensively cultured trees	SAES Ames IA	100	35	-	.60
Root development of intensively cultured trees	SAES Ames IA	100	94	-	1.30
Alternate sources of heat energy for rural Maine (also IIB1)	SAES Orono ME	60	11	-	.21
Cellulose availability	SAES Mississippi State MS	40	7	-	.37
Utilization of small diameter wood	Forestry School Missoula MT	10	2	-	.05
Development of techniques to measure and predict biomass of Single Leaf Pinyon and Utah Juniper	SAES Reno NV	50	4	-	.05
Forest biomass as a source of energy	SAES Univ. Park PA	100	25	-	.60
Biomass and productivity of Loblolly and Long-leaf Pines	SAES Clemson SC	50	18	-	.40
Chemicals and energy from forestry and related residues	SAES College Sta. TX	10	10	-	.12
56-765 147					

RESEARCH & DEVELOPMENT	Brief Descriptive Title of Project	PERFORMING ORGANIZATION AND LOCATION	%	ENERGY COMPONENT OF PROJECT			
				Funds, \$1000			
				1/ TOTAL	2/ THROUGH	3/ TOTAL	4/ THROUGH
	Conducting a demonstration as to the practicality of an energy forest as a fuel resource	SAES Manhattan KS	100	44	-		.70
	Forest management with emphasis on physiology regeneration, yields and species adaptability (also ICI, IIA3, IIAA)	SAES Athens GA	30	58	-		.84
	Forest residues energy project—direct burning	FS Houghton MI	35	249	DOE 249		0.00
	Thinning northern hardwoods	FS Houghton MI	7	50	-		.50
	Harvest and recovery of tops and limbs left after logging	FS Houghton MI	14	100	-		1.00
	Large volume uses of hardwood forest residues for fuel	FS Princeton WV	13	42	-		.50
	Old railroad ties for energy	FS Princeton WV	10	30	-		.50
	Development of a new suspension type burner for utilizing residue wood as fuel	FS Alexandria LA	5	45	-		.50
	Development of a mobile chipper for recovering forest residues for energy	FS Alexandria LA	34	330	DOE 200 IND 100		0.00
	Heat of combustion of 22 southern hardwoods	FS Alexandria LA	1	10	-		.10
	Harvesting full trees with their tap roots	FS Auburn AL	24	50	-		.50
	Energy and chemicals from wood and adhesives derived from forest products and residues	FS Madison WI	60	770	-		6.50
	Development of petrochemical substitutes	FS Olustee FL	100	522	DOE 318		2.00
	Evaluation of the potential for use of wood as a source of energy in the Northeast United States	ESCS Broomall, Pa.	100	34			1.00

RESEARCH & DEVELOPMENT	PERFORMING ORGANIZATION AND LOCATION	ENERGY COMPONENT OF PROJECT			
		FUNDS, \$1000			PER- SONNEL
		1/ TOTAL	PASS 2/ THROUGH		
Brief Descriptive Title of Project					
Increase timber supplies and reduce energy shortages through utilization of hardwoods, conversion of residues to petrochemical substitutes and utilization of residues and biomass for energy.	FS	100	425		4
			(New funding in FY 1980)		
1. Wood harvest - Missoula, Montana					
2. Characterization of wood residues for energy - Athens, Georgia					
3. Adhesives - Madison, Wisconsin					
4. Petrochemical substitutes - Madison, Wisconsin					
5. Chemicals from wood - Madison, Wisconsin					

RESEARCH & DEVELOPMENT	PERFORMING ORGANIZATION AND LOCATION	ENERGY COMPONENT OF PROJECT			
		Funds, \$1000			ST ³
		%	1/ TOTAL	2/ PEROUGH	
Brief Descriptive Title of Project					
3. <u>Energy Farming</u>					
Production of sugarcane and tropical grasses as a renewable energy source (also IIA1)	SAES Rio Piedras PR	70	43	-	5.74
Expansion of the Saccharum genetic base with growth regulatory chemicals (also IIA1)	SAES Rio Piedras PR	70	7	-	.50
Algal production from swine waste to feed	SAES Gainesville FL	100	40	-	1.03
Paraquat induction of resin soaking in Southern Pines	SAES Clemson SC	50	2	-	.05
Forest management with emphasis on physiology, regeneration, yields, and species adaptability (also ICI, IIA2, IIAA)	SAES Athens GA	30	58	-	.84
Maximum production of biomass for energy	FS Rhinelander WI	50	243	DOE 243	3.00

DEMONSTRATION AND EDUCATION	PERFORMING ORGANIZATION AND LOCATION	ENERGY COMPONENT OF PROJECT			
		Funds, \$1000			PER- SONNEL
		1/ TOTAL	PASS THROUGH	2/ THROUGH	

Initiate 10-20 demonstrations annually of improved management of forest lands through commercial use of forest residues for wood products and energy. Markets will be established for 20 million cords (2 billion cubic feet) or 6 percent of available forest residue by 1985. Assistance will be provided in establishing residue-related industries and a public information program will be established.

FS 100 \$9,628 85

See "Small-scale fuel-alcohol/methane demonstration program", page 12.

LOANS AND LOAN GUARANTEES:	Brief Descriptive Title of Project	PERFORMING ORGANIZATION AND LOCATION	%	ENERGY COMPONENT OF PROJECT			
				Funds, \$1000		1/ PASS THROUGH	2/ PER- SONNI
				TOTAL			
Industrial hydrocarbon and alcohol pilot project program (tentative approval of four loan guarantees)		CCC					
Biomass/SuChem Corporations (conversion of sugar cane bagasse to alcohol)		CCC Clewiston, Florida	100	15,000			
Guaranty Fuels, Inc. (fuel pellets from forest and agricultural residues)		CCC North Carolina	100	5,850			
Midwest Solvents Company, Inc. (conversion of milo, sweet sorghum and sugar cane molasses to alcohol)		CCC Santa Rosa, Texas	100	15,000			
Enerco Inc. (multiple mobile units for pro- ducing gas, oil and charcoal from forest and agricultural residues)		CCC Rural Community Locations	100	6,900			
Loan to Convert Waste to Gas		FmHA Lamar, Colo.	100	14,000			
Small-scale fuel-alcohol/methane demonstration program		FmHA SEA					Approximately \$30 million in USDA loan funds and DOE pass- through (subject to finalizing pass-through documents with DOE)
Loans for alcohol and methane projects		FmHA					Several loans are in the discussion stage. Considera- tion is being given to setting aside B&I, farm and community facility loan funds for this purpose. A \$140,000 loan for a farm alcohol plant was approved in FY 1979.

NEW PASS-THROUGH FUNDS FROM DOE	Brief Descriptive Title of Project	PERFORMING ORGANIZATION AND LOCATION	ENERGY COMPONENT OF PROJECT			
			Funds, \$1000			PER- SONN
			1/ TOTAL	PASS THROUGH	2/ THROUGH	
Biomass as an energy source *						
	Improve and increase production of the biomass resource through technology and management		100	12,000		
	Development of small-scale systems for alcohol, anaerobic digesters for methane production, and other other small scale applications		(New Pass-Through Funds from DOE)			
* Subject to finalizing Program Memorandum of Understanding and associated Interagency Agreement						

1/ Includes Federal and State appropriations and pass-through funds.

2/ Funds from other Federal agencies.

3/ Some pass-through funded projects have low SY's.

The CHAIRMAN. You mentioned that there are presently being produced from wood in the country 1.3 quads of energy, and there is a letter from the Secretary to Mr. Fithian of October 26 of this year that said 1.1, and I wondered whether we had had a dramatic expansion.

Mr. BARTON. No, I'm sorry, I don't think I can report a "dramatic expansion" of that dimension, Mr. Chairman.

The 1.1 quad figure came from a 1976 report. We knew that there have been increases in the use of wood for energy for home and industrial purposes and the 1.3 figure takes these changes into account.

The CHAIRMAN. The bill recommends a passthrough of \$25 million, and you said that you felt that that wasn't necessary at this time, which I suppose is what you've got to say. But if the committee, in its wisdom, were to decide that we would like to have the Department get engaged in a more active program, do you think that that would be a worthwhile thing? Is the Department equipped to expand its programs to very significant expansions? Almost six times what you have at the present time.

Mr. BARTON. Well, Mr. Chairman, we did indicate that we think that it might make sense for all to look at what is laid out in this memorandum of understanding—the program memorandum—and the types of projects that would be financed in this area through that pass-through funding from DOE to the Department of Agriculture of some \$12 million.

As you indicate, that is a substantial amount of money. It would represent several times the amount that is currently being spent directly in this area in the Department. However, I would make this point in that regard, that part of this will be discretionary money that will involve new projects, but a portion of that money will involve the oversight of ongoing projects, contracts, et cetera.

I think probably it might make sense to take a look at what we will be doing under that pass-through program, and then perhaps to consider whether additional amounts might be appropriate.

The CHAIRMAN. Well, he has recommended fairly specific areas in which this would be spent, and I suppose what we would like to have from you for the record is your assessment of that as to its advisability and what you think it might achieve if the committee were to do it.

Mr. BARTON. Perhaps, Mr. Chairman—

The CHAIRMAN. And your ability to handle it.

How many people do you have in the biomass program now?

Mr. BARTON. Well, it's a little difficult to say precisely, Mr. Chairman. For example, in Peoria, Ill., at the Northern Regional Research Laboratory, where much of the work is being done, there are probably three or four people that are pretty much full time in this area, but a number of those people work in the new crops area, which overlaps with the biomass area.

Then we have some people in the Forest Service. I mentioned the Madison, Wis., laboratory. In terms of personnel, I suspect that we have the ongoing capabilities in the Department to handle a substantial amount of additional money.

Perhaps what we might do is look at the programs and specific types of activities in this memorandum of understanding, and then take a look at the specific types of activities represented in Mr. Fithian's bill, and present an additional report to you on how we

would sort that out in terms of capabilities of the Department, and perhaps the wisdom of specific activities related to what we would be doing under these existing authorities.

The CHAIRMAN. I think that would be useful for us.

[NOTE.—Comment on Mr. Fithian's bill will have to be provided under separate cover because the terms of the memorandum of understanding have not been firmed up yet.]

The CHAIRMAN. In this loan guarantee that you mentioned, does the loan guarantee go to the purchaser or to the manufacturer of the equipment?

Mr. BARTON. In the case of the pyrolysis unit, it would go to the company that would be placing the unit commercially. Now, it happens that—

The CHAIRMAN. It would go to the purchaser, rather than the person who manufacturers and sells this.

Mr. BARTON. Well, it happens that, in this case, this is an extremely small company. It's about a two-person company, and the person who, in effect, invented the unit is a member of the firm, and the unit itself was constructed by a contractor then for the firm. So it would go to the company that developed the unit.

As I mentioned, that company now has the first of these units located at the Tennessee Valley Authority and is working with TVA making adjustments and running the unit. You have had a look, as I recall, in thinking about this, Mr. Chairman, at that unit—

The CHAIRMAN. That's correct.

Mr. BARTON [continuing]. And we would hope that within a relatively short timeframe they will have the continuous feed auger in place and problems worked out with the heat exchangers, and so on. These are things that you would ordinarily expect in developing a new unit of this type, and we would hope that within a relatively short time, these will be worked out so that the unit can be reproduced on something of a quasi-mass scale.

It would be at that time, then, that we would extend the loan guarantee to Enerco, Inc., the company that built the unit. The company would place those units at commercial locations so that they could have good access to wood raw materials and could sell the oil and the low-Btu gas and charcoal material that's being produced so so that it will be a commercial, ongoing concern.

At the time that we make the loan guarantee, it should be on a basis that it's commercially feasible.

The CHAIRMAN. Mr. Fithian pointed out problems of coordination between the Department of Agriculture and the Department of Energy.

Can you describe to us that relationship and how coordination works; any problems that you see and anything that we can do to help?

Mr. BARTON. Well, Mr. Chairman, I think personally that this is a relatively new area, and when you have a relatively new area you are naturally going to take some time to sort out relationships and the best relative roles of the agencies, the department in this case.

I believe that we are developing a very good posture for coordination between the agencies, represented perhaps most tangibly by this upcoming memorandum and the funding that will be exchanged between the departments.

After all, this will represent a larger amount of funding, about three times the amount of funding, that's flowing between the departments now in the direct solar and wind application area.

We would certainly like to keep in close contact with you and work closely with you. I think we are evolving a relatively good cooperative program, at least as we look at it from our perspective.

The CHAIRMAN. How is communication handled? Do you handle this yourself in the Department of Agriculture, or is there somebody who is assigned this responsibility?

Mr. BARTON. We serve—my office serves as—I suppose you would say the "primary liaison" and communications between the two departments. We have primary responsibility, for example, for the development and final completion of the memorandum of understanding.

However, as I am sure it works in all departments, there is diverse communication between our individual agencies and the respective units in the Department of Energy. I will assure you that there is full communication, some formal, much informal.

The CHAIRMAN. Do you have regular meetings, or do you just do it on an ad hoc basis?

Mr. BARTON. We don't have regularly scheduled meetings. However, we certainly have numerous meetings.

The CHAIRMAN. How many meetings would you say you had over the last month with the Department of Energy people?

Mr. BARTON. Last month? Probably. I could probably give you a more precise answer to that if I put an answer in the record that we had a major meeting of 2-hours' duration yesterday at the Forrestal Building. It's not unusual to have a meeting a day, but I wouldn't say that there was a meeting a day.

The CHAIRMAN. But there is frequent exchanging of ideas and information between the two groups.

Mr. BARTON. Definitely. I would add, Mr. Chairman, that much of this, of course, occurs by telephone, perhaps most effectively by telephone, because you can do that so easily, but there is certainly no paucity of communications between our two departments.

The CHAIRMAN. Mr. Miller, let me just ask you a couple of baseline questions, and then I will turn to my colleagues. I am taking more time than I had intended.

As I understand it, these programs in the Fithian bill were requested by the Department of Energy—from OMB?

Dr. MILLER. No, sir; not to my knowledge. Our request to OMB was precisely what we got, and if any of these projects were taken out, I guess I would be the one that ought to bear the criticism, because the budget that I forwarded to the agency was the one that the agency forwarded OMB, and it—

The CHAIRMAN. These were programs, then, that were recommended by the subdivisions of your—

Dr. MILLER. I will be as honest as I can with you. It's well over a year ago, and there isn't enough in the way of specifics in the Fithian bill for me to say: "Yes, I remember that we took this one out, or that." All I can say is that the budget that I forwarded to the agency was accepted by the agency and by OMB.

I would not be surprised if there were elements in the bill which, in fact, when we reviewed it, we did take out, but I really can't identify them on a one-for-one basis.

The CHAIRMAN. Mr. Fithian said on the floor—I'm sorry he's not here—that all of these programs were programs that had survived the review process within the agency.

It was my impression that they had been recommended by the agency to OMB. Now, it may have occurred at a lower level. But you think that is not accurate?

Dr. MILLER. No; it may have been from prior years. Some of these projects may have been left over from previous years and represented—

The CHAIRMAN. You are talking about fiscal 1980?

Dr. MILLER. Yes; I am talking about fiscal 1980.

The CHAIRMAN. Was there a discrepancy in fiscal 1979 between what the—

Dr. MILLER. Not significantly. You know, the biomass program has gotten—whether one believes that the budget level is right or not is another question, but it has gotten priority attention over the last 2 years and, almost without exception, has not been cut at any level in the Department.

If it is cut at all, it has honestly been done by, you know, at my level.

The CHAIRMAN. Mr. Fithian says:

The actual program staff levels oscillated between two and three full-time professional staff positions until the recent internal reorganization of solar programs within DOE. Although Congress recommended a total of 25 full-time professional staff for fiscal 1979, only three positions were actually filled last year.

Is that accurate?

Dr. MILLER. Yes. I think that that's very close to being exactly the case. As you know, when we testified to you last year, we had three full-time professionals on board. We scaled that up rapidly to six. We lost one recently on assignment to the United Nations, so we are back down to five.

If you look at the total overall resources available through the Branch, through staff available to me and staff available to the Assistant Secretary, the number is closer to 10 or 11.

The CHAIRMAN. But those would not all be full-time people.

Dr. MILLER. Yes, in a sense they are, although they—I mean they represent a full-time equivalent. Let me put it that way. They are not people who are designated precisely to provide biomass support, but, in the course of 1 year, if it's five people, then two-fifths of their time is roughly devoted to biomass. You end up with a couple of people on my staff who represent full-time equivalents.

The CHAIRMAN. Let me recognize my colleagues.

Mr. Anthony?

Mr. ANTHONY. Thank you, Mr. Chairman.

I have a couple of inquiries on the pilot program that you have—to Dr. Barton—on the wood energy pilot program and the 10-year management plan and beyond.

In talking about the great emphasis that you are going to place on the utilization of wood—wood fiber—and No. 1, knowing that the forest products industry has already been way ahead of the energy crunch and did so because it was smart to convert both their bark and white wood into energy because the cost of gas went up so fast. They were forced to do it because of economics before the Congress or the Government could even think about doing it.

That's one reason that the 46 percent is such an outstanding figure and is a good figure, and I think they have led the country as far as trying to develop alternate fuel sources to become totally self-sufficient.

But what bothers me is this. When you talk about the continued use in industry, and then the emphasis for home heating, then it bothers me whether or not we are going to create a terrible drain on the forests over and above the terrible drain that we are already causing just to keep up with the supply of homes that are going to be required to be built in the next 20 years—because we are already woefully behind in home construction—and I just wonder what other efforts you have on the drawing board or you plan to do besides this one 10-year study in one small section of the country, because we are going to have a wood fiber shortage and crisis just like we've got a fuel oil and crude oil crisis in this country if we don't do something.

What other thoughts do you have? What do you have on the drawing board to do this?

Mr. BARTON. Well, Congressman Anthony, the primary purpose of that New England program is really to protect the residual stands of timber in the process of taking the fuelwood off. The people were cutting the fuelwood anyway, and I suppose in a sense our primary concern was to try to provide this technical assistance and encourage a long-term, 10-year management plan of these relatively small woodlot owners so that hopefully we wouldn't cut the wrong kinds. We wouldn't cut wood that was too small or that had a higher value for lumber purposes or otherwise, and so the basic result of that program really won't just be using more wood for fuel purposes in homes in New England, but hopefully will be using it under conditions where we are better protecting the residual stands of wood.

Otherwise, I think you can be sure—and you are very familiar on the Forestry Subcommittee with the overall efforts of the Forest Service and forest management techniques. We expressed at the subcommittee this morning the concern that we keep the use of wood for energy purposes within the context of overall prudent, good management of the forests, National forests and State forests.

Probably one way of saying this is that we expect that much of our efforts tying it to this 10-year plan will be to make sure that we protect the forests and encourage the highest use, whether it's for lumber or for recreational purposes or for fuel or whatever. We can assure you—a major focus of the Forest Service's overall activities is in terms of forest management.

At the same time, one thing we are trying to do here with this 10-year plan is to—consistent with the protection of the forests—encourage additional use wherever we can of the residue materials, the slash materials left over from the logging operations, often which are burned off today—at least the Pacific Northwest—to use those for energy purposes.

Mr. ANTHONY. What bothers me is then you look at the total ownership of the land in the United States, you find that the Forest Service owns such a small percent, albeit they own a great deal. And when you add the industrial land, albeit they own a great deal, they still own a small percent. So the great ownership in this country is in the small woodlot owner.

What are we going to do, or what are you plugging into your equation to encourage that small woodlot owner, basically 100 acres and

below, to practice good forestry management so that, over and above those other programs, not only are you going to be growing the fiber for the homes but again, you are going to have that fiber that can provide a net outflow of energy, and not just make the industry itself self-sufficient but, going by your best case study, 4 quads or more, and have a net outflow of energy. But we are not going to have the fiber if we can't get to that small, individual woodlot owner to make him realize that, and to make his lands more productive.

Mr. BARTON. We have the State and private forestry program, a major division of the Forest Service in the Department of Agriculture. Even though we don't have direct control and leverage over State and private forests that we have over the national forest system, we do have management assistance, some cost-sharing assistance, technical assistance, research assistance that runs from the Forest Service to State forestry organizations, State forests and to private woodlots.

One thing that we have done in providing this kind of assistance is to keep it within the context of an overall forest management system, rather than trying to go with programs that are exclusively directed to energy—the production of wood for energy—when we work with the State forestry organizations and the private forests.

I can assure that our programs are not becoming unidirected, if you will, to just sheer output of wood for energy; that we are keeping this within a context of overall good management practices. At the same time, we are going to try to encourage the increased availability of wood sources wherever they are there.

I think Congressman Fish referred earlier to the use of the sawdust material, for example, from saw mills. It's really a waste residue today.

Mr. ANTHONY. It used to be a waste, but it's not any more. It's what's keeping some of them in business.

Mr. BARTON. We are finding that out in the context of this guarantee fuels project that I mentioned—the wood pelleting plant that we plan to make the loan guarantee for—they will be using, one of their primary sources of raw materials will be the sawdust.

Mr. ANTHONY. Are there not already plants on the market that have the pelletized—I saw one of those pellets in my family business 6 years ago. They were looking for investors then. I mean, the guy had a process, had already had it packaged and was ready to go.

Mr. BARTON. Yes, Congressman, there are some. There is one—one plant—in North Carolina.

Mr. ANTHONY. This one was located in Texas.

Mr. BARTON. But there are several across the country. This will not be a new technology, obviously, it's still a—

Mr. ANTHONY. Just quickly. I appreciate your answering and I don't want to cut you off, but I have other people that want to take time. I want to ask one quick question.

Do you have any research going on strictly for the utilization of bark? Bark probably contains more energy than any other single part of the tree. It's bought and paid for and not even considered when it's bought. Right now, I can tell you, I could cover the Capitol up with bark because of no use for it right now in the South. It appears to me that you could do this country a great service if you could channel some moneys into research and development for bark and bark alone. There is no telling what energy is just lying in waste at every sawmill site.

Mr. BARTON. I know that we do. I can't speak to the specifics of it. What I would like to do, Mr. Chairman, is supply some information for the record on our ongoing research on wood bark in particular and plans in that area.

Mr. ANTHONY. I would appreciate that.

The CHAIRMAN. We would be pleased to have that.

