

ALASKA LEGISLATURE SPECIAL COMMITTEE / SUBJECT FILES 86 / 2

950 SCOMM44: HOUSE POWER ALTERNATIVES STUDY COMM. 1979-80

The renewable biomass mass can be estimated from Montana's farm and forest production. Considering only wheat crops from the farm, and assuming that a pound of wheat produces a pound of straw, about 4 million tons of straw are produced from the 8 million plus acres under harvest in the state.¹ At present, the great majority of this straw is marketed or plowed back into the soil. Dependent upon the price that would be paid for straw used as a fuel, substitutes could be found, and some of this straw could be used as fuel. In one area south of Ft. Benton, about 100,000 tons of straw are available each year; therefore, an assumption is made in the calculations below that at some price, yet to be determined, one million tons would be available annually in Montana. The annual forest harvest in Montana had been about 200 million cubic feet per year.² Using representative data from the forest service on residues from sample forests in Idaho, Wyoming, and Montana, about one million tons of usable residue would be available on the ground after logging this amount of lumber. Thus, from farm and forest, two million tons of biomass are available each year in Montana. The present coal mining operations produces 30 to 40 million tons/year; thus, the renewable biomass resource is small compared to the coal resource. However, this annual statewide biomass supply is adequate to heat 50,000 homes from central heating plants and to provide ten tons of processed biomass fuel per year as heat for another 50,000 homes.³ The point can be made that if the

¹ Montana Agricultural Statistics, Vol. XVI, Montana Department of Agriculture and USDA.

² R. V. White and C. E. Keegan, "The Wood Products Industry in Montana," Montana Business Quarterly, Summer, 1978.

³ Individual homes $10 \times 50,000 = 500,000$ tons; Central plants: $(2,000,000 - 500,000)$ tons $\times 2,000$ lbs/ton $\times 8,000$ Btu/lb $= 24 \times 10^{12}$ Btu
 $50,000$ homes $\times 60,000$ Btu/hr - home $\times 4,000$ hrs $\times 50\%$ total system efficiency $= 24 \times 10^{12}$ Btu.

resource numbers are off by a factor of five, there is still sufficient renewable energy for 20,000 homes. One object of the program is to define the resource.

The present cost of natural gas delivered by the utilities in the state is around \$2 per million Btu. The cost for electric or fuel oils is about two to four times the cost of natural gas. The cost advantage of natural gas is significant, and any centralized heating plant using biomass cannot compete with natural gas delivered to the homes for heating as presently priced when fuel and capital costs are considered. There does appear to be a strong possibility that biomass would be cost competitive with electricity and fuel oil. The communities in Montana that should be considered for the demonstrations are therefore those without natural gas. In addition, because the cost of a hot water distribution system is expensive, the communities must have a relatively high density business and housing area.

As in the case of the other programs, the development steps follow in order, such that if at anytime it is determined that the concept would not be cost competitive to existing systems, the program can be terminated without additional cost. Because of the existing technology base, very little hardware development and testing will be required. By the time that large hardware expenses are necessary, the system costs will be known, and a go/no-go decision can be made on an economics basis. This program therefore requires only a commitment of money on a step-by-step process. The state will be in the position to stop the program if at any time the system's technical or operational cost goal cannot be met. In addition, the selected communities will be expected to make a cash or in-kind contribution of at least 10 percent of the installed system cost.

An example of the sequence of steps that must be accomplished is:

1. Identification of communities in Montana that are interested in such a centralized heating concept;
2. Preliminary study of community energy needs;
3. Identification and quantization of renewable biomass resource in region;
4. Study of collection, processing, storage, and transportation methods that are possible;
5. Preliminary design of heating plant and distribution system;
6. Initial estimate of cost for delivered heat to users;
7. First decision by community to continue program;
8. Selection by state of communities that will receive further state support;
9. Decision by community on ownership and operational concept of heating plant;
10. Detail study of fuel costs aimed at minimizing capital and operational costs and maximizing return to land owner;
11. Layout design of heating plant and distribution system;
12. Commitment for required fuel supply at negotiated price;
13. Second estimate for cost for delivered heat to users;
14. Study of home and business heating unit costs and financing amount and method that will be required;
15. Second decision by community to proceed;
16. Sign-up of prospective customers;
17. Detail design of heating plant and distribution system along with continued work on fuel collection, etc.;
18. Final community approval on project;
19. Construction;
20. Plant and distribution system check-out;
21. Home and business hook-up; and
22. Operation.