[Material to be supplied follows:]

RESEARCH AND DEVELOPMENT OF BARK AS AN ENERGY SOURCE

At the present time, most forest industry wastes, particularly in larger plants, are being burned. There are, however, quantities of bark at smaller plants that are not utilized. Two years ago the Forest Service developed a comprehensive slide-tape program on the economics of burning bark and other wastes for internal energy generation for small and medium-sized plants. This slide-tape program has had wide distribution. In addition, research is underway at Pineville, Louisiana; Athens, Georgia; and Madison, Wisconsin on converting bark to an adhesive to replace petroleum based phenolics. Phenolics are used in plywood and particle board essential to the building industry. Although phenolic resins make up only 3 to 5 percent of the product weight, it represents over 25 percent of the product cost. The basic research on producing adhesives from bark is an important problem area that the Forest Service will continue to work on.

Mr. ANTHONY. One particular problem; that is, if the bark happens to have a particular silicon in it that will not burn unless it's burned at such a high temperature that it absolutely tears up the refractory within the inside of the boilers or the system itself, whether or not you would be willing to spend and invest some money to get that out so that it could slag out at not such a high temperature, or develop some system that could withstand that type of heat.

There again, I can tell you that 46 percent would suddenly go to about 92 percent. It's there, but the technology's not there, and private industry has absolutely not been able to come up with an answer or spend the money.

I would challenge you that if you could solve that problem, that an awful lot of the woods products industry would take care of the rest of it.

Mr. BARTON. Thank you. We will supply that information, including the one that you raised for the record, Mr. Chairman.

The CHAIRMAN. Good. Thank you.

NOTE.—A specific response to the silicon problem cannot be provided without further clarification of the question. Followup on the question is being made by Forest Service research staff.

The CHAIRMAN. Mr. Hance?

Mr. HANCE. Bennett, I guess the specific question to you would be on—it seems that with all the programs that Congress has passed in the last few years to try to solve the energy crisis and the reorganization of the Department of Energy—well, starting the Department of Energy and the reorganization and everything, if H.R. 5428 passed, do you have the personnel to implement it?

I don't see—I think you all are doing a great job under the circumstances, with the number of projects that you have, that you are just inundated with. Can you take care of this even if it's passed?

Dr. MILLER. I think we could, Mr. Hance. You have to, I believe, recognize that we have tried very hard to decentralize our effort. We've got 20 people at SERI dedicated full time to the biomass program. We've got an effort at the San Francisco Operations Office,

and at Oak Ridge, and so if you look around at the people resources, they number probably 35 to 40.

Mr. HANCE. So this wouldn't pull you off some of the priorities that you are already working on.

Dr. MILLER. It would stretch us, clearly, but it is not as if we could not handle it. I think our people resources is not as big a problem today as it was 1 year ago. Then it was quite severe, but we have changed that, I believe.

Mr. HANCE. Thank you.

Mr. Barton, what about at the Department of Agriculture?

Mr. BARTON. I think I responded to some extent in the response to the chairman on that. I suspect that the same thing would go for the Department of Agriculture.

As I recall, in looking at the bill, there is a smaller amount of money that would be involved with the Department of Agriculture than with the Department of Energy, and I believe that we could handle that in terms of personnel.

We too have a relatively decentralized effort in this regard. I referred to the field laboratories awhile ago. We have people at a large number of additional laboratories—individual persons working in these areas. I think the short answer is we can handle it.

Mr. HANCE. Thank you.

I yield back the balance of my time.

The CHAIRMAN. Mr. Royer?

Mr. ROYER. I am going to yield to Mr. Davis.

The CHAIRMAN. Mr. Davis?

Mr. DAVIS. Thank you, Mr. Chairman.

I have a quick question, and let me just set the stage for the question. It primarily concerns my people in my particular district.

I am from Michigan, and represent 42 percent of the State of Michigan—lots of trees. Of that 42 percent of the State, 40 percent of it is owned by either Federal or State government. Some by local government.

The CHAIRMAN. Do they vote for you?

Mr. DAVIS. Pardon me?

The CHAIRMAN. Do they vote for you? The trees?

Mr. DAVIS. I haven't figured out a way to do it yet. We are working on it.

My question is this. We are working right now with the U.S. Forest Service. I have three national forests in my congressional district. We are working with the Forest Service right now, and we don't know what the response is going to be, but in the event that we don't get cooperation, we are going to come over and see you.

There are a lot of decayed trees—dead trees—on U.S. Forest property, much of it in one stage or the other of wilderness. It is my understanding that the policy is that the ordinary citizen cannot go on this land and pick up the deadwood, take it home, cut it up, and burn it.

We are working—we understand that there was such a program in Pueblo, Colo.—and we are working now. We have written to my three supervisors asking for permission to, and with cooperation of them, and probably with the community action agencies, using CETA employees to go out and get this wood, because there's lots of it out there; and cut it up and actually deliver it to the homes of people who have wood stoves, and we have an awful lot of them.

Are you involved in this at all, and what is the policy of the Department of Agriculture on this?

It is my understanding that the district people themselves can waive that particular rule, or whatever it is. Now, I don't know whether that's true or not.

Mr. BARTON. I am going to acknowledge to you that I am not knowledgeable on the specifics of this. I will be happy to take a look at it with the Forest Service people, and we make a further report to you on it.

Mr. DAVIS. OK. We would just like to——

The CHAIRMAN. Will the gentleman yield?

Mr. DAVIS. Sure.

[Material to be supplied follows:]

FOREST SERVICE POLICY ON WOOD GATHERING

The Forest Service had had a free-use permit program for personal use cutting of firewood since 1974 (Enclosure 2). Sales of firewood, under the timber sales program, are made to commercial operators.

The gathering of firewood in Wilderness areas would leave the "imprint of man's work" in the form of axe and saw marks, skid trails, etc., and would not be compatible with the Wilderness concept. There is a cost to Wilderness. It can block access to resources such as oil, gas, and firewood. We do not feel granting exception for a single use such as firewood is a viable approach. Rather, we should examine boundaries of areas carefully in respect to the resources lost before the areas are classified.

We are looking at opportunities for using CETA employees in firewood projects.

The CHAIRMAN. I would just like to express—and I meant to do it before—my concern and dismay that we got very poor cooperation from the Forest Service in connection with this hearing. We had asked that somebody be here. They apparently declined to appear.

Mr. BARTON. It certainly was not that we didn't want to accommodate the subcommittee. In fact, we were checking and we noticed that Doug Leisz was supposed to be here. I am not sure what we did wrong in that respect. He was before the Forestry Subcommittee in lengthy hearings this morning.

I will apologize personally, Mr. Chairman. I can see the interest in wood and forestry in particular, and we should have had more cooperation with the Forest Service.

The CHAIRMAN. We may ask. We are going to have another day of hearing and get OMB up here, and we might ask somebody from the Forest Service to come up at that time. We hope we would get the cooperation of the Department.

Mr. BARTON. You definitely will, Mr. Chairman.

The CHAIRMAN. I thank the gentleman for yielding.

Mr. DAVIS. Thank you, Mr. Chairman.

I won't take much more of the committee's time. I think it is probably a good idea to have somebody from the Forest Service, but it seems to me that not only in my particular area, but all around the country, there would be a very valuable source, especially to certain groups of people that are having a difficult time, first of all, getting the product out of the woods if they get permission, second, paying for it. And we are talking about something that would be free and available to them in other parts of the country, and there's a tremendous amount of wood lying around on U.S. Forest Service land that could be put to good use I think.

Mr. BARTON. As you know, Congressman, we do have a program across the board, barring for the moment the wilderness area, for making this—to the extent that we can—making this wood available free to the public to pick up for fuel use.

We did have occasion to mention this morning—Assistant Secretary Cutler represents that area and mentioned at the hearing this morning—that we may need to get into a posture of levying some kind of fee for protection of the forests from being overrun in that regard. I think—

Mr. DAVIS. Excuse me. We are not talking about letting the ordinary citizen go in. What you do is you contract with—

Mr. BARTON. I understand.

Mr. DAVIS [continuing]. An agency, and you let that agency, under supervision of the Forest Service—and I am primarily talking about one or the other of the designation of the wilderness areas because much of the land that I'm talking about is designated as "wilderness area," and under rules of the Department, it is my understanding that the ordinary citizen couldn't go in there, and, even if he could, he is not allowed to pick up this wood.

But under the circumstances we are in in this country, it seems to me that we ought to take advantage of that, and that's what we're working on.

We are working directly with people involved in my area, but it seems to me that it might not be a bad idea to have a policy that would allow this wood to be utilized during this crisis period.

Mr. BARTON. Let me make a check on that, the possibility of using CETA workers and an organization of that type, and we will make a report from here to you, Congressman, on that.

Mr. DAVIS. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Royer?

Mr. ROYER. Mr. Chairman, thank you.

Just to follow up a little bit on Congressman Davis' comments. I know that locally in our district we do have, on county-owned lands, a very good timber management program. I think it is working very well.

I would like to think that your Department would be working with local and State governments in cooperating with them, and if they haven't got plans to develop—because I think that there is a great supply out there. Even in following up Congressman Anthony's remarks, a good timber management plan can be extremely helpful as far as the timber growth is concerned itself, and so I think rather than being a detriment, it could be a real advantage.

Dr. MILLER. Mr. Royer?

Mr. ROYER. Yes.

Dr. MILLER. Could I make a comment on that, because I think there is a very interesting point that needs to be made.

The timber management techniques—modern timber management techniques—result in an enhanced value for the timber which sort of prices it out of the energy market. You get \$400 a ton for saw timber, and the best you can afford to pay for energy is about \$20 a ton, but by virtue of good forest management techniques you upgrade the stand to the point where the person who owns it is never going to sell it to anybody for energy. He's going to sell it to the local sawmill at 20 times what he could get for energy prices, and that's just a fundamental problem that we have in utilizing the wood resources.

Mr. ANTHONY. Would the gentleman yield at that point?

Mr. ROYER. Yes.

Mr. ANTHONY. But just to the contrary, when you go in with intensive forest management and you do the proper TSI work, you are going to take out the cull trees to make room for the good trees. Rather than having those trees stay in the forest and choke out the sunlight and take away from and provide cover from the small trees, and to the contrary, you are going to bring on more of that wood fiber, but it's going to be wood fiber that's not going to be good for anybody as far as future home and it's not going to be good for that woodlot owner because it's not going to have that good fair market value. But it would be good for energy. I think just to the contrary, a good forestry management program is going to utilize it on both fronts.

You are going to have so much culled timber brought out to be used for energy that you might have trouble getting rid of it.

Dr. MILLER. If you can bring the culls out economically, that's quite right, and that really is the issue.

Mr. ANTHONY. And this goes back to the inquiry that I made to Dr. Barton: Are there plans taking all that into consideration? You know, a well-balanced forest management program is going to be utilizing both aspects of it.

You are going to get the full growth for the home use, yet you are going to provide a method to get it out to be utilized either by industry or to be utilized for an additional source of income for that small woodlot owner.

Thank you for yielding.

Mr. ROYER. Thank you, Mr. Anthony.

The other question that I would like to ask—I am wondering, is there one mechanism between the Departments or do you each have a separate one for transition from R. & D. to the commercial market? Do we actually have a program?

Dr. MILLER. Well, in the Department of Energy we tried an experiment when the Department was formed 2 years ago which separated the commercialization function from the research and development function.

What has happened in the last month or so is that we are putting them all back together again, and one can draw his own conclusions about the experiment from that. I don't know how USDA does it in detail. Mr. Barton, I presume, will speak to that.

We are putting it all back together.

Mr. ROYER. I would like to hear from Mr. Barton.

Mr. BARTON. The Department of Agriculture is going directly to commercialization with some projects in the sense of directly funding pilot projects. The Bartow, Fla., methane facility, mentioned awhile ago, is an example. In another example, the Farmers Home Administration in USDA may work with DOE in ethanol projects by DOE tying together a loan with some grant assistance.

As far as internal organization, in the Department of Agriculture this is separated between agencies. Of course, the Science and Education Administration of the Department is primarily research and development oriented. At the same time, Science and Education Administration includes the Extension Service, which is the technology transfer mechanism pretty much across the board for the Department. But we also have the authorities in the Farmers Home Administration,

as you know, to make loans and to guarantee loans. Some of the same type of authorities are in ASCS, et cetera.

So I suppose the short answer is that we don't have a clean—we definitely don't have a clean—differentiation within the Department organizationally between the R. & D. on the one hand and the commercialization, if you will, on the other.

Mr. ROYER. I wasn't necessarily thinking that they ought to be separated, but I just wanted to make sure that there was one in place. I don't know whether it would be well to have at least some comment from each of the Departments for the record as to what you are actually doing.

The CHAIRMAN. In the commercialization area, you are talking about.

Mr. ROYER. Pardon?

The CHAIRMAN. You are talking about in the commercialization area.

Mr. ROYER. That's right; yes.

You know, the transition from the R. & D. to providing the incentives for—

The CHAIRMAN. I would express my own observations, if I might, and get the witnesses to testify—it seems to me that we know a good deal about how to get money out to people to research particular projects. We have been singularly unsuccessful in getting those projects into the marketplace and know much less about that.

We are experimenting now in the synfuels program with a bunch of incentives. We have had tax credits for solar. We are now going into a whole new series of efforts to get different kinds of incentives through utilities, but I think that's an area where we have been very short.

Let me turn it over to the witnesses so that they can answer. You had success in the Department of Agriculture with which I am not familiar.

Mr. BARTON. I would like to say, Mr. Chairman, that we are now making some loans through the Farmers Home Administration, for example, for small-scale ethanol facilities. We are currently operating under our existing authorities, farmownership, real estate, operating and business and industrial loans, and there are demands on those funds from the traditional place where they are—

The CHAIRMAN. Do you think anything has caught fire as a result of your commercialization area? Your loan guarantees? Your loans? Have you seen any of these technologies that we are talking about getting widespread acceptance?

Mr. BARTON. Well, there is an extreme amount of interest out there. In the alcohol fuels area, for example, I suppose that's best evidenced by the 3,500 applications for permits—for experimental permits—that the Treasury Department has. They have approved about 925 of those to date.

We see a tremendous amount of interest. There is still the problem of getting some workable distilleries in place out there that can be operated rather easily on an onfarm basis. As that is done, we are probably going to see some rather rapid duplication.

We are looking toward doing the same thing in the anaerobic digester area for methane production from animal waste materials.

We have one loan that is tentatively made to Lamar, Colo., for a \$14 million facility in that area to use cattle feedlot wastes to convert to methane gas.

I had occasion earlier this week to look at the project that Jim Fisher has at the University of Missouri at Columbia. He has an operating methane unit producing methane gas from wastes from hog operation—400 head of hogs there. That unit is, I think ready to duplicate. It's full scale. It's commercial size, if one is thinking in terms of farm-level commercial size, and we again look toward additional loans for small-scale production in that area through the Farmers Home Administration.

There is a tremendous amount of interest, and we expect—

The CHAIRMAN. You have been pretty good at getting fertilizers out and things like that, but I haven't yet seen results in energy. I think there is tremendous interest in gasohol, but I find it very frustrating.

Dr. Miller?

Dr. MILLER. I wish I could point to a long list of commercialization successes by the Department of Energy, but I don't think we can. I think commercialization is probably the most difficult challenge that the Federal Government faces, because, by and large, that has been done by the private sector in the past, and I think probably should continue to be. We've got to be catalysts and it is very difficult to point to the Federal Government and say we commercialize this or that or something else. Just a tough problem.

Mr. ROYER. Mr. Chairman, just to follow up, I certainly agree that that part has to be left to the private sector, but it seems to me if we are going to be spending the moneys that we are in research and development, somehow we have got to get it to the private sector so it starts to do some good. I think that is the point I was trying to make, and I would like to see the two Departments that are working together on this get together and figure out a way how to do it. I think it is imperative.

Mr. BARTON. We might mention, Congressman—I think we can say this program memorandum of understanding with DOE will include some moneys for grant assistance for small-scale alcohol production facilities, and small-scale methane conversion from animal wastes.

Now, what we would hope to do, and we will be working together with some grant assistance from that source, linked with loans from the Farmers Home Administration, is to try to get a small number in each of these kinds of facilities out on the farms. Hopefully, we can get to a place that the units are standardized enough and are proven workable enough, that then we can go to loans from the Farmers Home Administration on a more wholesale basis. But frankly, we are just not quite at that point yet, and we can't get ahead of the game and broadcast loans through the Farmers Home Administration until we go through this intermediate step. We have definite plans of accomplishing that intermediate step.

The CHAIRMAN. We are going to have to recess at this point, and I think I will do that first.

The committee will stand in recess.

[Recess taken.]

The CHAIRMAN. The committee will resume, however briefly. I was told there was going to be some time between votes, and I wonder if we could have Mr. Miller and Mr. Harris back.

I had asked Mr. Eaton to take a look into the problem that we had identified earlier, Mr. Fithian's statement that all the programs that he has requested were, in fact, requested by the Department and had passed Department review, and I understand in discussions with you, Dr. Miller, it appears that these were requests to the power systems program in another division of DOE, and not directly under the biomass program under solar applications.

Dr. MILLER. That's right, Mr. Chairman. I am really indebted to Mr. Eaton for bringing that to my attention, because it is clear that what Mr. Fithian was referring to were programs that were carried on the other side of the house when energy was split between energy technology and solar applications.

It is very difficult to identify them as "biomass" because they didn't have a biomass line item; they had a functional organization that had programs under things like systems application and marketing and what-have-you, and so it was not immediately apparent, and because of my own responsibilities, when people talk about biomass as a line item, I think only of the budget that we are responsible for, and my guess is that all of those items—

The CHAIRMAN. I understand that.

Have those responsibilities now been transferred?

Dr. MILLER. The organization that I am responsible for is now, together with the old solar applications organization, under one assistant secretariat, and that's Maxine Savitz in an acting capacity.

The actual melding of those two programs has not taken place yet. It will, I anticipate, in the next couple of weeks. I know that everybody is working very hard to move that reorganization along.

The CHAIRMAN. Would you supply for the record the progress of these particular programs that are in H.R. 5428 through the Department? That is, I would like to know what the agency's requested of the Department, what the division has requested of the Department, what the Department requested of OMB, and what disposition OMB made of them so that we can be sure to have that accurately when we go to the floor.

Dr. MILLER. Mr. Chairman, we will be delighted, because I certainly don't want to have any misunderstanding left on that issue.

[Material to be supplied follows:]

ANALYSIS OF FY80 BUDGET WITH RESPECT TO H.R. 5428

Biomass Descriptions	Internal DOE Request FY80	DOE Request to OMB FY80	DOE Request to Congress FY80	Congressional Appropriations FY80	H.R. 5428 Provisions	FY80 Appropriation plus H. R. 5428	H.R. 5428 Descriptors
Direct Conversion	1.0	1.0	10.0	10.0	16.3	26.3	Power systems (direct combustion), LBG
Alcohol by Fermentation	7.0	7.0	9.5	9.5	7.0	16.5	Gasohol tech. program
Aquatic Program	6.0	3.0	4.4	4.4	3.5	7.9	Integrated farm systems
Anaerobic Digestion	4.0	4.0	3.5	3.5	2.3	5.8	Anaerobic digestion
Gasification/Liquefaction	24.8	18.0	15.0	14.5	4.0	18.5	Pyrolysis (gasification) R&D
Innovative Conversion Process	3.0	4.0	4.4	3.9	4.1	8.0	Basic biomass research
Integrated Systems for Agricultural Crop & Residue Utilization	13.0	16.0	3.0	3.0	13.0	16.0	Agricultural resource utilization
Mission Studies, Personnel Resources, Misc.	4.0	2.3	2.3	2.3	4.4	6.7	Joint commercialization programs
Regional Energy Farms	13.0	5.7	5.7	5.7	8.0	13.7	Harvesting of forests, etc.
Totals	75.8	61.0	57.8	56.8	62.6	119.4	

The CHAIRMAN. I would also like to get an opinion of the people who were working on those programs of the efficacy of the programs. That is to say, whether they really think they are worthwhile matters to pursue if funds were permitted for that purpose, or if the Congress decided to disregard OMB's figures and pass the money.

I need some kind of an assurance that those programs are, indeed, worth while and what kind of results we might expect from them.

Dr. MILLER. Mr. Chairman, we will get you that.

[Material to be supplied follows:]

This proposed legislation would provide significant additional monies for research and development on biomass energy systems. These funds would supplement existing Department of Energy biomass energy R. & D. programs.

We believe that our presently structured program provides for a balanced research and development effort on biomass energy systems, the pace of which is consistent with the stage of development of the technologies and products being developed. Within the present program we believe we can provide for orderly development of currently identified technologies while at the same time retaining sufficient latitude to enable us to begin new activities which capabilize upon research results and breakthroughs.

Substantially increased biomass research and development funding as provided in this bill would, most probably, increase the rate of systems development but would also significantly increase the risks associated with the program.

The CHAIRMAN. I am concerned, and I think you heard expressed from some of my other colleagues who were here earlier, frustration with what my colleagues and I feel is an inadequate priority that has been placed on biomass. As you know, I feel that with respect to various aspects of the solar program as well.

I find it hard to conceive that a \$57 million program administered until just recently with three people and now with six people really represents a major effort. Do you think this anywhere near fulfills the potential of what the Government can do to stimulate activity?

Dr. MILLER. I think we all recognize that individually any program the sort that biomass is can use additional funds. On the other hand, ultimately there is a balancing act that the Department goes through, and that means that priorities are set, and in one way or the other they get reflected in the budget.

I guess what I would like to say along those lines is the following: What we see as the major area for energy impact from biomass is direct wood combustion, and there the technology exists; and there I think we know what it is going to take to get that energy impact. But the problems are not R. & D. problems, they are institutional problems, and in some sense don't require the kind of budget support that an R. & D. program does.

I would like to use one example at the risk of taking a minute or so.

One of the biggest problems with getting people to commit to major wood combustion is the fact that a powerplant constructor won't construct a powerplant because he doesn't see the people in the woods to supply the wood, and the people in the woods can't get money to upgrade their facilities because there isn't a powerplant there. So you get into this terrible "chicken-and-egg" problem.

One of the ways in which we are trying to address that is to pursue a design program aimed at having available a powerplant that would burn interchangeably wood or some alternative fuel, either coal or oil. And if we can develop that design, we think we will go a long way to solving one of these institutional problems.

Now if somebody builds a powerplant and it can burn either wood or coal, for example, then a bank will lend a company that's in the woods the money to buy chippers, because they know that there's a plant that will use it; the plant will be built because even if the wood isn't there, they could always burn the alternative fuel like coal.

We think that this is sort of a way of getting at this very difficult institutional problem, and that doesn't cost a lot of money. If that can catalyze—if that can catalyze the wood industry, it will take off on its own.

We have gotten just a whole host of inquiries on, what can we do to help? And invariably, we seem to end up with: "Well, help us build a powerplant," but that didn't get the people in the woods. "Help us with the people in the woods," but that didn't get you to the powerplant. We always seem to be caught in this vicious cycle, and this particular approach—this design approach—as pedestrian as it may seem, seems to us a way to help get at that problem.

The CHAIRMAN. In the area of alcohol fuels, I take it there are substantial advances being made with distilleries. Is that something that the Department is involved in to any degree?

Dr. MILLER. Yes.

The CHAIRMAN. Is there an opportunity there to accelerate the R. & D. end of things?

Dr. MILLER. I believe that there is, Mr. Chairman, and in fact, right at the moment, internally we are taking a very hard look at just that question, and I hope that we are going to be able to come back to you within the next 30 to 45 days and tell you whether or not we believe that there is a way to accelerate the whole alcohol production technology.

I guess I tend to be very bullish on that whole business and I think we are going to come back and talk very positively, but I personally believe that there is a real way to move the R. & D. on that.

The CHAIRMAN. I'm glad to hear that.

There is a review committee presently operating, I understand. They are contemplating a major push in this area? What stage of development is that at?

Dr. MILLER. There was a review committee that has met over the past few months, and there is now an internal review of that review committee going on, and it is that that I was referring to. I believe we are going to be taking a more positive stance on the alcohol issue.

The CHAIRMAN. What kind of time frame can we expect in terms of—

Dr. MILLER. I would hope within the next 30 to 45 days.

The CHAIRMAN. That's encouraging.

I am going to take the subcommittee to Brazil and maybe some other places as well. As you know, Brazil has an objective of having in the very near term all of its transportation run on alcohol, methanol, and ethanol.

I would hope that the Department would send somebody—perhaps yourself or somebody at a responsible level—along with us there, because I think we have got a lot to learn there. I don't know what the costs of that experiment are, and I understand they are pursuing it. On the present basis, it is not cost effective on the belief that the price of oil is going to rise. I suppose that's a fairly sound belief at this juncture.

Dr. MILLER. Well, we certainly were not aware of your plans to take the subcommittee. What I can tell you is that we were planning to send a group of people, and it would seem to me that in the interest of economy, if the committee would tolerate one of the DOE people along with them, we would be delighted to send somebody along, because we were in the process of setting up a visit to Brazil for, I suspect, essentially the same reasons.

The CHAIRMAN. Well, it might be well to coordinate the two. We are planning to go from January 6-18. I think we stop in Venezuela, and we may or may not go to South Africa to see the SASOL plant. Some people may go and some people may not.

Dr. MILLER. We would be delighted to coordinate those plans if you felt comfortable with that.

The CHAIRMAN. All right.

The OTA, in a recent report on gasohol, was very critical of DOE's efforts to coordinate its alcohol fuels activities with the Department of Agriculture's program.

We got the Department of Agriculture's views of that. I wonder if we might have yours.

Dr. MILLER. I haven't seen OTA's report, except a sub rosa copy, and I think there is a fair case to be made for the fact that a year or so ago there were very difficult problems of coordinating the activities of DOE and USDA.

I think we are much farther along now than we were. I think evidence of that is that DOE and USDA had consistent testimony today. That hasn't happened before.

We are talking a great deal together, and I think that we have gone a long way to meet some of the objections. Obviously, not all of them, and I really haven't seen the final OTA report.

The CHAIRMAN. We will be glad to supply you with one if you don't have it, but if we could have your comments on that, I think it would be useful for the record.

Dr. MILLER. I would be delighted.

[Material to be supplied follows:]

The OTA gasohol report is actually a technical memorandum which does not present an analysis of policy issues. As such we find it to be a useful collection of technical and economic information from various secondary sources, some more recent than others. Of course we look forward to reviewing the final report of OTA on energy from biological processes which is due to the Congress in January 1980. At that time, we will be able to assess the various policy issues and options presented in the context of the evolving DOE policy on alcohol fuels.

The CHAIRMAN. Mr. Harris, let me ask a question of you, and then I think I will probably have to go vote. The second bells just rang. I understand that you have five professionals now under you?

Mr. HARRIS. Four.

The CHAIRMAN. Four?

Mr. HARRIS. Yes.

The CHAIRMAN. The five includes yourself.

Mr. HARRIS. That's correct.

The CHAIRMAN. There are three vacancies.

Mr. HARRIS. Correct. Four now.

The CHAIRMAN. Four vacancies. What has been the problem in filling those vacancies?

Mr. HARRIS. The problem lies both administratively and finding the right people, sir.

The grades of three of the four available vacancies are frozen in the sense of finding people outside; therefore, we have to look inside for qualified people for those positions. We have constructively undertaken to do so. I believe that we probably have two of them fairly well locked up at the moment.

The CHAIRMAN. Unfortunately, I am going to have to vote.

Can I impose on you to stay a little bit longer?

Dr. MILLER. Absolutely.

The CHAIRMAN. I'll get back as soon as I can.

The committee will recess.

[Recess taken.]

The CHAIRMAN. I have asked Mrs. Heckler to join us, because I did have a question and I know she is very interested in it. That is, about the Army's National Laboratories in Natick, Mass.

I wanted to find out what the status of DOE funding and support for that program is; to what extent the work is coordinated with the mainstream of activities; and the work, as I understand it, has been the subject of continual threat of Army cutbacks; why the work is funded out of the CSA urban waste program rather than out of the Department.

As I understand it, Mr. Spano up there has been in this work now for 25 years and is generally considered a leader. There was a question as to whether or not we ought to build a test facility there, particularly in view of the work that was being done by Gulf and now is being done by the University of Arkansas. We would be interested in what the status of that is, too, from either of you.

Mr. HARRIS. With respect to the Natick work, Mr. Chairman, it is my understanding from recent conversations with the responsible official at the Department of Defense that it is their full intention to go forward.

They look upon us as support for this in the sense that we are co-operating in the development of the Natick Lab work. They do not intend, as I understand it, to finance the process demonstration unit of the pilot plant at this time, feeling that, for one thing, if the Gulf process goes forward in the sense of creating a pilot plant on a commercial basis, that they would rather have Natick continue the research work that they are doing, and it is my understanding that they fully intend to support that research unit.

The CHAIRMAN. Well, what is DOE's participation in this? Why, if it holds real promise, isn't the DOE—

Mr. HARRIS. We are actively participating in the coordination of that project. We have, at the present time, six cellulose to ethanol projects of various natures. Three of them are acid hydrolysis, which is the conversion of the cellulose through an acid method, and two of them are enzymatic, which is the Natick process.

We are coordinating with the Army. We support Natick in the sense of technical throughput, correspondence and so on. It is a semi-management responsibility on our part in collaboration with the Department of Defense.

The CHAIRMAN. What is your assessment at this point of the desirability of proceeding with a pilot plant at Natick?

Mr. HARRIS. The point of view that we have—the equitable point of view that we have—is that they are not at the point where we believe that the expenditure of the pilot plant at this time would be

justified, and the reason I say that is that the similarity in the work of the Natick Lab and of the Gulf process, which has already had a "proof of concept" through the operation of their 1-ton-per-day plant at Jayhawk, Kans., would seem to make it perhaps redundant at this time.

Now, if they come through—which is very possible—over the period of the next few months with an improvement in the conversion efficiency of their process, at that time I think it might justify going to a pilot plant operation.

The CHAIRMAN. Is that something, then, that the DOE would consider financing, or financing the Department of Army to do?

Mr. HARRIS. Well, I think that we would cooperate with the Department of Army. It is their desire and intention to fund that work. We certainly would cooperate with them.

The CHAIRMAN. If the Department doesn't determine to fund the pilot plant, you determine that that's desirable because of improvements in the efficiency of the operation, would DOE then pick that up?

Mr. HARRIS. I suspect that that would be true, sir.

The CHAIRMAN. Mrs. Heckler? Because you are so knowledgeable, I thought it would be useful to have you available to ask some questions on this.

Mrs. HECKLER. I appreciate that very much, Mr. Chairman, and I must say, I welcome the opportunity to hear from the Department of Energy on their plans and their attitudes toward the experiment, because, as we all know, the Natick Laboratory work has been found to be of an outstanding caliber—

Mr. HARRIS. That's quite true.

Mrs. HECKLER [continuing]. According to the National Science Foundation publication that was most recently issued.

It was very hard for me to understand, therefore, why they have had such difficulty in getting their funding. Apparently they are going to be allowed to continue.

You have stated, Mr. Harris, that DOD will allow them to go forward, but Dr. Spano has said that he is ready to upgrade the quantity of the experiment, and that if he simply continues—if he keeps this together he has achieved something, because, obviously, they represent a very valuable resource. United particularly. But if he is not allowed to proceed—to scale up his experiment—then how can he make a breakthrough?

And it is my understanding that the Army does not want to fund anything that will be of a larger nature. He is talking about something that would be somewhere between the present level of the experiment and commercialization. Not a commercialization plant.

Mr. HARRIS. I think there are two points that could be made here. Quite recently it was requested of us to help fund an analysis and review of the Natick process, which is being conducted by the Stanford Research Institute, and I believe that they will be forthcoming, probably in about a month, with the completion of that review.

I am a little bit surprised to understand that there are potential restrictions on Mr. Spano's group, because it was my clear understanding, aside from the question of building a pilot plant at this time, that the Army had full intention of going ahead.

Mr. CHAIRMAN. Maybe you could look into that for us.

Mr. HARRIS. Yes, sir.
[The material follows:]

The Biomass Energy Systems Branch of the Division of Distributed Solar Technology has maintained close contact with the Army on the Natick enzymatic hydrolysis project because of its relevance to the biomass program. We were aware of the potential funding problem but were recently advised that the Army is taking action to resolve it. Lt. Col. Avalon Dungen, the Army Contract Support Officer for the project, advised us that the Army has increased its 1980 budget request for fuels and lubricants research from \$0.6 million to \$2 million, \$1.4 million of which is specifically earmarked for the Natick project. The funding will enable the researchers to continue to process about 150 pounds of material per day.

The CHAIRMAN. And give us some assurances. We are concerned. Our own staff made a re-review of this and came out with much more favorable indications than their first go-round at it. Something with some other people, you said?

STAFF VOICE. Vulcan.

The CHAIRMAN. Vulcan Engineering. Apparently, the outlook is much more optimistic in terms of increased efficiencies than they had originally thought.

Mr. HARRIS. I do know that a commercial company was that taken with what Natick had done that they were seriously considering building a plant themselves, based on Natick.

The CHAIRMAN. Can you give us a comparison of the Gulf and the Natick processes?

Mr. HARRIS. In terms of what they are doing?

The CHAIRMAN. In terms of what they are doing and what the outlook is for their efficiency.

Mr. HARRIS. Both of them are the conversion of cellulose through enzymes to fermentable sugars in a continuous process. The work that Gulf has been doing, that is, that is presently at the University of Arkansas, had produced a 1-ton-per-day throughput plant, which is much too small, really, to be considered a pilot operation in this sense.

They have run that plant, I believe, in one run 17 days continuously for the production of ethyl alcohol as a continuing process.

The CHAIRMAN. Ethyl alcohol?

Mr. HARRIS. Ethyl alcohol, yes.

The problems that they had encountered, as I understand them from Dr. Emert, who is the director of that process, is that, over a period of time, they seemed to have some labor problems, which is why they never got more than 17 days out of that plant.

From the standpoint of a scientific process, they have proved the capability of the process to operate with, I believe, something on the order of about 25 different raw materials, including sawdust bark, crop residues, wood chips, various city urban wastes, to the point where they even imported a planeload of German waste to see if there was any difference.

The process is at a high level of conversion efficiency. It is estimated, I believe, by Raphael Katzen Associates, who have made a very close analysis of it, that the cost, using raw material that has been assessed at a current market price, will be below corresponding alcohol produced industrially from grains.

The Natick process is almost identical in intent. However, it would appear, at least without having a very close analysis, that the enzymes

that Dr. Emert has developed are somewhat more efficient than those which had been developed at Natick.

Now, that's a judgment that I would not like to be said to be fully accurate, because we do not know. We do not know the full process development that Dr. Emert completed, because it was, at the time it was done, the property of the Gulf Oil Co.

The CHAIRMAN. Can you furnish a detailed technical comparison for the record?

Mr. HARRIS. We will have a fully detailed comparison as soon as the SRI review is done, sir.

The CHAIRMAN. Good. And when is that?

Mr. HARRIS. I hope within the next month.

The CHAIRMAN. Very good.

[Material to be supplied follows:]

The report comparing the Natick process with the Gulf process was due in January. Natick has requested that the contract with the independent contractor be extended in order to refine the report further. The request for an extension is now under consideration by the manager for the project, Dr. Clayton Smith of the Solar Energy Research Institute.

The CHAIRMAN. Did you have anything else?

Mrs. HECKLER. Yes, Mr. Chairman, I would like to know what scale of experiment the Department of Defense is presently funding at Natick Laboratories. It is my understanding from Dr. Spano that they have exceeded their capacity; their system is working under current conditions, and at this point, if they don't scale up their experiments, they are not going to really progress to the next stage.

Mr. HARRIS. I am unable to give you exactly those figures, Mrs. Heckler, but I will assure you that I will obtain them.

Mrs. HECKLER. I would just like to have a characterization of the attitude of the Department of Energy on the question of Natick.

Mr. HARRIS. We are positive for it. We don't believe that we should put all our eggs in one basket in that type of an operation.

Mrs. HECKLER. I would certainly agree that it would seem that research of this value should be continued and should be allowed to expand according to its scientific merit.

Mr. Chairman, I want to thank you for allowing me to hear this, and I look forward to—

The CHAIRMAN. I want to thank you for taking the time and trouble to join us.

Mrs. HECKLER. Well, as you know, this laboratory has many ardent supporters in the Senate, as well as in the House, but it is critical that the Department of Energy takes a supportive attitude if the work is worthy of your commendation, as it seems to be by the standards of the other evaluators.

Thank you, Mr. Chairman.

The CHAIRMAN. I would like to say that Mrs. Heckler has really maintained a tremendous interest in this.

Mrs. HECKLER. And it will continue.

The CHAIRMAN. Has kept our feet very well to the fire.

We have people who have been waiting a long time. I want to thank you very much for your indulgence and your time, and I think you have been very helpful.

I do have some additional questions which I would like to furnish and have you respond to for the record.

Thank you for being with us.

Dr. MILLER. Thank you for inviting us, sir.

The CHAIRMAN. Because of the time situation, I would like to ask the next two panels to come up at once and I will do what I can to deal with everybody at once.

We have Dr. Jack Gibbons, the Director of the Office of Technology Assessment—he is not here, I understand.

Is Dr. Tom Bull here?

Dr. BULL. Yes; I'm here.

The CHAIRMAN. All right.

Dr. BULL. I have with me today Steven Plotkin, who is our environmental analyst at OTA.

The CHAIRMAN. Very good.

And we have Mr. Steve Morgan. Is Mr. Morgan here?

Mr. MORGAN. Yes.

The CHAIRMAN. From the New England Energy Congress.

Dr. Robert Peart of Purdue University?

Dr. PEART. Yes, Mr. Chairman.

The CHAIRMAN. Pull up a chair there someplace.

Dr. Paul Tarman of the Institute of Gas Technology. Dr. Tarman, it's good to have you with us.

I am going to proceed to hear from OTA first. I will see how that goes. I may or may not have questions then, and then hear from the rest of the witnesses.

[The biographical sketch and prepared statement of Dr. Bull follow:]

BIOGRAPHICAL SKETCH

Dr. Bull received a B.S. degree in basic chemistry at the University of California at Berkeley, and a Ph.D. in chemical physics at the University of Illinois in Urbana. Working in the area of nuclear magnetic relaxation to investigate basic molecular motions in model fluids and ion binding to the active sites of protein, Dr. Bull taught and directed graduate research at the Lund Institute of Technology, Lund, Sweden, from 1970-78. In 1975, he was appointed Docent, which is roughly equivalent to a U.S. associate professorship. In 1978 he joined OTA, where he is now an analyst and Project Director for the assessment of Energy from Biological Processes.

Dr. Bull is the author or co-author of over 30 scientific articles and is a member of Phi Beta Kappa, Phi Lambda Upsilon, the American Physical Society, and the American Association for the Advancement of Science.

TESTIMONY OF DR. THOMAS BULL
PROJECT DIRECTOR, ENERGY FROM BIOLOGICAL PROCESSES
OFFICE OF TECHNOLOGY ASSESSMENT
BEFORE THE
SUBCOMMITTEE ON ENERGY DEVELOPMENT AND APPLICATIONS
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
NOVEMBER 15, 1979

Mr. Chairman,

Thank you for this opportunity to testify before your Subcommittee about energy from biomass. We have witnessed a steadily growing interest in bioenergy over the last several years in an attempt to develop renewable domestic energy sources for our future. The series of shocks we suffered this past year because of our heavy dependence on foreign oil have greatly intensified this interest as we look for ways to substitute domestic resources for these imported liquids. Currently, we are completing a major assessment of energy from biological processes which is examining the long-term potential from biomass, its implications for our economy and society and policy options that may be adopted to accelerate the development of bioenergy. We have recently issued a technical memorandum discussing our major findings about gasohol and we expect to deliver the complete study in January 1980..

On the basis of this work we have estimated the potential from bioenergy to the end of the century. These data are listed in the table attached to the written testimony. By 2000 the U.S. could be producing as much as 16 quads from biomass. By far the majority of this would be from wood, amounting to as much as 10 quads. Gasohol from grains and sugar crops, as it is currently produced, could conceivably contribute 1 quad by 2000. Problems arising from competition with food

production, however, could reduce this to zero. The potential of ethanol from other sources, such as wood, grasses and crop residues, is less certain.

A knowledge of the location of the various segments of the biomass resource base is also important in determining the potential from bioenergy. The largest use of bioenergy today is from wood. The forest products industry currently consumes about 1.2 quads/year of the 1.4 quads/year being used for energy (roughly 2% of the nation's energy use of nearly 80 quads/year). Additional fuel wood could come from logging residues and the residues generated from increased forest management activities, such as thinnings and stand conversions. If the fuel wood is harvested as part of a forest management program, then there could be the added benefit of increasing the supply of timber suitable for lumber and paper production in 10-20 years.

About 75% of this wood resource would come from the eastern half of the U.S., where private ownership of forestlands predominates. Much of the nation's forestland is not readily accessible for intensive forest management, due to a variety of reasons including alternative uses for the forest and the rough terrain or lack of roads in many forested regions. Consequently, the numbers given in the table assume that only one fourth to one third of the nation's most productive forestland would be subject to the forest management practices by 2000.

The other main biomass resources are located as follows:

- o Increased forage grass production would come from lands currently used for forage grass by applying fertilizers to this land and increasing the number of harvests per year. Most of the land suitable for this is located east of the Mississippi River.

- o Crop residues which are available for energy uses (after sufficient residue is left to protect the soil from erosion) occur primarily in the most productive agricultural regions. About half of the resource is in Minnesota, Illinois, Iowa, Indiana, Ohio and Wisconsin.

o The animal manure is located mainly in small confined animal operations such as dairy farms with a few hundred head of cattle or less. Over 60% of the total is found in the North Central, West South Central and South Atlantic geographic regions.

o Food processing plants are generally found in the areas where the food is grown, with orchard prunings, Hawaiian sugarcane bagasse, and cotton gin trash providing the largest sources of wastes suitable for energy.

o Grain and sugar feedstocks for ethanol production can be grown on most agricultural land. At present, however, it is unclear whether there will be surplus farmland available for this type of crop production in 2000.

Our assessment is also considering the R&D opportunities that could most usefully help us achieve the goals listed in the table. To see where these opportunities lie it is useful to consider them in light of the major ways biomass can be used to produce energy.

The major biomass resources -- wood, grasses and crop residues -- can all be burned directly or via gasifiers; and by the mid to late 1980's there will probably be processes for converting them to fuel ethanol at prices competitive with grain derived ethanol. In addition, processes can be developed for converting these feedstocks to methanol and a type of low grade fuel oil.

In the next ten years, the use of biomass with the greatest potential for displacing imported oil is through direct combustion and gasification. The development of suitable air blown gasifiers would enable industrial users of oil and natural gas fired boilers to convert to biomass fuels at a lower cost than would be needed to purchase new wood boilers. At the same time, the users could return to oil or natural gas without additional cost if the biomass fuels were temporarily unavailable.

Although numerous gasifiers are currently being developed, federal support and commercialization efforts can probably help to accelerate the process. Simultaneous research into rapid gasification and the thermochemistry of biomass would

provide engineers with the information needed to design and build advanced biomass gasifiers, burners, and wood stoves, all of which have the potential for higher efficiencies, easier and more flexible operation, and lower costs. Related research and development is needed for methanol production; and applied and basic research into the thermochemistry of gasification, secondary gas phase reactions, and catalysts are likely to lead to interesting new applications in the production of fuels and chemicals from biomass.

At the same time, continued research and development of ethanol fermentation from wood, grasses, and residues is needed. These are the most advanced processes for producing high grade liquid fuels from the more abundant biomass resources, but additional work is necessary to develop and demonstrate processes which could be competitive with grain ethanol distilleries. The development and demonstration of a variety of anaerobic digesters suitable for on-farm use would help to make biogas from animal manure available to farmers while providing some environmental benefits. Finally, research and development of unconventional crops, including fast growing trees and grasses and hydrocarbon and oil crops, should continue, with a particular emphasis on plants that do well on land where conventional crops cannot be efficiently cultivated. We believe this latter point to be important for a balanced R&D effort on biomass. It is unclear whether the proposed legislation, H.R. 5428, will support this type of R&D.

The proposed bill also addresses the problems of developing a reliable, low cost supply of biomass feedstocks and matching the fuel sources to the potential users of bioenergy. This should be an important part of most biomass commercialization efforts. Based on our study, we believe that emphasis should be given to:

1) minimizing the environmental and aesthetic damage; 2) maximizing the potential benefits such as increased growth of high quality timber; and 3) developing a supply infrastructure that potential bioenergy users can rely upon.