It is proposed that four communities be selected for support through construction and check-out under this program with at least one using forest and one using farm biomass. Two would be started and would enter the construction phase before the second two would be selected by the state. The first two plants would be operational before construction on the second two plants would be started. Steps 10 through 21 will require about 20 months. Additional communities would be supported through step 17 if there is interest.

During the course of this program, the technical design, fuel processing, construction, and operational skills would be developed within the state, so that additional interested communities could develop their own plants through the established commercial capability.

The hot water distribution system developed under this program is quite similar to that proposed under the geothermal program. The community-size biomass heat plant technology is an excellent addition for any community that develops a geothermal supplied heat system that goes dry after 10 or 20 years.

The second element to be considered under this program is direct research and development support to furnace and stove manufacturers and biomass fuel processors. Improved stove and furnace design for lower manufacturing costs, improved efficiency, and pollution minimization must be developed. This must be done in conjunction with a detail study of the collection and processing of biomass fuels for direct home and business use. Fuel preparation and delivery costs must be minimized. The owner is buying Btu's, not

just a stove and fuel, and the whole business structure must be analyzed and developed within each community to provide this at minimum cost. Any expanded use of biomass will not come about by a significant increase in the weekend family trips to the woods to cut a load of firewood for the pick-up. For expanded use, the process must be commercialized with the resulting capital equipment and small businesses being established.

This stove and furnace program will directly support the passive and active solar heating programs that have already been supported by DNRC. In Montana, a biomass burning back-up heating system is ideal. Two to three tons of biomass fuel per year should be more than adequate for any properly designed solar home.

Resource and Need Assessment

In western Montana, the forests provide an extensive renewable biomass resource. As an example of the state output in 1976, twenty-five percent of the harvested roundwood products came from Lincoln County, 19 percent from Flathead County, and 13 percent from Sanders County. Four communities in this area without natural gas are Libby, Eureka, Thompson Falls, and Polson. Six hundred and sixty million board feet were harvested from these three counties in 1976, which is slightly lower than the average harvest over the past ten years.⁴ There has been a general trend of decreasing harvest from public lands which is the major acreage in these counties during the past ten years; therefore, the harvest in this region might not be expected to be increased.

⁴ R. V. White and C. E. Keegan, Ibid.

An average of the forest types and harvesting methods in a USDA Research Paper⁵ on the northern Rocky Mountain region indicates that 5,000 ft³ are harvested per acre, that after harvest, 35 tons/acre of residue in fines remain and three inches and greater are left on the ground. Computing the total acres harvested using the average yield per acre and the annual production gives 22,000 acres, with a biomass residue of 770,000 tons. This residue has a Btu content of 10^{13} Btu. Furthermore, if it is assumed that only one-half of this residue is collected and processed, this gives a total of 5×10^{12} Btu available per year from these three counties.

In 1970, there were approximately 80,000 people in these three counties; of which, say 20,000 are serviced by natural gas. At three people per home, the remaining occupy 20,000 homes. An estimate of heat need would be 60,000 Btu/home for 4,000 hours/year, or a total heat need of 4.8×10^{12} Btu. Thus, the biomass supply is approximately equal to the need for home heating when only one-half of that available is collected. If 770,000 tons are sold to the home and central heating plants at a cost of \$30 per ton, this would represent an economic activity of \$23 million per year for the local economy within these three counties. The \$30 per ton is about \$2.15 per million Btu and is equivalent to electricity at seven mils per kilowatt hour, or fuel oil at 32¢ per gallon.