During the course of our current biomass assessment effort, we have examined

the effect of the current level of R&D effort on development of renewable biomass energy. We have found that if a higher level of effort were expended on technologies needed to harvest the resources and convert them to useable fuels, heat, or electricity, and for expanding the resource base itself by developing new plant varieties or new growing strategies, more effective progress could be made in these areas. We note that H.R. 5428 calls for such an increase in effort.

Much of the needed research is of a nature that requires support for a period of several years. For instance, technology development efforts will require a minimum of 2 or 3 years for the simpler systems (e.g., demonstrating a range of first generation air blown gasifiers or anaerobic digesters), and at least twice as long for the more complex (e.g., thermochemical research and the advanced wood, grass, and crop residue to ethanol processes). Programs aimed at developing new plant strains may achieve results in a few years in some cases, but generally require far longer. We believe that the success of these research and development programs requires some assurance of stable funding for at least 4-6 years, and preferably longer.

It is our perception that the research community may not be able to efficiently absorb a very substantial increase in research funding in all of the required technical areas, unless the increases in these areas are phased in over a 2 or 3 year period. The long-term success of the biomass energy research program will depend upon the training of additional specialists in several key scientific areas -- for example, in thermochemical conversion. These specialists will come from university research programs and it is not clear that these programs will receive the necessary funding to carry out this mission if the total biomass R&D funding is expanded too rapidly.

In conclusion, OTA's analysis of the biomass resource indicates that materials such as wood, grasses, and crop residues are likely to provide the bulk of the biomass resource. We believe that the most effective way for this to happen is by emphasizing strategies for obtaining these feedstocks and converting them to useable

energy forms, while still supporting R,D&D into various other types of bioenergy. The programs proposed in the Biomass Research and Development Authorization Act, if properly phased in and continued for several years, can make a significant contribution to expanding the use of biomass as an attractive and viable energy source. Thank you for this opportunity to discuss our findings and we would be pleased to answer any questions.

BIOENERGY RESOURCE POTENTIAL
(quads per year)

	<u>1985</u>	<u>2000</u>
Forest Wood	2-5	5-10
Increased Forage Grass Production	1-2	0.5-3
Crop Residues	0.6-1	0.7-1.2
Animal Manure	0.1	0.2-0.3
Food Processing Wastes	0.1	0.1
Gasohol from Grains and Sugar Crops	0.1-0.2*	0-1 ⁺
Methane from Kelp	less than 0.1	unknown
Other Unconventional Agricultural Energy Crops	less than 0.1	unknown

*1-2 billion gallons of ethanol

⁺0-10 billion gallons of ethanol

STATEMENT OF DR. THOMAS BULL, PROJECT DIRECTOR, ENERGY FROM BIOLOGICAL PROCESSES, OFFICE OF TECHNOLOGY ASSESSMENT: ACCOMPANIED BY STEVEN PLOTKIN, SENIOR ENVIRONMENTAL ANALYST, OTA

Dr. BULL. Thank you, Mr. Chairman.

Thank you for this opportunity to testify before your subcommittee about energy from biomass. We have witnessed a steadily growing interest in bioenergy over the last several years in an attempt to develop renewable domestic energy sources for our future.

The series of shocks we suffered this past year because of our heavy dependence on foreign oil have greatly intensified this interest as we look for ways to substitute domestic sources for these imported liquids.

The CHAIRMAN. I would appreciate it, because of the time, if you would summarize or pick out the pertinent areas. We know there's a crisis.

Dr. BULL. OK.

On the basis of this work we have estimated the potential from bioenergy at the end of the century. This data is listed in the table attached to the written testimony so you can look there yourself.

By far, the majority of this would be from wood, amounting to as much as 10 quads by the year 2000. Gasohol from grains and sugar crops, as it is currently produced, could conceivably contribute 1 quad by 2000.

Problems arising from competition with food production, however, could reduce this to zero. The potential of ethanol from other sources such as wood, grasses and crop residues, is less certain at the present time.

I have also included in the testimony our estimate of where the various resources are located, as was requested in the letter.

The major biomass resource, wood, grasses, and crop residues, can all be burned directly or via gasifiers, and by the mid- to late 1980's, there will probably be processes for converting them to fuel ethanol at prices competitive with grain-derived ethanol.

In addition, processes can be developed for converting these feedstocks to methanol and a type of low-grade fuel oil.

In the next 10 years, the use of biomass with the greatest potential for displacing imported oil is through direct combustion and gasification. The development of suitable air-blown gasifiers will enable industrial users of oil and natural gasified boilers to convert to biomass fuels at a lower cost than would be needed to purchase new wood boilers or coal boilers.

At the same time, the users could return to oil or natural gas without additional cost if the biomass fuels were temporarily unavailable. Although numerous gasifiers are currently being developed, Federal support and commercialization efforts can probably help to accelerate the process.

Simultaneous research into rapid gasification and the thermochemistry of biomass would provide engineers with the information needed to design and build advanced biomass gasifiers, burners, and wood stoves, all of which have the potential for higher efficiencies, easier and more flexible operation, and lower costs.

Related research and development is needed for methanol production; and applied and basic research into the thermochemistry of gasification, secondary gas phase reactions, and catalysts are likely to lead to interesting new applications in the production of fuels and chemicals from biomass.

At the same time, continued research and development of ethanol fermentation from wood, grasses, and residues is needed. These are the most advanced processes for producing high-grade liquid fuels from the more abundant biomass resources, but additional work is necessary to develop and demonstrate processes which could be competitive with grain ethanol distilleries.

The development and demonstration of a variety of anaerobic digesters suitable for on-farm use would help to make biomass from animal manure available to farmers, while providing some environmental benefits.

Finally, research and development of unconventional crops, including fast-growing trees and grasses and hydrocarbon and oil crops, should continue, with a particular emphasis on plants that do well on land where conventional crops cannot be efficiently cultivated.

We believe this latter point to be important for a balanced R. & D. effort on biomass. It is unclear whether the proposed legislation, H.R. 5428, will support this type of R. & D.

The proposed bill also addresses the problems of developing a reliable, low-cost supply of biomass feedstocks and matching the fuel sources to the potential users of bioenergy. This should be an important part of most biomass commercialization efforts.

Based on our study, we believe that the emphasis should be given to one, minimizing the environmental and esthetic damage; two, maximizing the potential benefits, such as increased growth of high-quality timber; and, three, developing a supply infrastructure that potential bioenergy users can rely upon.

During the course of our current biomass assessment effort, we have examined the effect of the current level of the R. & D. effort on development of renewable biomass energy. We have found that if a higher level of effort were expended on technologies needed to harvest the resources and convert them to usable fuels, heat, and electricity, and for expanding the resource base itself by developing new plant varieties or new growing strategies, more effective progress could be made in these areas.

We note that H.R. 5428 calls for such an increase in effort.

Much of the needed research is of a nature that requires support for a period of several years. For instance, technology development efforts will require a minimum of two or three years for the simpler systems, for example, demonstrating a range of first generation air-blown gasifiers, and at least twice as long for the more complex.

Programs aimed at developing new plant strains may achieve results in a few years in some cases, but generally require far longer. We believe that the success of these research and development programs requires some assurance of stable funding for at least 4 or 6 years and preferably longer.

It is our perception that the research community may not be able to efficiently absorb a very substantial increase in research funding in all of the required technical areas unless the increases in these areas are phased in over perhaps a 2- to 3-year period.

The long-term success of the biomass energy research program will depend upon training of additional specialists in several key scientific areas. For example, in thermochemical conversion. These specialists will come from university research programs, and it is not clear that these programs will receive the necessary funding to carry out this mission if the total biomass R. & D. funding is expanded too rapidly.

In conclusion, OTA's analysis of the biomass resource indicates that materials such as wood, grasses, and crop residues are likely to provide the bulk of the biomass resource. We believe that the most effective way for this to happen is by emphasizing strategies for obtaining these feedstocks and converting them to usable energy forms, while still supporting R. & D. in various types of bioenergy.

The programs proposed in the Biomass Research and Development Authorization Act, if properly phased in and continued for several years, can make a significant contribution to expanding the use of biomass as an attractive and viable energy source.

Thank you for this opportunity to discuss our findings and we would be pleased to answer your questions.

The CHAIRMAN. I just have a few questions and instead of taking you through the next witnesses, maybe I'll dispose of that.

You estimate 10 quads in what time frame?

Dr. BULL. We estimate the potential of 5 to 10 quads from forest wood at year 2000. The primary problem there is developing the forest management infrastructure—infrastructure for forest management.

We have assumed in this number that only one-third to one-quarter of commercial forest lands would be subject to this management, because we are aware that a large fraction of our forests would not be accessible to forest management because they have alternate uses, or because they are in rough terrain or roads are not available, et cetera.

So of the total forest land, about two-thirds is commercial. Now, we have only assumed one-third to one-fourth of this commercial timber land would be subject to the intensive forest management and that would produce these numbers.

The CHAIRMAN. You said the number one problem we have to answer is environmental problems.

Dr. BULL. Beg your pardon?

The CHAIRMAN. You said the No. 1 problem that had to be resolved was environmental problems.

Dr. BULL. No; I said that in addressing the problem of obtaining the feedstock, there are three general areas which should be addressed, which should be emphasized, in a program designed to increase the supply of wood, and the first of those was that one should minimize environmental and esthetic damage.

The second is that one should maximize the potential benefits, such as growth of high-quality timber. The third of these was trying to develop an infrastructure which could provide a reliable supply of this wood to the potential users.

The CHAIRMAN. I think most people—this committee included—have been proceeding under the happy notion that most of these renewable energy resources were environmentally benign. Where do the environmental problems that need to be addressed with priority occur?

Dr. BULL. I will ask Steve Plotkin to answer that.

Mr. PLOTKIN. I think that the interesting thing about biomass energy is that you can postulate these scenarios where everything goes according to your management plan, and I think it is accurate to say that, if everything does go according to plan, the environmental impacts will be relatively small, although there are still some left.

The problem is that a great part of the biomass strategy depends on a lot of small technologies, a lot of harvesting, just a lot of people who are not subject to central management.

For instance, the management of logging on commercial forest lands is very poorly controlled right now, so it is very difficult to say that, in fact, our management will go the way we think it's going to go, and there can be very substantial damages from poor management, both in the harvesting and also in the conversion.

I would note also that one of the attractive things about biomass—at least attractive to the press and to many of the advocates—is that it can be used on a relatively small scale. People can be relatively energy-independent at the local level, but what goes along with that is that it is very difficult to control in a regulatory sense. So you want to try to build environmental controls right into that technology, rather than have it depend on people's behavior to control.

At this point, it is hard to say that we are going to be able to achieve the level of control that we would like.

The CHAIRMAN. Is the problem supervision of the people who go into the woods, or is the problem actually the design of the program?

Mr. PLOTKIN. Well, in the harvesting process, I think on most commercial forest land, a well-trained forester and a good crew can take out the wood and really end up with very little environmental damage.

However, there is no economic incentive now to practice these best management practices.

The Environmental Protection Agency is in the process of developing these best management practices for forestry, but there is no guarantee that they will be carried out. It takes a tremendous amount of regulatory strength at the State level, and I don't think that right now—it's fair to say—that the States have that manpower capability.

The CHAIRMAN. If a commercial outfit wants to go into the forest for any purposes, I suppose the easiest thing to do and the most economical thing to do is to take everything with it.

Mr. PLOTKIN. Not necessarily. Actually, I think the most economical thing to do is what we call "high-grading," where you go and you take out only the best commercial timber and you leave everything else.

The CHAIRMAN. Why do they clear-cut?

Mr. PLOTKIN. There are examples where clear-cutting makes some environmental sense. I know this is a tremendous area of controversy in the environmental community, but there are many instances where, if you can clear-cut the land and site-prepare it, then you can grow a forest which is more productive, has the species of trees that you would like to grow.

If you just high-grade it, you end up with a forest which will decline in productivity and, in fact, in many parts of the East, there are these kinds of forests that are in lousy shape. There are certainly many who would say that for those forests which are now mostly very low-grade lumber, the best thing to do would be to go in, clear them, use that wood for energy, and then let re-growth occur, or else plant and end up with a fairly valuable commercial forest.

The CHAIRMAN. I think we won't resolve that here.

Your recommendation, I take it, Mr. Bull, then, would be that we go for a longer term bill rather than for Mr. Fithian's bill, 5428 as presented. We ought to do something like we have just done for wind or we did for photovoltaics, and lay out a 5- or 6-year program?

Dr. BULL. As you know, OTA doesn't make recommendations, but it is our perception that—

The CHAIRMAN. Well, that would be the soundest thing to do.

Dr. BULL. It is our perception that you would probably get more for your money if you carried it out over a number of years, yes.

The CHAIRMAN. Are there areas that ought to be addressed in the biomass field which are not addressed in this legislation?

Dr. BULL. It is unclear to me whether section 108 would involve the growing of—the development of plant hybrids and plant species, and both water-based or land-based ones which have the potential for surviving environmental stresses of the type that food crops cannot survive that would be thus suitable to grow on marginal croplands where normal food crops cannot be grown.

The reason for this is that this stems from our perception that there is a real uncertainty as to how much good quality cropland will be available for energy production in the future.

There are plausible scenarios in which there is none, so relying on an assumption that it will be available is a shaky assumption.

The CHAIRMAN. Well, taking that into consideration, are these seven areas which are identified for additional funding areas which would be—from OTA's standpoint—priority areas?

Dr. BULL. If you are interested in promoting the use of biomass energy, then I think that these are among the most cost-effective areas that you can spend research and development and commercialization money in.

The CHAIRMAN. And are there additional areas that we ought to include?

Dr. BULL. As I say in my testimony—I think I included most of the areas in my testimony that I believe should be covered, and virtually all of them are covered [except the development of plant species] that I see as being the most important for the next 10 years.

The CHAIRMAN. All right. Thank you very much.

We will hear next from Mr. Steve Morgan.

[The biographical sketch and prepared statement of Mr. Morgan follow:]



NEW ENGLAND ENERGY CONGRESS

SIX BEACON STREET, SUITE 1111, BOSTON, MA 02108 (617) 742-3598

H. Bailey Spencer, Director

Steve Morgan is a member of the senior research staff for the New England Energy Congress. The Energy Congress was established in 1978 to assist the New England Congressional delegation in formulating energy policy. Over 100 energy experts representing a dozen diverse constituencies have completed a 500-page report, A Blueprint for Energy Action, highlighting its conclusions and recommendations. The Congress has recently formed an Implementation Group to complete its work. Mr. Morgan has been responsible for renewable energy issues research and analysis. He delivered a paper to the Wood Energy Institute Seminar in September 1979, entitled "Expanding the Biomass Supply to Ease the Home-Heating Oil Crisis in New England." He is an active member of the New England Wood Energy Advisory Council, a forum for public policy discussions in the region.

Mr. Morgan has a Ph.D. in Social Policy and Planning From Brandeis University. He was formerly Director of the Nader-inspired Massachusetts Public Interest Research Group.



NEW ENGLAND ENERGY CONGRESS

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H. Bailey Spencer, Director

WOOD ENERGY TESTIMONY
FOR THE
ENERGY DEVELOPMENT AND APPLICATIONS SUBCOMMITTEE
OF THE
SCIENCE AND TECHNOLOGY COMMITTEE
November 15, 1979

Steve Morgan
Senior Research Associate
New England Energy Congress



NEW ENGLAND ENERGY CONGRESS

SIX BEACON STREET, SUITE 1111, BOSTON, MA 02108 (617) 742-3598

H. Bailey Spencer, Director

Wood Energy Testimony for the Energy Development and Applications Subcommittee
of the Science and Technology Committee: Steve Morgan

One hundred twenty New England energy experts with diverse backgrounds ended a year long deliberative process last June with a clear, resounding message to their 25-member, six-state New England Congressional Caucus: Wood energy is the most abundant near term resource available to reduce the region's precarious 80% dependence on oil. The New England Energy Congress' Blueprint for Energy Action exhorts Congress, the Department of Energy, and the Department of Agriculture to act upon some 15 specific recommendations designed to overcome barriers thwarting the desirable utilization of the wood energy potential in the country. Serious consideration of the wood stove tax credit and of HR 5428 are two Congressional responses which improve the prospects for realizing our objectives for wood energy use. To this point, however, we have been extremely disappointed in a federal program which virtually ignores the present day obstacles limiting feasible expansion of a fuel source whose energy contribution today practically equals that of nuclear power.

But is there enough wood out there available for fuelwood to justify significant new government programs to stimulate production and consumption? The answer is yes! For the next two decades New England wood utilization should not be constrained by fierce competition for a vanishing resource. While forest product industry spokesmen and others caution against an increased reliance on wood combustion in the residential, industrial, and utility sectors, prudent forest management and harvesting practices should enable a several-fold increase in wood energy

applications. Yet it is imperative that government initiate today forest utilization and wood energy planning to determine end-use priorities for biomass. Without such planning, our forest resource will continue to be managed poorly, utilization will not necessarily serve the country's best interests, environmental damages could be severe, and over the longer term, deforestation could destroy our precious resources. Wise utilization based on carefully conceived priorities should enable the harvesting of up to one-half a quad of energy annually by the 1990's or over 80 million barrels of oil equivalence for residential combustion, industrial process steam and cogeneration in the region. That number is 12% of our total energy consumption today. New England's large reserves of one-time yields from nonmerchantable wood (rough, rotten, diseased, dead, irregular, inferior quality) offer the achievable potential of over 25 million barrels of oil equivalence annually for the next twenty years. In contrast, today we use six and a half to seven million barrels of oil equivalence in wood energy throughout the region. As early as 1985, we could utilize over 50 million barrels equivalence, an eight-fold increase over 1978.

In the forest products industry and in the residential sector, the oil savings potential is particularly dramatic. The forest products industry can move from its current 20% self-sufficiency to 80% in this century. From a current baseline of approximately 1.4 million barrels of oil equivalency in wood, the industry can achieve a 1990 potential of 17 million barrels equivalency. Combined with a vigorous conservation program, the residential sector could displace 45% of our current consumption of heating oil; 26% of that displacement would be provided directly with wood. The industrial sector can meet 10% of its needs with wood; the commercial sector, 5%. While these numbers are New England-specific estimates, the Southeast, Pacific Northwest, mid-Atlantic, and North Central states also have a vast untapped resource in wood wastes, logging residues, and especially nonmerchantable wood now left to rot in our forests. For the rest of

the century, these particular wood energy resources will still be available after the forest products industry has consumed all it can profitably use.

If there is so much wood out there to harvest for wood energy, why do we need government assistance at all? We have heard much of Vermont's experience, for example, in which a quintupling of residential wood burning has taken place without government involvement since 1973. Today over 20% of Vermonters burn wood as their primary home heating fuel and better than 40% operate one or more wood stoves. The recent OPEC price increases have stimulated record breaking stove sales. Demand may increase 100% this winter over last. Yet supply will not meet the demand and a host of unpleasant externalities hamper the fuelwood industry in New England and elsewhere in the country. Public programs are required because the wood energy industry is hamstrung by a variety of factors preventing the firewood market from operating effectively: consumers lack adequate information about firewood availability and value and about efficient stove purchase, installation and maintenance. Landowners don't understand the economics of the fuelwood and timber markets, the technologies available for harvesting, and the principles of forestry management. Loggers are inexperienced in running a business and cannot get the capital required to purchase the machinery they need for today's harvesting technologies. New entrepreneurs cannot get loans from banks to start needed fuelwood distribution and marketing businesses. Small industries and utilities cannot be assured of the long term supply contracts they need in order to convert their fossil fuel boilers to wood because the supply infrastructure is chaotic - a situation exacerbated by landholdings distributed among hundreds of thousands of individual owners.

The information dissemination, technical assistance, and R & D needed to break the near term bottlenecks do not require enormous expenditures of public dollars. A modest federal program, representing just over 1% of the current federal energy budget, can produce a near term cost-benefit ratio far superior to that invested in any other supply resource. HR 5428 offers a balanced national biomass program worthy of immediate implementation. Merging gasohol, integrated farm applications, anaerobic digestion, and basic biomass research into a comprehensive commercialization program is an eminently sensible idea. The Power Systems, Commercialization, and Forest Resource Utilization Research-Demonstration components, totalling \$41.8 million, are particularly appropriate for the Northeast and sections of the North Central, Southeast, and Northwest. The only significant amendment I would propose is an additional \$7 million allotment for consumer education programs - the development of brochures, media campaigns and local conferences to inform woodburners about appropriate and safe utilizations of the resource. (See Appendix III.)

What these programs can accomplish very quickly is quite demonstrable: Consumers properly informed will burn dry and not green wood and buy 55% and not 35% efficient stoves. Learning efficient stove operation techniques will generate even more BTUs than buying a more efficient stove. As a consequence, five cords - not ten or twelve - will be sufficient as fuel for the heating season. Wood burners properly informed about stove installation and maintenance will also be less likely to cause accidental house fires - a problem of increasing concern in New England. A recent study of 104 1977-78 stove related fires in Massachusetts revealed that over 75% were attributable to unsafe installations. A Maine Audubon firewood study discovered that almost 40% of stoves in that state were installed without attention to recommended guidelines.

Landowners properly advised will enroll overstocked stands in forest management plans designed to maximize production of firewood and sawtimber while safeguarding environmental, recreation, wildlife, and aesthetic uses of their woodlots. As a consequence, hundreds of thousands of acres in forestland will be opened up to the fuelwood market for the first time in a century. Therefore environmental impacts will be distributed more broadly across the region.

Loggers will be able to secure the capital for the costly skidders and feller-bunchers which are virtual necessities for most fuelwood operations. Benefited by business advice and technical assistance, loggers will be able to get the loans banks are reluctant to make today. New entrepreneurs, including fuelwood brokers, will similarly find capital very difficult to find today.

By virtue of a government technical assistance program, small and moderate industries can gain the engineering, accounting, and financial expertise necessary to make boiler conversions for process heat and/or cogeneration systems. Utilities considering small scale wood-fired electricity stations will have better data about the resource availability and better opportunities to secure long term contracts for the fuel.

The R & D activities that improve harvesting capabilities, the efficiency and safety of wood burning devices, and the market penetration of the fuel for priority uses are important programs for DOE and USDA support. The testing of stoves for efficiency and emissions is a worthwhile program to continue: The greater the stove efficiency the less the air pollution impact. The testing and development of multi-fuel boilers is another. Funding for pelletization demonstrations promises to deliver fuelwood to markets - commercial buildings, the elderly, the disabled, the lazy - currently underutilizing wood for fuel. Support for new small-scale harvesting equipment will accelerate harvesting on small woodlots and on difficult access terrains. Wood gasification systems offer great promise in residential,

commercial, and industrial settings.