The biomass resource in this region can certainly be a cost competitive fuel if it can be delivered at \$30 per ton. One significant factor in

⁵ R. E. Benson and C. M. Johnston, "USDA Forest Service, Research Paper INT-181: Logging Residues Under Different Stand and Harvesting Conditions, Rocky Mountains."

determining whether or not this would be possible is the price of transportation which depends upon the harvest area and the use areas within these counties. One of the first steps of the program is to identify specific interest within the state. The four cities mentioned represent about 8,000 people or maybe 2,000 to 3,000 homes and businesses that could be heated by centralized hot water systems. There is certainly ample forest waste available on an annual basis to supply these homes.

In the grain growing regions of central and eastern Montana, a renewable resource equivalent to the quantity of forest biomass is available. The principal crop products of Montana are wheat and barley which, as an example, accounted for over 200 million bushels in 1975. The majority of the straw from this grain is presently marketed, plowed back, and used by the farmer in some beneficial manner. There is a real need for much of this straw; however, since it must be disposed of before a new crop is planted, disposal is more important than efficient use. What is implied here is that if there was another cash market for straw then some portion of that which is presently available could be made available for this market. The variation in the straw grown from one year to the next is sometimes as high as 1,000 pounds per acre or about four million tons statewide.

On the Highwood bench east of Great Falls, there is a 100,000 acre area on which year around wheat farming is practiced. The soil and climate conditions are such that the straw remaining after the wheat harvest cannot be plowed back into the ground. This straw must be removed from the ground in the couple of weeks between harvest and planting. There is not a sufficient

local market to use the available supply; therefore, this straw is "disposed of" in the easiest manner possible. As a renewable energy resource, this straw, at an average of one ton per acre, represents 1.4×10^{12} Btu annually, which could satisfy the heating needs of approximately 20,000 people, assuming an overall heating system efficiency of 60 percent.

The cost for baling and collecting straw from wind rows in the field after harvest has been computed⁶ to be \$4.15 per ton, plus an additional charge of \$2.70 per ton for hauling to the edge of the field (one mile is the assumed average distance per trip). These baling and hauling costs of approximately \$7 per ton are for large round bales; the small rectangular baling costs are \$12 per ton.

Straw can be burned directly as collected from the fields; however, for any widespread use involving long hauling, this will probably not be economical. (This conclusion should be verified by further study to determine the critical hauling distance at which densification of the straw becomes economical). There are many processes by which straw can be compacted^{7,8} to 55 lbs/ft³ which is about the same as coal. In this densification process, the straw is usually pellitized to uniform size and dried to 10 to 12 percent moisture, making it a fuel which is very competitive in Btu content, combustion, and handling characteristics to western coal. In addition, the pellets have increased resistance to moisture absorption. The energy input for the complete processing is estimated at eight percent of the

⁶ J. D. P. Partridge and D. G. Hodgkinson, "Manitoba Crop Residues as an Energy Source," Proceedings of Forest & Field Fuels Symposium, October, 12, 13, 1977, Winnipeg, Canada.

⁷ J. LaRue and G. Pratt, "Problems of Compacting Straw," Ibid.

⁸ R. K. Broeder, "Successful Marketing of Pelletized Field Residues," Ibid.

energy in the straw.⁹ The total operating and capital cost of the densification plant has been estimated to be between \$9 and \$10 per ton.⁹

The straw densification plant considered above for the 10⁵ tons on the Highwood bench area would have to operate 333 days to process the total tonnage available. During the course of the year, the straw could be transported from the edge of the fields to a central plant in the region. This transportation cost would add another \$4 per ton to the final straw cost. Assume that bulk hauling of the pelitized straw in 20 ton trucks for a one-way distance of 50 miles would add another \$5 per ton, this gives a delivered cost of processed straw of \$25 per ton. Assuming the farmer is paid \$5 per ton in the field, the price of the straw 50 miles away ready for combustion would be about \$2 per million Btu. This represents a competitive price for fuel in many regions of Montana. One of the first elements to consider under this program is the refinement and verification of these calculations. In addition, other farming regions need to be identified that could provide a dependable, renewable biomass resource that could be used by a community or sold to individuals for their own private heating system.