Education, technical assistance and research and development are the areas in which federal support is most needed. The landowner, the logger, the fuelwood distributor, and the consumer - residential, industrial, and utility - are all intended beneficiaries of a well-conceived federal program. Since regional differences within the country are profound, the regional solar centers and the state energy offices should administer many of the programs forthcoming from a meaningful wood commercialization effort. Planning must begin now.

First, an integrated forest management plan must be developed for the region and for each state. Timber, pulp and paper, other forest products, energy, wildlife, aesthetics, recreation, and environmental considerations must be balanced in a complex, but necessary planning process to determine our forests' future and to allow the implementation of sound management practices.

A simultaneous part of the planning process requires wood energy planning in the context of overall energy plans developed at regional, state, substate and local levels. Wood energy's role in an integrated forest management plan must be determined in part by how much wood energy will be required to meet the region's future needs. Periodic and comprehensive demand estimations by sector and end-use are required, as are assessments of other indigenous resources and their expected contributions to the energy supply.

President Carter's objective to lower oil imports produces the most severe pressure on New England to conserve and to find other sources to replace oil. Undertaking a forest planning effort, coordinated by the U.S. Forest Service and each state forestry department, and a wood energy plan, as part

of an overall energy plan coordinated by the regional office of the Department of Energy and each state energy office with the cooperation of the forestry departments, will hasten the day the region can emerge from its excessive, costly and dangerous oil dependence. These are recommendations very similar in thrust to those of the Mitre Corporation's Wood Combustion Commercialization strategy for DOE. I recommend to you their Phase III Working Paper as an excellent resource for organizing a comprehensive DOE and USDA cooperative program.

Securing a coordinated approach to programs administered by federal agencies, particularly the Forest Service in the Department of Agriculture and the Department of Energy's newly reorganized Solar Division, is essential. The pass through monies from DOE to USDA and vice-versa for related commercialization and forest utilization programs proposed by Representative Fithian are helpful. Successful implementation of these various programs and effective decentralization of services requires the permanent formation of wood energy coordinating councils at the federal, regional and state levels. The federal council should be chaired by DOE and include representatives of USDA, EPA, NBS, DOD, SERI, the RSECs, industry, consumer and environmental groups. Similarly structured regional coordinating councils might be chaired by the regional solar energy centers. These are specific recommendations in the Mitre strategy paper that deserve implementation immediately.

DOE is in the process of reorganizing itself to improve its capabilities for responding to new biomass priorities. The reorganization will hopefully result in a structure which (1) successfully integrates program management operations between the old Fuels from Biomass (ET) and Wood Commercialization offices (C & SA); (2) involves formally other relevant federal agencies, SERI, and the regional centers; (3) recognizes the emerging near term needs of the residential and industrial sectors.

The USDA wood energy programs similarly require reorganization. Wood energy has received the same neglect in USDA as it has in DOE. The Pilot Fuelwood Project administered by the Agricultural Stabilization and Conservation Services is a recent and refreshing exception. Here are some suggestions: Expanding and reorganizing the forestry management services, particularly those provided by the U.S. Forestry Service, County Extension Services, and state forestry departments, should be a first priority. For New England, at least \$1 million per year (beyond the Pilot Fuelwood Program) in additional federal funds will be required to hire new personnel and redirect forester efforts towards developing an integrated forest management plan, including a component tailored for public forestlands; working with landowners to develop their own management plans and teaching good forestry management practices; cooperating with appropriate agencies to help wood energy entrepreneurs and marketers in developing marketing plans and instituting sound business practices; and completing accurate and periodic subregion total biomass surveys.

We are placing great expectations upon biomass for resolving a part of our worsening energy dilemma. Over the next twenty years we will apply old and new technologies to the task of extracting large volumes of a valuable natural resource. Whenever an industrial society has undertaken such a large scale effort, environmental damages have been severe. The dangers to our forest cannot be overstated. That is why we have placed a great emphasis on wood energy planning. New England has already been deforested twice; we wish to avoid a third repetition. We urge DOE and EPA to continue to expand their research efforts along several fronts. Specifically, completing studies of air quality impacts and forest nutrient cycles will assist our evaluation of the limits wood harvesting and burning must respect. We urge the budgeting of \$10 million to investigate

the following:

1. The characteristics of pollutants and the relationship between pollutant emissions and the characteristics of the wood resource.
2. The relationship between system design and operation and pollution.
3. The control of creosote formation.
4. The chemical content and health effects of pollutants.
5. The impacts of whole-tree and other intensive harvesting techniques on soil erosion and water pollution, damage to residual stands, and effect upon forest productivity.
6. Effective forest management practices to modify these impacts.

With proper forest management and planning to determine end-use priorities, we can improve the quality of our overstocked forests while meeting our short term wood energy objectives. For New England, appropriate end-uses will highlight residential direct combustion, forest product industry cogeneration and co-firing, and small industry boiler conversion for process steam and/or electricity. With adequate planning and government involvement, we can look forward some day soon to an organized supply infrastructure. Without it, we can look forward to a patchwork of underutilized stands and environmentally devastating impacts.

Wood should be looked upon as a transitional energy source, enabling the region to move into the twenty-first century with a sound and more desirable energy economy. Similar statements are probably applicable to wood energy utilization in other sections of the country. The longer term biomass efforts receiving priority attention from the Fuels from Biomass section of DOE may come to fruition as the renewable contributions from wood gradually diminish at the turn of the century. The relatively short transition period underscores the urgency of our call for commercialization programs which address near term problems. The Energy Congress, now in its Implementation Phase, has a wood committee composed of foresters, large and small industry representatives, environmentalists, consumers, government officials and educators in the process of considering specific DOE and USDA program changes and additions

for FY 1981. In addition to attaching our Blueprint recommendations approved last spring, we will forward to our Congressional delegation new proposals as they are developed over the next three months. Meanwhile, we urge this committee and Congress to act with all deliberate speed to enact HR 5428.

APPENDIX I: NEW ENGLAND WOOD ENERGY POTENTIAL¹

	10 ¹⁵ BTUs					
	ME	NH	VT	MA	CT	R.I. N.E. TOTAL
Renewable Yield						
Cull Increment	.13841	.03844	.045367	.02292	.014796	.003236 .26317
Annual Mortality	.00054	.00015	.00014	.000089	.000058	.000001 .00978
Annual Thinning						
Poletimber Stands	.009568	.004245	.00341	.00299	.00209	.000417 .02272
Mill Residues	.00255	.00069	.000476	.000405	.000069	.000012 .004202
Logging Residues	.04345	.00520	.005525	.003502	.000816	.00017 .058803
Non-Renewable Yield						
Land Clearing	.00787	.00520	.00158	.01409	.00967	.00145 .03986
Existing Cull	.096776	.026878	.031757	.016029	.01346	.002207 .187162
One-Time Thinning	.04271	.01895	.012193	.013353	.009345	.00186 .09841
1985 TOTAL	.431874	.099753	.109448	.073195	.050348	.0094087 .684047
Post-1985 Renewable Yield						
Logging Residue Increment	.0869	.0101	.0110	.0070	.00163	.00034 .1176
Milling Residue Increment	.0051	.0014	.00295	.00081	.00014	.000024 .00840
Biomass Plantations	.00150	.00092	.00219	.00038	.00236	.00076 .01759
20% Productivity Increase	.02119	.00315	.0031	.00216	.000772	.000156 .0305
2000 TOTAL	.4700	.115223	.117688	.083345	.05525	.010688 .858
Barrels of Oil Equivalent	80,967,000	19,866,000	29,291,000	14,490,000	9,525,000	1,842,000 147,951,000

¹ Pole-sized stands acreage: Maine: 5339; New Hampshire: 2369; Vermont: 1524; Massachusetts: 1669; Connecticut: 1169; Rhode Island: 233.

² Steve Morgan, Expanding the Biomass Supply to Ease the Home-Heating Oil Crisis in New England, Wood Energy Institute, St. Louis, September 12-13, 1979, p. 60.

APPENDIX II
NEW ENGLAND WOOD ENERGY POTENTIAL
ACHIEVABLE ANNUAL YIELDS BY 1985*
(In Millions of Barrels of Oil Equivalence)

	Forest Products Industry	Industrial Sector Excluding FPI	Commer- cial	Residen- tial	Total
Present	1.4	.1	--	5	6.5
1990 Potential	17	3.5	3.5	28.5	52.5
Percentage of Present Oil Use 1985 Poten- tial Represents** 80%		10%	5%	26%	13%

* The achievable potential is estimated as half of New England Wood Energy Potential, Table

** Based on 1975 Oil Consumption by Sector, New England Energy Situation and Alternatives for 1985, p. 49, and Blueprint for Energy Action, pp. 76-89.

¹ Steve Morgan, Expanding the Biomass Supply to Ease the Home-Heating Oil Crisis in New England, Wood Energy Institute, St. Louis, September 12-13, p. 61.

APPENDIX III

Specific Program Suggestions for HR 5428

TITLE I. Department of Energy Functions

Section 102. Power Systems

- \$7 million in consumer education programming should be added to the \$3.1 million appropriation budgeted for supporting the design and implementation of safety and efficiency standards, etc.
 - 1) Consumer brochures addressing proper stove installation, maintenance, and operation should be completed and widely disseminated.
 - 2) A buyer's guide should be developed and disseminated.
 - 3) Wood-purchasing and wood harvesting information and education programs for local delivery must be developed.
 - 4) Fire departments with stove inspection responsibilities would benefit from a self-training manual for individual inspectors.
 - 5) A multi-media approach to maximize exposure is warranted.
- Provide funding to Energy Offices for wood energy planning efforts.

TITLE II Department of Agriculture Functions

Section 202. Commercialization

- \$5 million to expand state and private forestry programs to hire more foresters to assist land-owners in understanding financial incentives for wood energy harvesting, proper forestry management practices and harvesting techniques.
- Provide technical assistance (engineering, financial, accounting) to small and moderate sized industries capable of converting to wood.
- Provide funding to state forestry offices for forest utilization planning and end-use priority-setting efforts.

Section 203. Forest Utilization Research and Demonstration

- Support R & D for:
 - 1) multifuel boilers;
 - 2) pelletization experiments for residential, commercial, and industrial applications;
 - 3) small-scale harvesting equipment.
- Develop business assistance programs, perhaps in conjunction with the Small Business Administration, to assist loggers and new entrepreneurs in business management, financial analysis and in securing of bank loans.

SPECIFIC RECOMMENDATIONS¹

L. Wood Energy

A) Electricity Generation

Provide subsidies and assistance to public and private parties to enable the development of at least 200 MW (1.7 MM88L/yr) of wood-fired electrical capacity in New England by 1985. This capacity should be dispersed throughout the region and should be comprised of appropriately sized units proximate to the available supply. Specifically, this program will require:

- 1) Extending the time-frame for the investment tax credit for alternative energy from 1982 through 1985 by amending the Energy Tax Act of 1978, Title 3.
- 2) Requiring FERC to rule, under the Public Utility Regulatory Policies Act of 1978, that biomass generating plants under 80 MW in size shall be exempt from federal utility regulatory authority as long as the state in which such a plant is sited has adequate state environmental laws and regulatory powers.
- 3) Developing a loan guarantee program (\$100 million for New England, \$200 million nationally through 1985) that provides collateral backing for commercial loans given for the purpose of building wood-fired cogeneration systems.

B) Thermal

Provide subsidies and assistance to develop a market of approximately 60×10^{12} BTUs/year of thermal applications (10 MM88L/yr) in industry and 54×10^{12} BTUs/year of residential applications (9 MM88L/yr) by 1985. Specific elements are:

- 1) Develop a loan guarantee program (in conjunction with program under A) for thermal wood energy applications in industry (\$100 million for New England, \$400 million nationally through 1985).
- 2) Require the Secretary of the Treasury to include wood stoves and furnaces as applicable energy conservation investments for the purposes of the residential tax credits of the Energy Tax Act of 1978.

C) Supply Infrastructure

Provide an additional 10% investment tax credit (from 10% to 20% through 1988), in addition to NEA provisions, for purchase of equipment for harvesting, processing and transporting wood supplies for the wood energy market.

D) Forest Management

Expand forestry management services, particularly those provided by the U.S. Forestry Service, County Extension Services, and state forestry departments. For New England, the expansion should be a minimum \$1 million per year (\$5 million per year nationally through 1985), and should be directed towards:

- 1) Informing landowners of the merits of environmentally sound wood energy harvesting techniques, and demonstrating such techniques publicly.
- 2) Working with appropriate agencies in order to help wood energy entrepreneurs and marketers in developing marketing plans and instituting sound business practices.
- 3) Working with landowners and wood harvesters teaching good forestry management practices.
- 4) Completing accurate and up-to-date subregion total biomass surveys.
- 5) Disseminating educational materials to the public on multiple uses of forestland, utilizing a variety of communications media.

E) Environmental Impact

Instruct the Department of Energy, the Environmental Protection Agency and other appropriate federal agencies to undertake and/or complete studies of the environmental impacts of wood energy use, focusing primarily on air quality impacts and the question of forest nutrient cycles. These studies will cost an estimated \$10 million (nationally) and should include, but not be limited to, these topics:

- 1) The characteristics of pollutants and the relationship between pollutant emissions and the characteristics of the wood resource.
- 2) The relationship between system design and operation and pollution.
- 3) The impact of creosote on household safety.
- 4) The chemical content and health effects of pollutants.
- 5) The impacts of whole-tree and other intensive harvesting techniques on forest nutrient cycles.

**STATEMENT OF STEVEN MORGAN, SENIOR RESEARCH ASSOCIATE,
NEW ENGLAND ENERGY CONGRESS**

Mr. MORGAN. I am part of a unique precedent-setting, consensus decisionmaking process. In New England, the congressional delegation—all 25 members—got together and asked diverse people from across the region to deliberate for a year to see if they could make some recommendations to the Congress about opportunities for public policy that could have a major impact on reducing the region's 80 percent dependence on oil, 80 percent of which is imported.

The CHAIRMAN. Excuse me. Mr. Bull and Mr. Plotkin, you may stay, but you may also leave.

Dr. BULL. Thank you, Mr. Chairman.

Mr. MORGAN. After a year, the delegates came back with a 500-page "Blueprint for Energy Action," which concluded, not surprisingly, that wood energy was the most abundant near-term resource available to substitute for oil.

In fact, the Energy Congress determined that there was a half a quad available by the year 1985 if we could get to it.

The first general problem we had was the Department of Energy's programs, which the Energy Congress found quite inadequate. The long-term, centralized, high-risk technologies the Department was focusing on are not the kind that New England needs.

The first particular task that the group addressed was: Is there really enough wood out there?

I am summarizing my testimony quite a bit to say that we found that there was; that we could quintuple or sextuple the amount of wood energy that we are utilizing now in the residential and industrial sectors primarily, and still have plenty left over after the forest products industry used all it needed—including the prospect of Northwest industries moving into New England increasingly, the particle-board industry getting off the ground, and other new competition we imagined arising.

We found that we could utilize 80 million barrels of equivalence by 1990 for wood energy. That's not just how much is out there, but how much we could utilize by then. We found that by 1985, we could probably use 50 million barrels' equivalence, compared to a total now of about 6.5 million or 7 million barrels, most of which is consumed in the residential sector.

Some have argued that we really don't need Government intervention in the commercialization process. They point to, for example, Vermont, which has quintupled its use since 1972, going from 5 percent of consumers burning wood for residential use to about 20 percent now using wood as their primary heating source, and over 60 percent using wood to provide some heat in their homes.

So if that is the case, why do we need Government intervention at all? Because there are serious barriers that have prevented the free market—in firewood particularly—from operating effectively.

Consumers lack adequate information about firewood availability and value, and about efficient stove purchase, installation and maintenance. Landowners don't understand the economics of fuel wood and timber markets, the technologies available for marketing and the principles of forestry management. Loggers are inexperienced in running a business and cannot get the capital required to purchase the machinery they need for today's harvesting technologies.

New entrepreneurs, particularly dealers, cannot get loans from banks to start needed fuel wood distribution and marketing businesses. Small industries and utilities cannot be assured of the long-term supply contracts they need in order to convert their fossil fuel boilers to wood, because the supply infrastructure is chaotic; and this is a situation that is exacerbated in New England by landholdings distributed among hundreds of thousands of individual owners.

I might add that the small industries—not the paper and pulp industries—in Maine and elsewhere also have a capital formation problem still existing today. They can't get the money together that they need to convert, even when the economics would indicate that the price of oil has shot out of sight and it makes sense to convert to wood. The payback is still too long without some kind of subsidization, and we have over 2,200 of these industries in New England today that have wood residues available on site or nearby that have not yet converted.

So if we do need Government intervention, what does the Fithian bill do to provide help? The answer is: A good deal.

We finally have a commercialization program introduced in the Congress that we think can make a significant impact in New England, primarily for its near-term focus—where we need the most help.

The power systems, section 102 in title I, \$3.1 million budgeted for "supporting design and implementation of safety and efficiency standards," would benefit from a \$7 million addition in consumer education programming. We think such a program can make a big difference for consumers who now don't know the difference between a 35-percent and a 45-percent-efficient stove and the impact it can make; they don't now know how to operate stoves effectively, and we find that understanding how to operate a stove can make even more of a difference than a 10-percent efficiency difference in buying a high-performance stove can make in Btu's saved.

The consumer brochures that are needed should address proper stove installation. We have seen a couple of recent studies indicating that between 50 to 70 percent of stoves installed in New England are done so without proper regard to installation guidelines. A Massachusetts fire marshal's office study indicates that better than 75 percent of fires related to stoves in the State were caused by improper installation of maintenance of stoves, and only 2 percent were due to the stove design.

So DOE must pay more attention to these problems. We need more consumer education about how to buy wood, how to cut your own, and we've got to get that information out quickly, because we think demand is up over 100 percent in New England. Because of the chaotic supply infrastructure I made reference to, supply is not going to meet that demand. Therefore we are going to have skyrocketing prices this winter.

We were worried a couple of months ago, assuming there was a home heating oil shortage, that we were going to have a massive conversion to wood and there wasn't going to be enough. We think now the situation is not quite so bad, but we are finding prices of \$130 or \$150 a cord, and I am sure in Westchester County, Congressman Ottinger can tell me there are prices that are higher than that. We think that the consumer education program must be a highlight of the DOE program, because the States and local governments don't have the resources to establish a significant one themselves.

The CHAIRMAN. That's about the ball park in Westchester, \$125 a cord from a commercial supplier. In Westchester County, though, they do open the county parkland to take fallen wood, and under supervision you can go up there and take the wood free. But you have to have a vehicle to transport it and you have to have the equipment to saw it up, so it takes a certain amount of enterprise, but a tremendous advantage is being taken of that.

Mr. MORGAN. Yes. We have some of that going on in New England, but not nearly enough.

In section 202, under the Department of Agriculture's Functions, under "Commercialization," we recommend that \$5 million be added to expand the State and forestry programs to hire more foresters to assist landowners in understanding financial incentives for wood energy harvesting, proper forestry management practices and harvesting techniques—a program not unlike the pilot wood fuel program that the Agriculture Department has just announced will be expanded in New England next year.

We need to provide more technical assistance in the form of engineering, financial, and accounting services to small- and moderate-sized industries that are capable of converting to wood—many of the 2,200 that I mentioned earlier.

Under section 202 as well, we need to provide funding to State forestry offices for forest utilization planning and end-use, priority-setting efforts.

As I mentioned earlier, there is plenty of room to expand wood utilization, but there must be some priority-setting done so that we don't have a patchwork of underutilized stands and environmentally devastating impacts.

In New England the appropriate end uses will highlight residential direct combustion, forest product industry cogeneration and cofiring, and small industry boiler conversion for processed steam and/or electricity.

New England is behind the rest of the country in the forest products industries' movement toward self-sustenance. We have read figures of 45 to 50 percent self-sustenance nationally, but we have achieved approximately 20 percent in New England. Therefore, a great deal more can be done; most of it has to be done by the forest products industry with only some encouragement from the Federal Government.

Basically, we have to look upon wood as a transitional energy source, enabling the region to move into the 21st century with a sound and more desirable energy economy. The committee under which I worked made some environmental recommendations as well as some planning recommendations.

The environmental recommendations include some more research into the characteristics of pollutants and the relationship between pollutant emissions and the characteristics of the wood resource; the relationship between system design and operation and pollution; the control of creosote formation—some work is being done now in some of these areas—the chemical content and health effects of pollutants; the impacts of whole-tree and other intensive harvesting techniques on soil erosion and water pollution; damage to residual stands and its effect upon forest productivity; and effective forest management practices to modify these impacts.

Finally, I want to reemphasize the effort and planning that needs to be done. I want to refer you to an excellent study done by Mitre very recently. It is called "Wood Combustion Commercialization Strategy for the Department of Energy, Phase III Working Paper," which suggests a detailed comprehensive DOE and USDA cooperative strategy.

I urge you to talk to some of the Mitre staff. They also have made a focus on coordination, not only at the Federal level, but between the Federal and the regional levels under the leadership of the regional solar energy centers. The State departments of forestry and the State departments of energy must be involved so that we establish a forest utilization plan on the one hand and renewable energy utilization planning on the other—then we will know how much of the forests we really want to use for wood energy by State and sub-State areas.

Finally, I want to say that the Energy Congress has a continuation grant from DOE and that we have a Wood Committee working to recommend even more specific program suggestions for the Department of Energy and the Department of Agriculture, for which our principal audience will be the New England congressional delegation. We will be glad to share with you the specific detailed plans that we develop by the end of January.

The CHAIRMAN. We would very much like to have that.

You are a voluntary, nonprofit organization?

Mr. MORGAN. We are. We are actually a creation of the congressional delegation in New England and Tufts University. We received a 1-year grant from the Office of Environment in DOE and the Department of Congress, EDA, that ended last June. Our implementation phase to elaborate on our very general recommendations was funded by DOE'S Office of Environment, and we are slated to end this phase at the end of March 1980.

The CHAIRMAN. Very good. Let's hear next from Dr. Peart.

Mr. FISH. Could I ask one question?

The CHAIRMAN. Of course.

Mr. FISH. Mr. Morgan, what is your connection, if anything, with the Boston-based regional SERI?

Mr. MORGAN. Right now we have no official connection. We talk with them a great deal, and members of the Northeast Solar Energy Center are on our volunteer committees that propose the policies I mentioned to you.

We bring in all the energy actors—the governmental agencies as well as nonprofit, private, consumer, labor, and so on. Every constituency with some expertise in energy is represented on various committees.

Mr. FISH. You talk about you bringing them in—

Mr. MORGAN. In a voluntary status.

Mr. FISH. How about them bringing you in?

Mr. MORGAN. Pardon? There are five staff members. I am paid on the DOE grant.

The CHAIRMAN. What Mr. Fish is asking is, do they use the information that you generate in their programs? Do they finance any of your activities? The Regional Energy Center?

Mr. MORGAN. Yes; we have enjoyed a great deal of cooperation. The Energy Congress has been a vehicle for coordinating a great deal of the programing that's done, and we have a myriad of regional and

State agencies that are getting involved in energy policy to a degree they didn't expect 2 years ago and—am I answering your question, or are you asking something else?

The CHAIRMAN. No. What we wanted to find out particularly, we got some severe criticisms that the Regional Energy Center in Boston was not, in fact, reaching out.

Mr. MORGAN. If I can step back and give my own viewpoint, I would say most were probably very fair criticisms. We have had excellent cooperation from a couple of Northeast Solar Energy Center staffers in particular on our committees. Our experience is somewhat different from the experiences reported to me by individuals working at other energy-related organizations.

I would say that they have been more cooperative as an agency with us than they have been with some of the public interest organizations, local groups, and State energy offices.

The CHAIRMAN. All right. Dr. Peart?

I want to thank all of you for your indulgence today. We were blessed by having a large number of members of the committee here at the beginning, and it took longer than we anticipated.

[The biographical sketch and prepared statement of Dr. Peart follows:]

Biographical Summary: Robert M. Peart, Professor of Agricultural Engineering
Purdue University, W. Lafayette, IN 47907

Birth Date: November 11, 1925

Soc. Sec. No.: XXXXXXXXXX

Education: B.S. (AgEn) Iowa State University, Ames, IA 1949
M.S. (AgEn) University of Illinois, Urbana, IL 1957
Ph.D. (AgEn) Purdue University, W. Lafayette, IN 1960

Experience:

Industrial:

Eastern Iowa Light and Power Co-op, Agricultural Engineer, 1949-1954

Academic:

Univ. of Illinois, Agricultural Engineering Dept., 1954-1958, 1960-1961.
Purdue Univ., Agricultural Engineering Dept., 1961-present.

Professional:

Member:

American Society of Agricultural Engineers (past director and Fellow)
American Society for Engineering Education
American Association for Advancement of Science
Society for Computer Simulation
National Society of Professional Engineers
Sigma Xi
Gamma Sigma Delta

Registered Professional Engineer:

Iowa

Scholarship and Professional Honors:

National Science Foundation Faculty Fellow, 1958
American Society of Agricultural Engineers National Paper Awards, 1970 and 1967.

Patents:

Co-Inventor on 3 U.S. Patents

Research Interests:

Simulation of grain drying, crop ecosystems and farm energy input/output dynamics; field studies of grain drying with solar energy, heat pump and other energy sources.

Recent Publications:

Peart, Robert M. and Otto C. Doering, III. 1977. Evaluating energy-saving practices by simulation. In Agriculture and Energy. Wm. Lockeritz, ed., Academic Press, N.Y. pp. 65-73.

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Biomass Energy Research and Development
 Subcommittee on Energy Development and Applications
 of the Committee on Science and Technology,
 U.S. House of Representatives
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Testimony by Dr. Robert M. Peart
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I am pleased to testify on the need for increased biomass energy research and development. I speak from my own experience with research on solar corn drying, gasification of corn cobs, and systems studies of agricultural energy inputs and outputs over the past five years. In addition, I have been fortunate to work with a group of outstanding scientists in the Agricultural Experiment Station and in the Laboratory on Renewable Resources Engineering at Purdue. Recently, we have concentrated on production of alcohol from cellulosic materials such as cornstalks and woodchips including the important agricultural and forestry production problems.

To highlight some of our findings relative to biomass research and development, we wish to first expose four myths that are too widely accepted. Then we discuss near-and long-term biomass potential and point out important areas needing study.

Myth Number 1. A quad is a quad.

Our short-term and long-term energy shortage is primarily a shortage of liquid fuels, not energy, per se', so a quad of gasoline or ethanol is more precious than a quad of coal or biomass. Replacing and conserving imported oil must have highest priority. In the Corn Belt, we can produce 350 gallons of ethanol from an acre of corn grain using about 10 gallons of diesel fuel and 60 gallons equivalent of natural gas. If coal or biomass are used for ethanol production, net liquid balance is very favorable. Associated with this myth is the notion that an alternative that does not save at least one quad is not big enough to consider. A quad is a tremendous amount of energy, 10^{15} Btu's, 170 million barrels of oil. A saving of half or even 1/10 of a quad is significant. We need many solutions. There is no one big solution.

Myth Number 2. Making ethanol uses more energy than it produces.

The old technology of beverage alcohol spawned this myth. A recent Science review (2) lists several methods using a range around 50% of the energy in the ethanol, and this relatively low-grade process heat can come from several non-liquid and waste heat sources. Work has only just begun on efficient fuel alcohol fermentation and distillation. Within the last few months, Ladisch and Dyck (3) at Purdue have discovered a low-energy method of removing most of the difficult last 10% of moisture from ethanol to make it anhydrous. Continued research on energy-efficient fermentation and distillation is sure to pay off.

Myth Number 3. Crop agriculture uses more energy than it produces.

Our studies show that the corn grain alone contains 6 times the energy that was used in its production, including all field machinery fuel, drying fuel, fertilizers and pesticides. Counting one-half of the corn residue as available for alcohol production (leaving the other half on the surface for soil protection), this ratio increases to 9 units out per unit in.

Myth Number 4. Removing crop residues requires more energy input for the added fertilizer than is gained.

Our calculations show that the one tone of cornstalk residue removed requires added fertilizer amounting to about 10% of the energy content of the cornstalks removed. Harvesting, packaging and transportation energy for cornstalks is less than 1% of the energy content of the cornstalks.

BIOMASS ENERGY POTENTIAL FROM CROP AGRICULTURE

Our group at Purdue has recently estimated the near-term capability for production of ethanol from grain, crop residues and grass and legume forages grown for energy. We believe these are fairly conservative estimates of what is technically feasible (not considering economics) in the next few years, certainly as soon as ethanol production could be built. These estimates do not include any biomass from forestry or from livestock wastes, both large additional energy sources.

The potential from forestry has been estimated to be larger than from crops, and we are excited about the potential for narrow-row trees, harvested every few years. This tree crop could fit in as an additional source of supply for a cellulose ethanol plant utilizing crop residues and excess forages so that a continuous supply of raw material would flow year-round.

Crop Residue

The procedure used for estimating crop residues considered both soil conservation and collectibility in arriving at the estimates for each crop. Total residue availability was estimated for each crop and region. The fraction of total acres which could be harvested for

residue without causing excessive soil erosion was estimated for each land resource area and state. For those acres which could be harvested for residue, the amount of residue which needed to be left on the soil for conservation purposes was subtracted from the total amount available and ranged from 2000 to 3500 pounds per acre (4).

The total amount of residue produced each year in the United States was estimated at about 400 million tons. The total usable residue estimate is 78 million tons and is expected to range between 70 and 86 million tons per year.

Table 1. Resource Availability Summary

Source	Potential Production	Energy Production ^b Ethanol (Bil. gal.)
Crop Residues	39.7-58.7 mil. tons	1.5 - 2.3
Forage	68.2-153.3 mil. tons	2.7 - 6.0
Grain		
From available cropland not now cropped ^a	1.925-3.25 bil. bu.	5.2 - 8.7
From set-aside acres (1978)	900 mil. bu	2.5
TOTALS		11.9 - 19.5 ^c

^a The figures shown for production from available cropland assume corn is grown on this acreage. The alcohol yield would be about the same if sweet sorghum were grown on this acreage.

^b These production figures reflect only technical potential and do not imply that energy production from any of the source would be economic.

^c These totals are somewhat high because some of the land now used for pasture is counted in both the forage and crop categories. With the available statistics, it is impossible to clearly separate these categories.

Ninety percent of the usable crop residues come from corn and small grains. The majority of usable residues is concentrated in the Corn Belt and Great Plains states. The top five states—Minnesota, Illinois, Iowa, Indiana and Ohio, contain half the total U.S. usable residues. Three-fourths of the total residues are concentrated in the top 13 states. Because of the concentration factor, it is not likely that

residues would be used to a large extent in centralized conversion facilities in states other than the top 13. However, assuming two-thirds of the residues in these 13 states could be economically transported to a plant, 1.5 billion gallons (.13 quads) of alcohol could be produced from residues each year. If three-fourths of the total usable residues in the U.S. could be economically transported to a plant, 2.3 billion gallons (.19 quads) of alcohol could be produced each year. We believe a realistic assessment of potential alcohol production from residues is in this range of 1.5 to 2.3 billion gallons per year. This assessment is purely on technical grounds and implies nothing about the economics of producing alcohol from crop residues.

Extra Forage

Extra forage production possibilities were estimated at about 102 million acres of pasture and hayland in the Northeastern, Northcentral, and Southern states that could support increased yields for energy production. Through more intensive management (principally increased fertilization and more frequent cuttings), forage yields could be increased by one, two or possibly even three tons (dry weight) per acre per year. A one ton yield increase corresponds to 102 million tons per year of cellulosic biomass which could be utilized for energy. This amount is greater than the total amount of usable crop residues for all crops in the United States. However, we estimate that the forage material could be produced for a price not less than \$40 per ton and perhaps higher as compared with residue prices beginning around \$27 per dry ton. The extra fertilizer represents about 10% of the energy contained in the extra forage yield.

Expanded Grain Production

To estimate a range of potential energy production from pasture and hayland acreage, we assume that the lower limit is two-thirds of the one ton per acre increment and the upper limit is three-fourths of the two ton per acre increment. Alcohol production would range from 2.7 to 6.0 billion gallons per year.

To estimate the potential for expanding grain production for energy, we estimated the land which might be available for increased crop acreage. Many believe that land currently utilized for crop production is free for increasing agricultural output. In fact, there are stringent limitations on bringing additional land into continuous crop production on an annual basis.

One of the limiting factors on bringing new land into production is rainfall. We assume that if additional land were to be brought into production, it would have to be land that now received adequate rainfall for crop production. We do not envision the improvement of arid lands by the addition of energy-intensive irrigation in order to grow energy crops. The cost of irrigation, in economic and energy terms, is fast becoming too great to allow such a development.

The requirement for adequate rainfall limits one to the central and eastern half of the United States. By examining historical land use

patterns, we estimated that about 40 million acres would be available for expanded crop production after accounting for land needed for food production. In addition to the historical perspective, we also assumed recent work assessing potential crop land availability on the basis of land quality irrespective of historical use. A recent study by the Soil Conservation Service indicates that there would be 44 million acres in the adequate rainfall region of the country that is not now cropped which has what they consider a high probability of being converted if cropland were needed. (1) Our best estimate is that somewhere from 30 to 50 million acres would be available for expanded crop production, and some of this is land which might alternatively provide forage production for biomass energy. Assuming corn yielding an average of 65 bushels per acre (lower productivity than land currently in production) were grown on this land, an additional 1.95 to 3.25 billion bushels of corn could be produced. If all of this corn were converted to alcohol, 5.2 to 8.7 billion gallons (0.44-0.73 quads) of alcohol could be produced per year.

Set-Aside Acreage

We treat the potential energy production from set-aside acreage separately because of the important policy implications involved. In 1978, about 6.1 million acres of corn land and about 8.4 million acres of wheat land were in an set-aside and diversion programs. The potential production from these set-aside lands was 370 million bushels of corn and 226 million bushels of wheat. When alcohol is produced from grain, for every three pounds of grain used, one pound of a by-product called distillers grains is produced. That distillers grain can be fed just as corn for beef cattle or it can be substituted for soybean meal in animal diets. Since this distillers grain is recycled, so to speak, back into the animal feed system, the 600 million bushels of potential production can be increased by another 300 million to account for the recycled grain. Hence, about 900 million bushels of grain could have been withdrawn from the agricultural sector had the set-aside lands from 1978 been used for corn and wheat production which in turn was converted to alcohol and distillers grains. About 2.5 billion gallons of alcohol could have been produced from the excess crop production capability in 1978 (5).

The technical potential for alcohol production ranges from 11.9 to 19.5 billion gallons per year. Using a base U.S. gasoline consumption of 120 billion gallons, the total alcohol production potential, if all used for gasohol, could yield a mixture ranging from 9 to 15 percent ethanol. It must be stressed that these numbers represent technical potential only.

Time to Bring Biomass on Stream

Grain ethanol is capable of rapid development in the short run, 2 to 5 years. In fact it is the only real liquid fuel alternative in the short run. Concurrently with expanding use of gasohol, research and development is needed to improve the energy efficiency of anhydrous ethanol production. Small and intermediate-size operations need design studies, and the possibilities of dehydration to anhydrous ethanol at a central facility after fermentation and partial distillation in small

units needs study. Handling and feeding of wet distillers grain to save the substantial drying energy should be investigated. Opportunities for separating valuable corn oil and protein for human food rather than animal feed should be pursued. Improvements that prove themselves can be added as the ethanol production industry expands.

Cellulose based ethanol is mid-term, probably not reaching significant production until 1985 or later. Laboratory research developments are currently very encouraging, but no pilot plants are in operation yet, and these are necessary before commercial plants can even be designed. Many R & D questions remain unanswered. Acid vs. enzyme hydrolysis, best compound(s) to produce from hemicellulose, used of lignin, as well as process optimization are just typical of profitable problem areas.

Longer-term biomass potential, beyond 20 years, could be greater or less than near-term potential. So much depends on world population and the capability of the rest of the world to produce its own food and biomass energy. U.S. food production capability continues to grow, and substitution of some vegetable for animal protein sources can stretch it further.

RESEARCH AND DEVELOPMENT NEEDS IN BIOMASS ENERGY

There are tremendous payoffs awaiting a broad R and D effort in biomass energy, we feel. These should cover a range from fundamental work on methane and alcohol-producing organisms and nitrogen fixation to applied studies on materials handling and process design. No equipment is available for harvesting and chipping row-crop trees. No methods or equipment are known to package crop residues dense enough for maximum highway loads without overheating and spoilage. Ethanol-producing yeasts are inhibited at about 10% ethanol concentration. Various cellulose-to-ethanol processes show promise, but are not even in the pilot plant stage yet. How can municipal garbage be separated and the high paper content be converted to ethanol? Will farmers harvest and deliver crop residues for \$30. per ton? How can the continuous production of methane from livestock wastes be utilized on a continuous basis or stored for use later? No current diesel engines can burn 100% farm-produced ethanol, and while gasoline engines can be modified, most farm power is diesel.

Agricultural policy must be coordinated with biomass energy policy, and studies are needed in this area. Agricultural exports, grain reserves and support prices will interact with biomass energy developments, and the consequences of each of these policies must be analyzed.

These are just examples of the types of research needed, and we believe the Fithian bill covers the important areas of needed work very well. The concept of an integrated systems approach is of particular interest to us.

INTEGRATED SYSTEMS APPROACH

The concept of integration is important in two ways; 1) biomass energy production must be integrated with other agricultural and silvicultural production, and 2) research and development work must have some thread of communication and integration between researchers over a broad disciplinary range from agronomy and biology, through materials handling, logistics and economics to processing and distribution of the energy. Such an integrated approach allows us to look at a variety of sources for raw material throughout the year and couple this with developing knowledge on process alternatives. For example, while cornstalks are an abundant and relatively low cost source, we believe that storage problems would preclude the use of cornstalks as the total year-round raw material for alcohol production. We are studying the possible amounts available and times available for other raw materials such as logging wastes, sawmill wastes, low quality hay and woody biomass from short rotation trees harvested with heavy duty choppers. It is important to tie this research work closely to the processing and alcohol production work to make sure that similar equipment and processes can handle a variety of raw materials. For example, one of our significant findings is that an acid preservative for wet corn stalk storage may be very compatible with the first step in processing which separates the hemicellulose from the cornstalks with a similar acid treatment. Other preservatives were considered, and other hemicellulose processes were considered, but with communication among the researchers it appears that a compatible and economic system can result.

We feel that the inclusion of agricultural research coincident with research on conversion and fuel production is very critical to the success of biomass energy work. We are convinced that energy production from agriculture can be an orderly development utilizing current conventional products and waste products from agriculture handled with current agricultural equipment. In fact this is going on, as gasohol is being produced from agricultural products, mainly corn. Silviculture also can be an important source and will probably begin as part of current forest operations. Here too this has begun with commercial use of forestry wastes for forest industry heat uses. We feel that the concept of an energy plantation with a very large concentrated acreage of an exotic energy crop flowing into a specialized plant is a system that will take a much longer period of time to develop and the appropriate arable land base may not be available.

Naturally, many research questions must be compartmentalized and studied separately in great detail, but we feel that lack of a concept of integration of biomass energy research and of the systems approach has been a weakness of these programs nationally.

DOE/USDA COOPERATION

The research and commercialization program within DOE that relates to agriculture, forestry and biomass has been loosely defined and confusing. These areas of work have not heretofore received any serious commitment from DOE, nor has USDA been overly concerned with the broader

energy concerns of its traditional agriculture and forestry missions. At the same time, USDA, has been hampered by personnel ceilings in trying to organize an energy research effort. One problem in the past has been the designation of DOE as the lead agency for all energy related activities. USDA's functional responsibility with respect to all of agriculture and forestry cuts across DOE's responsibility for everything in the nation related to energy. As a new agency DOE has appeared reluctant to risk the loss of any portion of its rather unrealistic total energy mandate. Contrary to official protestations, there has been conflict and bickering between USDA and DOE. Given a continuation of the ground rules that have held in the past we would only see a continuation of this, to the detriment of any research or commercialization. Given that biomass is now in vogue, the stake is large enough for USDA and DOE so that we would expect little cooperation for its own sake. The ground rules have to be changed so that it is in the enlightened self interest of each agency to cooperate.

One alternative to cooperation is the explicit assignment by Congress of specific tasks and areas of responsibility to each agency. This may prove to be the only way that cooperation can be initiated as it would settle some of the turf battles. Whatever solution is attempted, there are some critically important institutional factors and characteristics of biomass production which have to be considered in planning research or commercialization.

1. Biomass production is dispersed and highly diverse. Biomass production systems that are economic, energy efficient and environmentally acceptable will have to evolve on a regionally specific basis, and will probably have some unique system components as well.
2. Given that biomass is only a small portion of the total energy equation there will have to be a degree of coordination between biomass and other energy production or conservation efforts.
3. Biomass policy is the mirror image of food and fiber policy. There has to be either close coordination or unity of policy decision-making on biomass and food and fiber policy.
4. The agricultural and forestry sectors of the economy are the only ones having their own publically funded research and commercialization institutions with traditions of leadership in these sectors.
5. These institutions have a tradition of independence and are often accused of being slow to change.

Congress could assign full responsibility for biomass activities to either DOE or USDA. There would be some clear advantages and disadvantages which ever organization was chosen.

If USDA was chosen to undertake the nation's biomass effort, the advantage would be that USDA staff understand agriculture and forestry and have some ready access to a broad base of research and educational resources throughout the U.S. For DOE to acquire the same knowledge

base and staff would be very difficult and costly. USDA already has an established mechanism to initiate a new research effort at substantially less overhead and indirect cost than would be required utilizing private contractors or upgrading another government agency. Technology transfer would be accomplished by using the existing network of cooperative extension which is already credible to its clientele in the agricultural and forest industries. Biomass policy would be set in the same arena as food and fiber policy.

In terms of disadvantages: The placement of this one area outside of DOE's responsibility results in a partial fragmentation of the national energy program. There might be some loss in allied application and commercialization if this segment were outside of all other programs. This fragmentation would make a major exception to the "lead agency" concept, and might cause other difficulties as a result. The fragmented arrangement could lead to new barriers to coordination and cooperation between the two agencies. There might also be less inclination to include outside talent and resources in the existing programs firmly placed in the more traditional agricultural institutes.

Alternatively, one could maintain the entire biomass effort within DOE and force DOE to establish a recognizable and coordinated program that would be adequately staffed and funded to meet the diverse needs of biomass research and commercialization. The obvious advantage of this option is that of keeping all energy related programs within DOE. With a viable biomass program in DOE, the emphasis and funding will be more appropriate to the perceived national energy needs - assuming the necessary commitment to this area within DOE. The sharing of developments in biomass with other sectors should be easier and more effective. The funding for biomass efforts will be a straightforward DOE decision, not subject to the whims of other agencies. The primary disadvantage is that this option will work only if DOE actually makes a strong and effectively administered commitment to the biomass area. This has not occurred in the past, and such a commitment would exact some cost from other strong program areas within DOE. It would be difficult for the DOE program to make the most effective use of the agricultural research and extension institutions around the U.S. Substantial costs would have to be met for overhead and indirect costs.

The best option may in fact be some combination where cooperation is forced by assigning specific tasks to each agency. Under such an option DOE's staff should be strengthened to bring biomass expertise to bear in its planning and policy functions. In addition, DOE's staff should not be strengthened in specific technology or application areas where existing USDA-tied institutions have adequate competence. Conversely, USDA and its allied research and extension institutions would have to be willing or have sufficient inducement so that the problems of biomass production and utilization becomes a major program effort.

Our concern is that within USDA, within DOE, or on a joint basis we have not seen coordinated efforts in research or commercialization relating to biomass. We believe that this should be a matter of urgency for both agencies. Finally, and most important, neither the formal organizational structure nor the informal organizational characteristics

have lent themselves to informed, logical and consistent decisions over time in this critical area.

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STATEMENT OF DR. ROBERT M. PEART, PROFESSOR OF AGRICULTURAL ENGINEERING, PURDUE UNIVERSITY, WEST LAFAYETTE, IND.

Dr. PEART. Thank you. I am glad to be here and I enjoyed listening to the hearings.

I have had some help in my testimony from colleagues of mine that have worked together on biomass energy for the last several years, and I will just summarize this written testimony that we have submitted.

The CHAIRMAN. Very good.

Dr. PEART. We mention some myths—what we think are myths—in the way of biomass energy. "A quad is a quad." We feel that a quad of liquid fuel, which is our real shortage, is much different than a quad of coal—high-sulfur coal. We emphasize that a lot of this relates to ethanol because we feel a lot of the potential in the Midwest especially is for ethanol, a liquid fuel.