Technical and Development Issues

The program objective is to determine the economic feasibility of biomass as a fuel in homes, businesses, and central heating plants. There

⁹ T. B. Reed and B. Bryant, "Energetics and Economics of Densified Biomass Fuel Production," Solar Energy Research Institute Report.

are no critical technical unknowns in this proposed concept for the direct combustion of biomass. Certain steps in the process are well understood, and the equipment and technology are fully developed with little possibility of improvement. At the farming/forest end of this process, probably the least cost effective steps are in collection and densification. This represents 2/3 of the costs in the straw example illustrated. These two processes have not been examined by any equipment manufacturer to date, and there may be a possibility of reducing the cost. Transportation (most probably done by truck) costs to the combustion site and storage costs are well established. Central plant combustion is well characterized, and the technology exists to meet all pollution standards at the same combustion efficiencies of coal. Although the majority of the designs for the present direct combustion home-size heating units have been around for years, there is considerable need for improvements in combustion efficiency and in minimizing emissions. These two factors become more critical as more and more units are installed and as weatherization programs make homes more air tight. Research and development work in these areas, using Montana fuels, will be necessary and can be accomplished at DNRC's supported Anaconda Combustion Facility.

The first issue that must be resolved for any community interested in a heating plant or widespread usage of individual heating units is to identify a dependable renewable energy supply. In the case of farming activities, this is easy; however, in the forest regions, the distances between harvest and combustion site will vary from year to year, and this variation must be fully explored and considered in determining lifetime costs of any system established.

Probably the single most costly item of a central plant system is in the hot water distribution system. There are a few examples of this in the U.S., e.g., the Boise, Idaho geothermal system, which can provide cost estimates. The more numerous and furthest advanced technically are those in the European and Scandanavian countries. In the small towns of Montana, this may be the one factor which will prevent the central plant concept from being cost effective. Extensive study and a conceptual hot water distribution system design for a representative town must be initiated at the start of the program.

The ownership and operation of a community-size plant are issues that must be resolved by each community individually since the ten percent cost or in-kind contribution are closely related to these issues. Of equal concern to the possible hot water users is the cost of home installation of heating units and what to do with the existing heating systems. Another point that needs to be considered by the community is whether or not the central plant will be operated year around or just in the cold months.

For an individual home or business use of biomass for heat, there are fewer economic questions. The major issue today is in establishing enough users in one region to justify the cost of the collection and densifying equipment. Assuming that an average home would use six tons of biomass per year, the Highwood bench straw processing facility example would provide biomass for 16,650 homes. Smaller processing plants and the use of fewer tons of straw will certainly have to be studied if only direct home combustion was used, since the signing up of that many customers initially would be doubtful. The advantage of central heating plants for towns and individual

heating units in the less dense living areas is certainly apparent if the maximum use of a region's renewable resource is to be made.

During the early stages of the program, all critical issues will be studied, and costs will be determined. If the projections are favorable, detail design of facilities and equipment will be made, and any required development programs will be undertaken. Communities and individual businesses interested in biomass fuel marketing and equipment marketing and servicing will be supported to the maximum degree possible. Direct support of a large-scale project will be provided once economic feasibility has been established. Each step must be justified on the projected economic feasibility, and if this cannot be done, the program is redirected or terminated.

Additional Issues

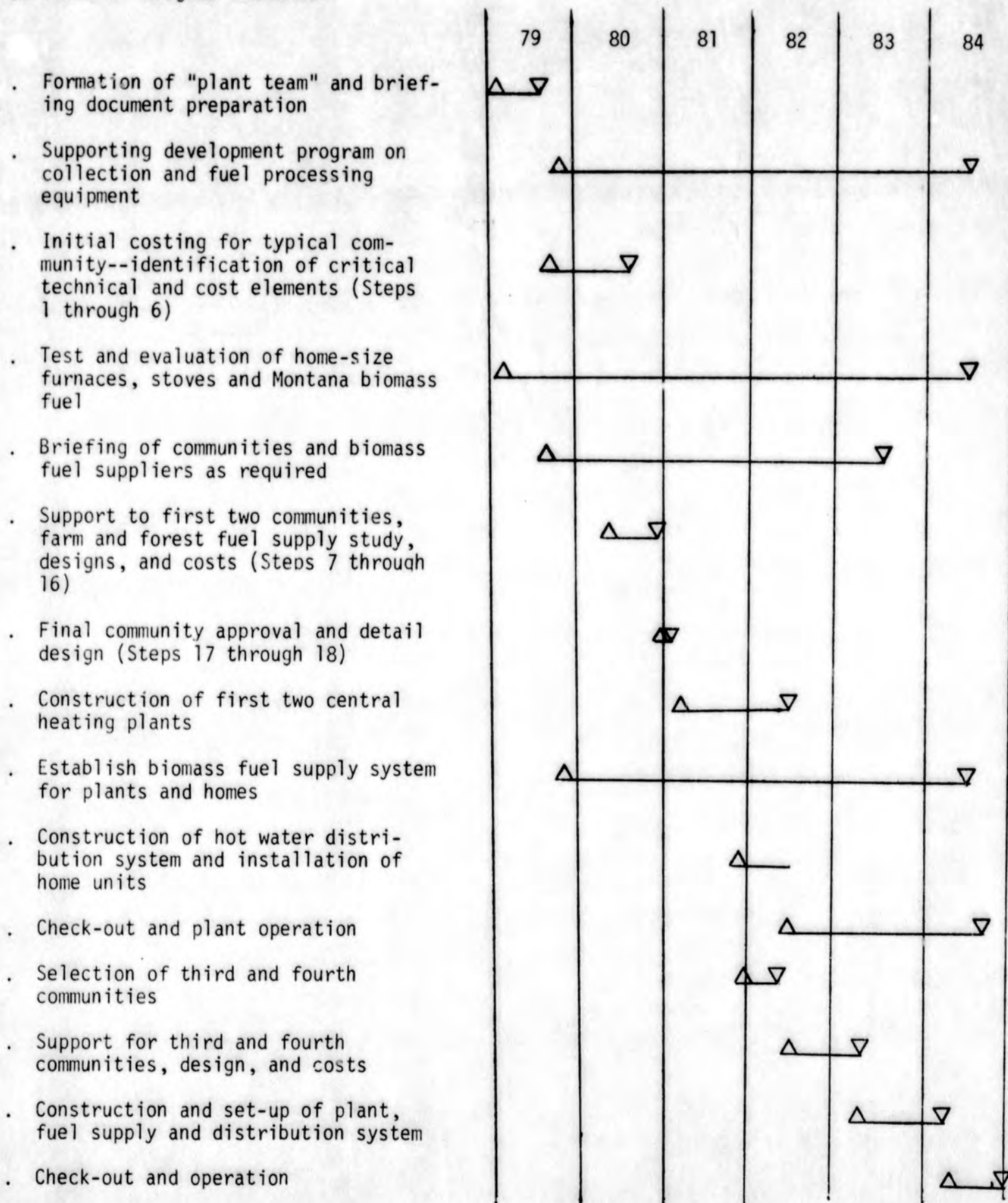
The central heating plant concept may be in the area of a community utility. The legal implications of this need to be fully explored.

If new farm/forest equipment is required, Montana firms or national farm equipment firms should be encouraged to establish manufacturing plants in Montana for this equipment.

Tax incentives to businesses supplying renewable fuels could be considered.