The second one we mentioned is that many people still say it takes more energy to produce a gallon of ethanol than it contains, which is not true with modern technology, and that can be improved with more research and development.

Some people think crop agriculture uses more energy than it produces, and it does not. Corn production, for instance, gives six units of energy out for every unit in. People worry about removing crop residues because of the energy costs to remove the residues, but that's a very small part of the energy that is removed.

We have done some estimating of the biomass energy potential from crop agriculture, and those figures are summarized on page 3, and I would like to emphasize that these do not include any forestry at all, and do not include livestock wastes.

They include crop residues and we have used a fairly conservative figure there, deducting the crop residue that should be left on the surface for soil erosion, and ending up with 1.5 to 2.3 billion gallons of ethanol from the crop residues.

Then there are millions of acres of forages that could be increased in production fairly readily, and we estimate that those could produce from 2.7 to 6 billion gallons. Then we have separated grain into set-aside acres and into increased grain production on land that is now available for cropland but is not in grain production. The total of all that comes out to 11.9 to 19.5 billion gallons, or in quads that's 1 to 1.6 quads of energy.

I would like to briefly summarize, starting on the bottom of page 5 the timeframe for bringing some of this biomass on stream, and one of the people listed here, Professor Tyner, made the point that grain ethanol is really almost the only short term—that is, in the next 2 years—the only short-term answer for really producing more liquid fuel in a hurry, and that's one of its big advantages. There is still plenty of research and development to do in that area, though, because the energy efficiency of that process can be improved, and a lot of aspects in fermentation and in distillation especially where energy can be saved.

The CHAIRMAN. Have you worked with membrane technology at all?

Dr. PEART. No, I haven't, but I am aware that that's one of the avenues that might pay off, not only in separating the alcohol from the water, but I think in separating the water from the left-over distiller's grain that would require quite a lot of energy under current technology to dry that feed material.

Then cellulose—ethanol from cellulose—is a little longer term, we feel, than grain alcohol, because of course we have grain alcohol right now, and we are thinking probably by 1985 cellulose can start to become commercially significant, and even there, there are many research and development questions that need to be answered before that time. Even after the first commercial plant is in operation, research and development will pay off.

A longer term biomass potential, beyond 20 years, I think it's really hard to say, world population and the capability for producing food are really important and really hard for us to estimate.

I have just mentioned a number of research and development needs, all the way from the basics of microbial and genetic aspects, developing new strains of microbes that might live in a higher concentration of alcohol and nitrogen-fixation, all the way to the more applied areas of materials handling and systems for gathering these crop residues. That's a field that I'm familiar with and can see the needs there, compaction and efficient transportation and storage without spoilage.

I am particularly pleased with the systems aspects of this bill, because that is a need that is important, I believe to consider how this is going to affect agriculture as a whole, and how these energy crops can be worked into current agriculture as a part of it, and not just simply replace it by some huge energy plantation, which I don't think is very realistic in the short term.

So looking at the entire system, not only from the standpoint of how it blends in with current agriculture and how it works in throughout the calendar year, but also integrating it from the standpoint of having scientists in a broad range of disciplines having communication in this research and development.

We found at Purdue that in working with Dr. Tsao and his group in the laboratory on renewable resources engineering that there are many valuable ideas that come out of having a kind of synergistic effect among the persons working on the processes and the people in production in agriculture.

One example I mention here was that for preserving the wet cornstalks we have looked at acid preservatives—the agronomists and the engineers have looked at that—and that's very important for the people working on processing, because we might be using the wrong acid or if we used the right acid it will fit right in to one of the processes that they are working on.

So in some part of the research and development, I think that broad systems approach is important.

Now, on DOE and USDA cooperation, we have made some comments here, and several of us have had some experience with that. Myself, I have been involved with a small solar energy program that USDA has been running with pass-through funds from DOE ever since 1974, and that has worked fairly well. It has been a small program, and it has not grown particularly, and, of course, there could be improvements in it, but that program has run fairly well.

I have been involved in some separate DOE energy conservation projects there at Purdue in our research work, and we point out here that the cooperation has not been the best in the past and that—

The CHAIRMAN. Would you elaborate on that a little bit? I noticed that in your statement.

Dr. PEART. This memorandum of agreement—

The CHAIRMAN. What kind of things?

Dr. PEART. Well, it just seems like it's slow. This memorandum of agreement, I have been hearing about that for a year-and-a-half, it seems like they are working on it. I think they are getting pretty close now, but the passthrough money that I was familiar with was in one restricted area, solar energy, and I think there was some really good work done with that. And there was some cooperation with the—university people were involved in that quite a lot and had some input. I think we would have liked to have had a little more input, a little more long-term planning, but that was a pretty good program. I think in these larger aspects of biomass—this \$12 million that was mentioned—I feel that from our standpoint in the land grant universities, we don't feel that we've been called upon as much as we might have been to have some input into their planning, either into DOE or USDA.

But in our written testimony here we really point out the problem with the way DOE has been set up to handle all of energy, and then, on the other hand, USDA has been traditionally working with all aspects of agriculture, and you are bound to have some problems there, because, before DOE, if there was a problem that dealt with energy in agriculture, USDA worked on it. Now they have to be a little more careful about that.

So we have listed, on page 8 there, about five different aspects of the problem that does make it difficult—naturally difficult—to get some coordination there.

The CHAIRMAN. Where do you think the primary fault lies, or is it equally distributed? Has the Department of Agriculture, in your experience, been unwilling to deal with Department of Energy in these programs—been unreasonable—or has it been the other way around? Is it just a question of coordinating two quite different—

Dr. PEART. My impression has been that the Department of Agriculture has done—has not been uncooperative. DOE, being a new organization, I think, has been always getting organized, and that may have been part of the problem.

I think that I agree with some of the earlier testimony here or comments from the committee that perhaps USDA hasn't been as sold on biomass energy or hasn't gotten sold as soon as some other people have been.

And, of course, that has been a rapidly changing thing. This oil price has changed my attitude. A couple of years ago I thought grain alcohol was silly, and it was not economically feasible, but the situation has changed a lot of our viewpoints.

The CHAIRMAN. All right. Does that conclude—

Dr. PEART. Yes; that's a summary of that.

The CHAIRMAN. Mr. Fish, do you want to wait? I see you put your light on.

Mr. FISH. I think we are going to be on the floor in a minute—there we are.

Just a couple of things quickly here. Doctor, you mentioned, I think, 40 million acres under the heading of "Expanded Grain Production."

"We estimated 40 million acres to be available for expanded crop production after accounting for land needed for food production." If we take that literally, you are saying there are 40 million acres that are presently fallow?

Dr. PEART. No; that would be mostly pastureland, hay, some forest land that perhaps would be cleared.

Mr. FISH. But after deducting what is needed for pastureland, for livestock and hay, for food, you say the 40 million acres are available for——

Dr. PEART. Yes. Would be converted——

Mr. FISH [continuing]. Things that would turn into fuel.

Dr. PEART. Yes.

Mr. FISH. Then on the bottom of page 5, "Grain ethanol is capable of rapid development in the short run, 2 to 5 years. In fact, it is the only real liquid fuel alternative in the short run."

"Liquid fuel alternative," are you talking transportation fuels exclusively?

Dr. PEART. Yes. Yes; I'm excluding gaseous fuels, producer gas, or anything like that. We are saying liquid—something to replace gasoline or fuel oil.

Mr. FISH. Could that be used for manufacturing purposes, electrical generation purposes? Do you just limit it to transportation fuels?

Dr. PEART. Yes; we were thinking of transportation fuels, but the ethanol could be used for these other uses, as well.

Mr. FISH. Thank you. Thanks, Mr. Chairman.

The CHAIRMAN. Mr. Tarman, we will try to get you in before the vote.

[The biographical sketch and prepared statement of Mr. Tarman follows:]

Biographical Sketch
of
Paul B. Tarman, Vice President
Process Research Division
Institute of Gas Technology

Present Duties

Mr. Tarman now directs the program of the Process Research Division of IGT. These programs range in scope from basic kinetics to laboratory investigations, process development unit tests, and large integrated pilot-plant operations. They are directed to fossil-fuel conversion systems, involving coal, oil shale, liquid hydrocarbons, and high- and low-Btu gasification. About 200 people are engaged in these programs.

Experience at IGT

Mr. Tarman joined the staff of IGT in 1956. In his 23 years at IGT, he has conducted experimental research in the areas of adsorption of sulfur compounds on soils, transport of aerosols in pipes, pneumatic transport of solids, production of hydrogen by the steam-iron process, production of reducing gases by catalytic partial oxidation, and hydrogasification of coals, shales, and oils. Mr. Tarman's work has included the accumulation and evaluation of experimental data, and his experience includes high-pressure equipment design, particle dynamics, and reactor design.

Education and Professional Activities

Mr. Tarman received a B.S. and an M.S. in Chemical Engineering from Illinois Institute of Technology in 1956 and 1958, respectively.

Mr. Tarman is a member of the American Chemical Society and the American Institute of Chemical Engineers.

Publications and Patents

Mr. Tarman is author or co-author of over forty publications and sixteen patents in the field of production of liquid and gaseous fuels from carbonaceous materials.

Statement by Paul B. Tarman, Vice President
Process Research Division
Institute of Gas Technology
Before the House Subcommittee on Energy Development and Applications

November 15, 1979

Mr. Chairman and Members of the Subcommittee:

My name is Paul Tarman. I am Vice President of the Institute of Gas Technology, a not-for-profit research organization, affiliated with the Illinois Institute of Technology of Chicago. IGT specializes in energy related research and development, and educational programs. The Process Research Division, which I direct, specializes in the development of advanced energy conversion systems. I am pleased to appear before you today to share with you some of my experience and observations about the research and development now underway for the conversion of biomass to useable energy forms.

When I first began working at IGT in 1956, even though there was no such thing as a recognized energy shortage, a great deal of our efforts were directed towards the conversion of fossil fuels, principally coal and oil shale, to methane. Even then, we were interested in securing a domestic energy supply for the future.

This research has already been instrumental in developing an awareness of both peat and Eastern Devonian shale as new energy reserves, which add significantly to our reserves of coal and shale oil. Each of these resources will be utilized to produce synthetic gas and oil and will, therefore, play a major role in solving our current domestic energy shortage.

The sun is the ultimate source of energy. For most of human history, man has depended upon solar income — the renewable resources of solar energy such as growing plants, falling water, and wind. Recently, man has discovered how to use solar capital — accumulated products of solar energy deposited over millions of years on the earth in the form of fossil fuels.

We are fortunate in having large reserves of solar capital in the form of gas, oil, coal, shale, and peat. Although these reserves are large and will be available for many years to come, they are finite and not renewable. It is important for our domestic security to extend our reserves as much as practical, through the use of renewable resources. Biomass is available now, and its development as a renewable resource should not be postponed. I am, therefore, pleased that this subcommittee is holding these hearings to call attention to the development of this important energy resource.

Energy can be obtained from biomass by direct combustion or by conversion to a fuel form more compatible with existing delivery and utilization systems. The direct combustion of biomass, such as wood, on a wider scale for such applications as home heating immediately comes to mind, and is a very popular idea — familiar and easy to understand. However, the problems of fuel collection, preparation, and delivery, and the prevention of atmospheric pollution quickly become prohibitive as the scale of use is increased. Moreover, central heating systems currently in use cannot readily be adapted to the

I N S T I T U T E O F G A S T E C H N O L O G Y

use of solid fuels. A more practical approach would be to convert the biomass to more useable and transportable forms of energy in central conversion facilities. This would also allow the conversion of biomass residues, such as those from forests and crops, in the conversion process.

Biomass lends itself well to two types of conversion processes, biochemical and thermochemical. Biochemical conversion utilizes microbial action to convert organic material in biomass to gaseous or liquid fuels, depending on the type of microorganism and reactor conditions. Thermochemical conversion utilizes high temperature to break down the organic material to gases and liquids which can then be processed to provide useful fuel forms.

Our research in the conversion of fossil fuels has pointed out a critical factor in all thermochemical conversion processes. This factor is related to the presence of hydrogen gas during conversion. The use of hydrogen greatly enhances the quality of the product yield.

Pyrolysis is a form of thermochemical conversion in which biomass is heated in the absence of oxygen. The products are gas, oil, and charcoal. The gas and oil are complex mixtures of organic compounds containing large amounts of nitrogen and oxygen. Extensive refining with hydrogen is required to convert them into clean-burning hydrocarbon fuels.

Hydroconversion is a form of thermochemical conversion which uses hydrogen directly to produce liquids and gases rich in hydrocarbons that require only mild upgrading to produce useful synfuels. Hydroconversion is a flexible process. Conditions can be selected to produce SNG which is energy intensive, environmentally clean, and which can be transported in existing pipelines to other market areas. Or, high grade liquid fuels can be produced if desired. In all cases, the hydroconversion processes can be designed to operate under environmentally acceptable conditions producing clean burning fuels. This country has a huge capital investment in equipment designed to use simple, low molecular weight, hydrocarbon fuels, e.g., home heating systems and industrial processes. Hydroconversion converts biomass to clean-burning hydrocarbon fuels that can be used in standard combustion equipment without modification to these devices.

Hydroconversion has another advantage in that nitrogen contained in the biomass will be converted to ammonia in the presence of hydrogen. This by-product ammonia can then be used to enhance biomass growth, by using it to replenish soil nitrogen depleted by removal of nitrogenous plant matter. This also avoids some of the problems associated with direct combustion of biomass which requires special combustion devices to minimize nitrogen oxide and particulate emissions.

I must point out that it is not necessary to produce hydrogen separately or bring it to the conversion plant to realize its benefit. The necessary hydrogen is made within the reaction system by reacting some of the carbon in the biomass with steam and oxygen. Thus, biomass can be converted with hydrogen produced internally in the same steam-oxygen reaction system. This can be accomplished by using a fluidized bed to carry out the hydroconversion. Fluidized beds, which are used extensively in the oil conversion and ore processing industries, have proven to be the best means for obtaining the intimate contact between gas and solids needed for the efficient conversion of fossil fuels.

This approach has proven highly effective for the conversion of all types of coal, shale, and peat. During development of these energy resources, testing has progressively increased from small scale laboratory apparatus to large scale pilot plant equipment capable of processing tons of raw material to test process scale-up and to evaluate process performance. I believe that the experience gained by the R&D community in developing these technologies can be very profitably applied to the development of the hydroconversion of biomass. Research techniques are already available and much of the necessary experimental equipment can be adapted for this purpose.

We, at IGT, have conducted laboratory tests to evaluate thermochemical hydro-conversion of biomass. These tests show that in addition to producing higher quality products with hydrogen, high conversion rates are obtained with biomass. Test results show, for example, that when wood products are reacted with hydrogen, a five-fold improvement is obtained in the conversion to combustible gas as compared to pyrolysis. In addition, the rate of biomass conversion is 2-3 times as fast as that of bituminous coal at otherwise similar operating conditions. These data indicate that the hydroconversion of biomass can be accomplished in much smaller reactors than required for coal. These findings indicate that the hydroconversion of biomass offers considerable promise and should be aggressively pursued.

It has taken many years to develop coal gasification which is now ready for commercial demonstration. I believe that both the technical and programmatic knowledge gained in coal gasification, can be usefully applied to the development of biomass. Because of this existing background, a significantly accelerated program is possible in developing this initiative to early demonstration.

I would now like to address the field of biochemical conversion of biomass to produce methane by anaerobic digestion and liquid fuels by microbial fermentation. Anaerobic digestion has been used on a commercial scale for many years, here and abroad, to convert sewage sludge, landfill wastes, and feedlot wastes to methane. In this process, the biodegradable fraction of the organic matter is converted to methane and carbon dioxide by a mixed population of bacterial species. Methane production generally varies from 3 to 6 standard cubic feet per pound of organic matter added to the digester. An approximately equal quantity of carbon dioxide is also produced in the process. Conversion efficiencies in these processes range from 40% to 60% typically leaving about one-half of feed organic matter unconverted as non-biodegradable residue.

Anaerobic digestion is actually a three-step process. In the first step, the complex organic matter is broken down to simple compounds, such as amino acids and sugars. These compounds are further metabolized in the second step to acetic acid, carbon dioxide, and hydrogen. In the final step, the acetic acid and the carbon dioxide and hydrogen are converted to methane. The first two steps are carried out by nonmethanogenic bacteria and the final step is carried out by methanogenic bacteria.

In this process, methane yield, and hence, overall efficiency, is usually controlled by the nonmethanogenic bacteria. Reaction kinetics, and hence the size of the digester, is controlled by the methanogenic bacteria. As a result, single phase digestion using mixed bacterial cultures requires large digesters to hold the material for 20-30 days for maximum methane yield.

IGT is actively engaged in the use of anaerobic digestion to produce SNG from aquatic and terrestrial biomass forms. Current research in this area shows that many improvements over conventional digestion systems are possible:

- Two-phase digestion can be used to separate the nonmethanogenic and methanogenic bacteria and, thereby, increase reaction rates, reduce overall digester size, and improve culture stability.
- Chemical, biological, or physical pretreatment of raw biomass can be used to increase hydrolysis and biodegradability and thereby increase overall conversion efficiency.
- Solids recycle can be employed to increase the holding time of the unreacted matter and of the methanogenic bacteria, thereby improving reaction kinetics and reducing digester size.
- Innovative process designs can be employed to optimize the activities of desired bacterial species or to simplify digester operation.

Research is also in progress on a novel method for converting biomass to ethanol. This method uses a mixed bacterial culture capable of digesting biomass for direct conversion to alcohol. If successful, biomass could be used to produce alcohol fuels directly without the feed pretreatment or pasteurization steps now necessary when using pure cultures of yeast or bacteria.

This experience leads to some observations and conclusions that I would offer for your consideration.

- Biomass holds great promise as a renewable source of energy for extending fossil resources of solar capital, and its development should be aggressively pursued for both short-term and long-term applications.
- DOE's FY 1980 budget for the Biomass Energy Systems is 58 million dollars, which is over 10 times the funding level of three years ago. However, the potential of biomass energy especially because of its current short-term and future long-term applications warrants increased funding levels.
- Biomass by its nature is a versatile raw material for which no single conversion technology is universally applicable. It can be used to make both gaseous and liquid synfuels in centralized large-scale systems as well as in decentralized small-scale conversion facilities. In implementing a program of such wide applicability, the use of agencies with extensive field networks, such as USDA, have been suggested to aid in the development of these conversion facilities and in the dissemination of related information. This use of agencies merits consideration.

Several figures are appended to the text of my testimony to provide more detailed information about biomass conversion processes.

Thank you for allowing me to testify before you today. I will now be pleased to answer any of your questions regarding this testimony. I have brought two colleagues with me today to help in this regard. Dr. David Chynoweth directs IGT's research on biochemical conversion and Dr. Suresh Babu directs our research on thermochemical conversion.

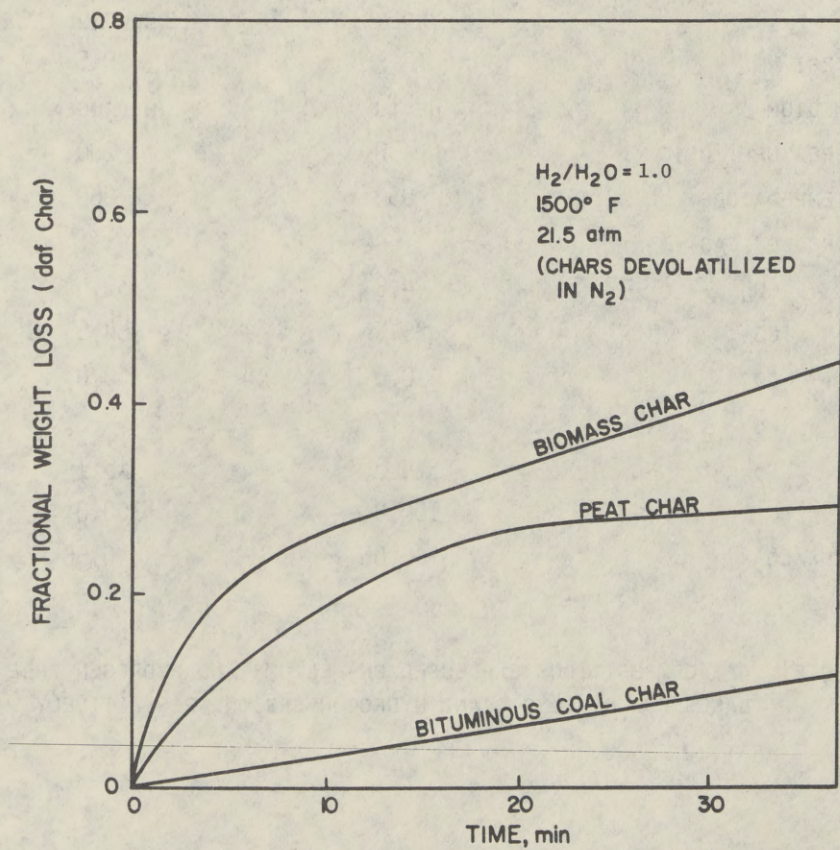
I N S T I T U T E O F G A S T E C H N O L O G Y

THERMOCHEMICAL CONVERSION OF BALSAM FIR PUCKERBRUSH

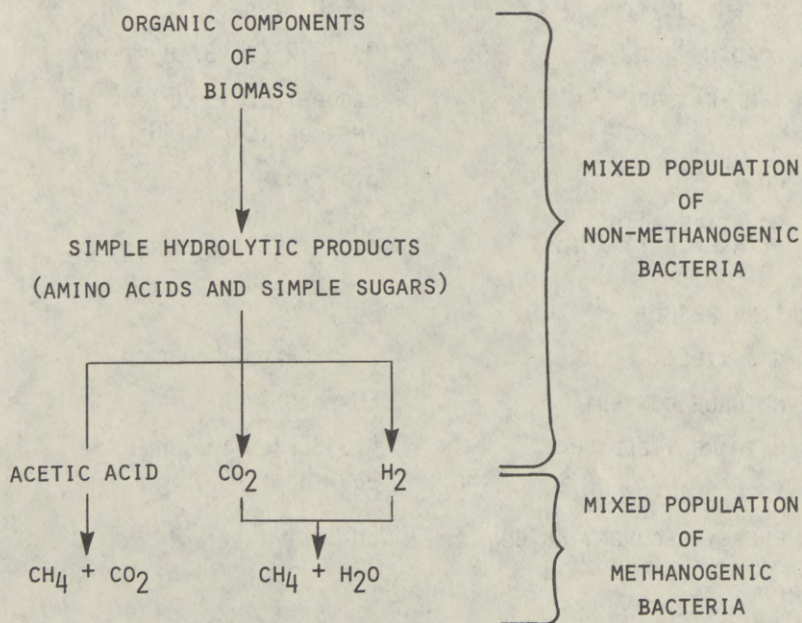
	<u>PYROLYSIS</u>	<u>HYDROCONVERSION</u>
TEST	P-7	P-5
MEDIUM	HELIUM	HYDROGEN
PRESSURE, PSIG	50	200
TEMPERATURE, °F	950	960
PRODUCT GAS, %		
CH ₄	4.8	30.4
CO ₂	86.5	54.5
CO	0.0	0.0
H ₂	4.2	-
C ₂ H ₆ +	<u>4.5</u>	<u>15.1</u>
	100.0	100.0
CH ₄ /CO ₂	0.06	0.56

NOTE: GAS COMPOSITIONS EXPRESSED ON HELIUM- AND HYDROGEN-FREE BASES FOR PYROLYSIS AND HYDROCONVERSION, RESPECTIVELY

COMPARISON OF CHAR GASIFICATION RATES



BIOCHEMICAL REACTION STEPS IN ANAEROBIC DIGESTION



TYPICAL PERFORMANCE OF ANAEROBIC DIGESTION

OPERATING CONDITIONS

RETENTION TIME	10-20 DAYS
LOADING	0.1-0.2 LB VS/CU FT-DAY
TEMPERATURE	MESOPHILIC (95°F) THERMOPHILIC (130°F)
pH	6.5-7.5
VOLATILE ACIDS (AS ACETIC ACID)	50-30 MG/l

OPERATING RESULTS

GAS YIELD	7.5 SCF/LB VS ADDED
METHANE CONTENT	60 MOLE %
METHANE YIELD	4.5 SCF/LB VS ADDED
VS REDUCTION	65%
ENERGY RECOVERY AS CH ₄	60%

NOTE: VS (VOLATILE SOLIDS) ARE EQUIVALENT TO ORGANIC MATTER.

HYDROCONVERSION DEVELOPMENT AND DEMONSTRATION PROGRAM

Program Tasks	Years After Program Begins								Thousand Dollars*
	1	2	3	4	5	6	7	8	
I. Process Development Program									1,500
II. Pilot-Demonstration Program									
a. Detailed Design									500
b. Equipment Modification and Construction									2,000
c. Operation									18,000
d. Environmental and Economic Studies									2,000
III. Commercialization									
a. Design and Construction									
b. Operation									

Total Costs 24,000

*Mid-1979 Dollars

PLAN FOR THE DEVELOPMENT OF THE
IGT BIOMASS HYDROCONVERSION PROCESS

Phase I. Process Development Program

- Biomass Characterization - Survey of forest and crop residues and their characterization to identify resources appropriate for conceptual centralized biomass hydroconversion plants.
- Bench-Scale Experiments - Devolatilization and gasification studies on selected biomass materials, to determine the effects of major operating variables on rate and extent of organic matter conversion. Develop kinetic models useful for reactor design and scale-up.
- Process Development Unit (PDU) Tests - Half ton/hr (biomass feeding capacity) PDU will be operated with selected materials, at temperatures and pressures of up to 1500°F and 300 psig to produce gas/or oil by hydroconversion. These tests will determine the feasibility of operation under adiabatic conditions as would be encountered in commercial reactors.
- Environmental and Economic Studies - The PDU test results will be used to assess the fate of toxic compounds during hydroconversion and the characteristics and environmental impact of process effluents. The PDU results will also form the basis for economic studies to estimate investment costs, and product gas/or oil costs.

Phase II. Pilot Demonstration Program

- Detailed Design - A detailed process and mechanical design for a pilot demonstration plant (PDP) of 100 tons/day (biomass feeding capacity) will be prepared jointly with an engineering firm. This design will form the basis for modifying an existing pilot plant at IGT.
- Equipment Modification and Construction - IGT will modify the selected existing plants and construct additional equipment and instrumentation to build the PDP for biomass hydroconversion tests. During the final phase of equipment modification and construction the PDP will undergo pre-operational inspection.
- Operation - After initial PDP shakedown full-scale operation will begin to study the effect of process variables on product yields and qualities.
- Environmental and Economic Studies - PDU environmental and economic studies results will be evaluated and reassessed with the PDP test data to project the performance of commercial hydroconversion plants.

Phase III. Commercialization

- Design and Construction - IGT will employ the PDP results in working closely with a selected engineering/construction firm to design and build a hydroconversion commercial plant.
- Operation - The plant will be operated to produce commercial quality products.

STATEMENT OF PAUL B. TARMAN, VICE PRESIDENT, PROCESS RESEARCH DIVISION, INSTITUTE OF GAS TECHNOLOGY, CHICAGO, ILL.

Mr. TARMAN. Thank you very much for inviting me to testify today. I have submitted written testimony, but in the interests of time, I would like to summarize.

The CHAIRMAN. We will include your full testimony.

Mr. Peart, you have a plane to catch, and if you have got to leave, you may do so.

Dr. PEART. Thank you.

Mr. TARMAN. I am vice president of process research at IGT.

Over the years we have developed several processes for the conversion of fossil fuels to higher energy forms, and I believe that a great deal of research developed in the fossil fuel area can be applied to production of synfuels from biomass.

The CHAIRMAN. Can you pull up the microphone just a little bit so I can hear you a little better and the reporter can hear you better?

Mr. TARMAN. Biomass is quite unlike coal or shale. It is quite a versatile resource. It lends itself to two types of conversion processes: the thermochemical and the biochemical.

The thermochemical processes use heat to break down the organic matter into gases and liquids, which can then be processed to provide useful fuel forms.

Biochemical conversion uses bacteria to convert the organic matter to gaseous or liquid fuels.

I would like to make a few comments about both areas of this conversion.

Our research on fossil fuels has pointed out a very critical factor in all the thermochemical processing. This factor is related to the presence of hydrogen gas during the conversion process. The presence of hydrogen greatly enhances the quality of the product yield.

Hydroconversion could be considered a form of thermochemical conversion that uses heat and hydrogen to produce liquids and gases rich in hydrocarbons which require only mild upgrading to produce useful finished synfuel forms. Hydroconversion is quite flexible. Conditions can be selected to produce SNG or high-grade liquids which are energy intensive, environmentally clean, and which can be easily transported to other market areas.

Hydroconversion has other advantages. Because of the use of hydrogen it converts most of the nitrogen in the biomass to ammonia. This byproduct ammonia could then be used to replenish the soil nitrogen and therefore enhance biomass growth.

In addition, because of the presence of hydrogen, no nitrogen oxides are formed and no sulfur oxides are formed during the process.

I must hasten to point out that it is not necessary to produce the hydrogen in a separate process, or to bring hydrogen to the conversion plant to realize these benefits.

The necessary hydrogen can be made right within the system by reacting some of the carbon or organic matter in the biomass with steam and oxygen. Thus, biomass can be converted with hydrogen produced internally within the same steam-oxygen reaction system.

This approach has proven very effective for the conversion of all types of fossil fuels. I believe that the experience gained by the entire R. & D. community in developing these technologies can be very profitably applied to the development of hydroconversion of biomass.

Research techniques are already available, and most of the necessary experimental equipment can be adapted for this purpose.

We have made some preliminary laboratory tests to evaluate the hydroconversion of biomass. These tests show that hydrogen produces both higher quality products and also promotes higher conversion rates.

Test results show, for example, that when wood residue is reacted with hydrogen, the conversion to a combustible gas is improved five-fold, as compared to straight, hydrogen-free pyrolysis.

In addition, the rate of biomass conversion is two to three times as fast as that of bituminous coal for comparison purposes. These data indicate that hydroconversion can be accomplished in much smaller reactors than required for coal, and the findings indicate that hydroconversion of biomass offers considerable promise and that should be aggressively pursued.

I believe that I would like to now address a little bit on the field of biochemical conversion. Biomass can be converted in two ways, biochemically, directly to methane by anaerobic digestion or directly to liquid fuels by fermentation.

Anaerobic digestion has been used for many years to convert sewage sludge, landfill wastes, feedlot wastes, et cetera, to methane. In this process, the biodegradable fraction, which is normally about half of the original organic matter, is converted to methane and carbondioxide by different types of bacteria.

Anaerobic digestion can be considered a three-step process. First, hydrolysis, then acid formation, and then biomethanation. In the first step, the organic matter is broken down into relatively simple compounds; amino acids, sugars. These compounds are further metabolized in the second step to acetic acid, carbon dioxide, hydrogen; and in the final step, the acetic acid and the carbon dioxide and hydrogen are converted to methane.

The first two steps are carried out by a type of bacteria referred to as typically nonmethanogenic bacteria, and the final step is carried out by typically referred to methanogenic bacteria.

In this process, efficiency of the process—the overall efficiency of the process—is controlled by the first two steps, the presence of the nonmethanogenic bacteria, and the size of the digester, or the rate of the reaction is controlled by the methanogenic bacteria. Thus, for maximum methane yield, a single digester which contains both types of bacteria must be very large to accommodate both—a holding time of about 20 or 30 days in order to obtain a high conversion efficiency.

Current research that has been done on the anaerobic digestion shows that many improvements over conventional processes are possible.

First: Two-phase digestion can be used. This separates the two major types of bacteria, and thereby increases reaction rates, reduces overall reactor size, and improves culture stability.

Second: A chemical and biological or physical pretreatment of raw biomass can be used. This increases the biodegradability and therefore increases the overall conversion efficiency.

Third: Solids recycle could be employed. This increases the holding time of the organic matter, and it also increases the concentration of bacteria, thus improving kinetics and reactor size.

The CHAIRMAN. We are going to have to break off, unfortunately. The second bells have rung.

Mr. TARMAN. OK. I can conclude in about 1 minute.

The CHAIRMAN. OK. Good.

Mr. TARMAN. I would like to conclude as follows: I think biomass holds a great promise. It's a renewable resource, it greatly expands our fossil fuel resources, and I think its development should be pursued.

DOE's budget is now \$58 million. That's over 10 times what it was 3 years ago. However, I think because of the potential of biomass, this budget ought to be increased.

I think biomass is very versatile material. No single conversion technology is universally applicable. It can be used to make gases or liquids, and, because of this wide applicability, I think the use of agencies with extensive field networks such as USDA, which has been suggested to aid in the development and in the dissemination of information concerning the development of biomass—I think this suggestion merits your consideration.

Now, I have appended several figures for the testimony, and I have also included a preliminary development plan for this hydroconversion process.

I would like to thank you for listening.

The CHAIRMAN. I'm very sorry we have to cut it short.

Mr. TARMAN. Quite all right.

The CHAIRMAN. You are supporting the Fithian bill?

Mr. TARMAN. In general, yes, because I believe biomass is a very important piece of research and I think it has to be expanded at all levels of research, in both small and large development efforts.

The CHAIRMAN. We thank you very much.

We thank our reporter for sticking with us.

We are not going to be able to continue. I've got to run—literally—for the vote. I just have to apologize to you, Mr. Gibson. We do have your testimony, however.

[The prepared statement of Mark Gibson follows:]

STATEMENT OF MARK GIBSON
LEGISLATIVE ASSISTANT TO SENATOR JOHN A. DURKIN

Before the Committee on Science and Technology
Subcommittee on Energy Development and Applications

November 15, 1979

Mr. Chairman and Members of the Committee, it is indeed a pleasure to appear before you today on H.R. 5428, a bill designed to encourage the development and commercialization of bioenergy applications.

Mr. Chairman I would like to talk to you today about the USDA and DOE biomass programs. I would like to discuss the administrative and technological aspects of these programs and how H.R. 5428, if passed, can act to alleviate many of the administrative and technological deficiencies of these programs.

There are more than 10 different agencies in the federal government administering biomass programs. In addition to USDA and DOE, the National Science Foundation, the Department of Commerce and the Department of Defense all fund various biomass programs and projects. Overall, in fiscal year 1980 the federal government will spend somewhere between \$90 and \$100 million directly on biomass research and development (this does not include off-budget expenditures such as loan guarantees). Of this total, USDA and DOE programs account for about \$80 million. This level of funding is much greater than is commonly acknowledged. There is obviously a great deal of R&D being supported in many places, and one

would wonder whether passage of H.R. 5428 is justified. In fact, despite the significant level of federal R&D there is an even greater amount of R&D and commercialization that needs to be done. There are areas of research and commercialization that need to be done. There are areas of research and commercialization which the private sector probably will not get involved in, and which the federal government is ideally suited to support. Moreover, passage of H.R. 5428 can rectify many of the management problems (such as interagency coordination) which have stifled the federal biomass programs.

DOE and USDA Programs

The various biomass programs in USDA and DOE have been administered independently of one another, resulting in overlapping or duplicative efforts.

The availability and utilization of biomass energy cuts across so many administrative and technological jurisdictions, that it may be appropriate for a number of agencies with differing authorities to administer a bioenergy R,D&D effort. A multiplicity of federal R&D programs on bioconversion can be compatible with the diversity of options in biofuels production. This concept would be in contrast, with the idea of a single mission oriented agency (such as DOE) directing and funding a solitary bioenergy development program. In either case, however, a clear or comprehensive inter-agency strategy could be beneficial.

DOE has been designated as the lead agency in bioenergy R&D with responsibility to integrate and coordinate national efforts. DOE's plans and activities however, have not indicated that a comprehensive framework has been established which to perform this role, the absence of a clearly defined mission, poor coordination and communication, and reorganization uncertainties, all have contributed to poor inter-agency coordination.

A greater degree of inter-agency coordination is needed for effective technological development. For example, biomass production and utilization is embedded in the food and fiber sectors of the economy. This being the case, the success of DOE efforts in some bioenergy commercialization activities is contingent upon the implementation of complementary biomass production policies by the Department of Agriculture. If biomass commercialization programs are to be successful it will require an integration of agriculture and energy programs and policies.

Inter-agency coordination appears to be improving, however. Recent agreements between the two mark a significant change in the way the Federal government's programs have been administered. It remains to be seen, whether these agreements can be successfully implemented.

DOE PROGRAMS

DOE has provided modest support to the development of near-term biomass applications in the past. Most of the Agency's emphasis has been on the development of mid- and long-term bioenergy applications. As a consequence little in the way of commercialization strategies and policies have emerged. In contrast the Forest Service, agencies of the Department of Agriculture, and the Tennessee Valley Authority have all initiated relatively aggressive commercialization programs for selected technological applications.

In the one area where DOE has begun well conceived and balanced biomass commercialization initiative -- wood conversion to energy -- the commercialization activity suffers from several administrative inadequacies. Although this program has a clearly stated responsibility, it has not received significant operating budgets. Serious problems confront this program, and despite its considerable responsibility, may not have the necessary authority or resources to accomplish its purpose.

In many technical areas DOE has supported the development of gaseous or liquid (synthetic) fuels of similar character to conventional fuels. There has been little support for the development of comparatively low quality fuels (such as non-producer gas) which may be of high value in unconventional or on-site applications (e.g. package boiler applications) and which have near term potential. One consequence of this is that the emphasis of the programs has been skewed towards developing mid- and long-term biomass applications. In part, this may be the reason why coherent strategies have not been developed to bring technologies to the point of commercialization.

DOE has given a high priority to developing large scale production and conversion systems in the past, and has placed little emphasis on intermediate and small-scale designs. Few funds have supported modular industrial-sized conversion systems, residential applications, or on-farm applications.

In some cases promoting the development of large scale biomass systems is advantageous in that the development of high-yield energy production systems is also promoted. This is not always the case, however. For example, with anaerobic digestion and wood biomass gasification, the optimum scale for energy production may not necessarily be large, and emphasizing the development of large centralized systems may not be the most effective or desirable approach. In addition, such an emphasis may overlook institutional and economic advantage of smaller applications.

DOE biomass programs have in the past, been poorly administered. For example, program management of the principle biomass program has been highly transient, last year experiencing four changes in leadership within a nine month period. The programs have evolved without a clear or comprehensive plan, and management has made few evaluations of program priorities.

In an attempt to change past administrative and technical shortcomings DOE management has within the last year restructured and reorganized its biomass programs. The character of the programs in many areas appears to be changing.

However, due to institutional momentum and past budgetary commitments, DOE has not been able to change its programmatic emphasis expeditiously. Many deserving technologies will not be supported because of lack of funds and (mainly) because the DOE biomass programs are still in the shadow of past biomass programs.

USDA PROGRAMS

On balance, bioenergy R,D&D receives a low emphasis in USDA. The Department has no real energy mandate (DOE has been designated the lead agency for energy related activities). Moreover, USDA has an understandable tendency not to undertake or fund work relating solely to energy; USDA is reluctant to burden its research and development budget and staff resources by taking on new energy-related projects.

Those bioenergy activities which the Department has undertaken, with some exceptions, have no clear direction or mission. Although an Office of Energy was recently formed to coordinate aspects of the Department's energy activities, no well established biomass development strategy has been evident. The role to the Office of Energy may be changing to that of a monitoring and implementing rather than coordinating office. A new solar-biomass program established in FY 1980 may give the Energy Office somewhat more leverage in directing USDA's bioenergy development effort. However, the fundamental problems hampering the Office's coordinating ability will not disappear with the establishment of this program.

The Department of Agriculture has the capability to support the development and implementation of biomass systems, and because bioenergy development is intertwined with food and forestry policies, the Department may have a necessary role to play. Given USDA's administrative character and the agency's record in bioenergy development however, it is highly doubtful that the Agency will promote

bioenergy (by, for example, using wood energy development as a significant forest management technique) without receiving considerable pressure from the Congress.

SUGGESTIONS FOR CONGRESSIONAL ACTION

o Passage of H.R. 5428.

The passage of H.R. 5428 will rectify many if not most of the administrative and technical deficiencies of the DOE and USDA programs cited above. Perhaps more importantly, the pass-through funding technique employed by the legislation will stimulate better inter-agency coordination.

o Intensive and continued oversight of the Federal bioenergy programs.

o More vigorous support for near-term biomass commercialization.

o Scrutinize current reorganization activities to insure that biomass commercialization is given an adequate role.

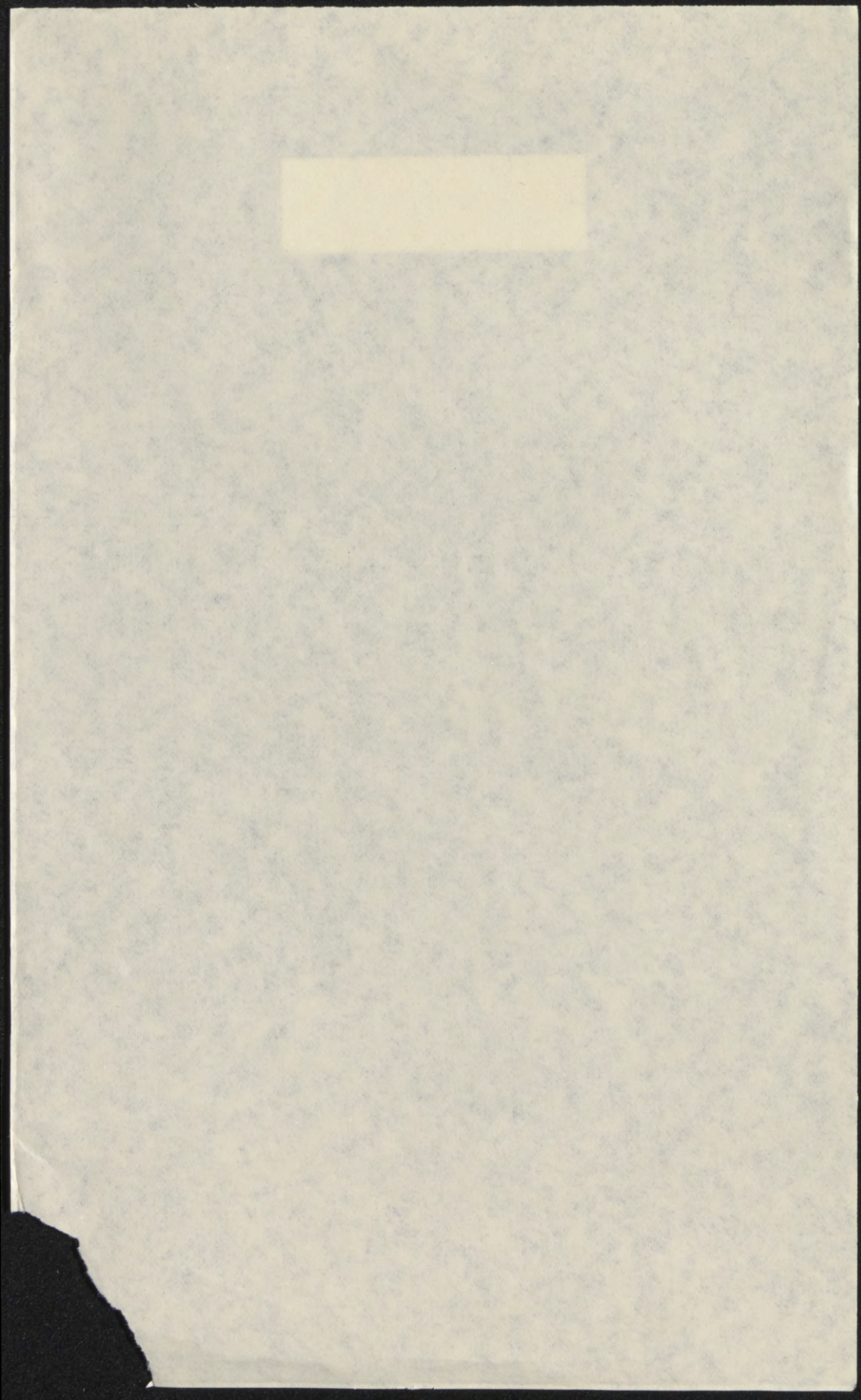
o Conduct additional hearings on bioenergy commercialization.

o Conduct additional hearings on the Federal role in bioenergy research and commercialization.

The CHAIRMAN. Thank you.

[Whereupon, at 5:50 p.m., the subcommittee was adjourned.]







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