Schedule and Cost

Schedule of Program Elements



Major Cost Categories by Years (Dollars in Thousands)

	79	80	81	82	83	84
. Biomass combustion plant team	350	350	300	300	200	200
. Test and evaluation of home-size units and fuels	200	200	200	200	100	100
. Plant and distribution system design	0	0	145	0	400	0
. Plant and distribution system construction (additional financial support from communities required)	0	0	1200	1650	2550	4850
. Biomass fuel supply equipment development	60	150	200	225	160	150
. Support to fuel supply "companies"	40	100	150	175	200	100
Total Cost	650	1355	2195	2450	3610	5400

It is proposed that the yearly costs are shared between state and federal government at a one to five ratio.

BIOGAS GENERATION SUBPROGRAM

Introduction

There has been national and international interest and activity in the generation of biogas (approximately 65 percent methane, CH₄) from municipal sewage and animal manures since before World War II. Both community and large dairy farm size facilities exist in the United States. In addition, units down to the size of 50 pounds of manure a day exist in other countries. Biogas generation is not in widespread use in Montana; however, there are numerous facilities in other northern states.

The DNRC has supported a study on the potential in Montana for biogas generation, and there appears to be three sizes of facilities. The smallest is for the generation of a few hundred cubic feet of methane per day for home and farm/ranch building space and hot water heating. The next larger unit is that associated with a dairy or cattle feeding activity and would use the manure from a few hundred cattle to supply the gas for all heating needs for the activity and surrounding homes or small businesses. The last facility is one that would use municipal waste and possibly agricultural or forest residues. Montana communities without natural gas service and with additional biomass residues are the most likely candidates for the first facilities of this size.

Available Technology

The basic principles of biogas generation or methane fermentation, also called anaerobic digestion, are widely used in modern sewage treatment plants and involves the decomposition of organic matter in an oxygen-deficient atmosphere. The process involves three stages: first the proteins, carbohydrates, and fats are dissolved; next, non-methanogenic bacteria convert

the soluble organics into organic acids; and last, methane-forming bacteria reduce the organic acids and other oxidized compounds to methane (CH_4) and carbon dioxide plus traces of other gases. The process is usually maintained at 95°F for optimum performance but biogas can be generated between 40°F and 140°F. The equipment required is simple: feed mixer, pumps, piping, and reactor tank. The overall conversion efficiency is dependent upon the degradation of the volatile feed material and for certain materials and facilities it is as high as 60 percent.

In addition to the biogas produced, the degradation of the feed material can transform the organic nitrogen into ammoniated nitrogen to yield a more stable residue for application as fertilizer or soil conditioner. For the small ranch or farm digester, with cattle manure used as the feed stock, the process improves the value of the manure as fertilizer.

Additional research into the digestion process and economic analysis of components and different combinations of feed-in and fertilizer-out are needed before the optimum designs for use in Montana will be known for small size facilities. Design and cost information are better known for community size sewage facilities.

Program Tasks

The majority of the program activity will be directed toward the farm, ranch, cattle feed lot, and dairy farm use. In the area of large facilities, a study will be made of communities for municipal size biogas generation. The key elements of the study will be the community need and the additional biomass waste available. Adequate large scale technology exists so that minimum research and development is required. Design trade offs with emphasis on total system costs, including community participation, will be performed.

Selection will be made of one community in Montana for the construction of a biogas generation facility and methane distribution system. As in the other community scale renewable energy subprograms, the community will make the final decision and state financial support will be limited to system studies, design, and up to 90 percent of the actual cost of construction.

In the range of the middle size facilities, support will be provided for two facilities. Hopefully, one dairy farm and one feed lot size facility can be found. Interested individuals and organizations will be asked to submit a request for consideration. The program will provide initial design and cost estimates as requested. The selection of the two facilities to be supported will be based upon the applicability and appropriateness of the facility as a demonstration in Montana and the amount of construction cost sharing provided by the owner. Additional research and development of components and processes may be required in support of specific design problems during the course of this segment of the program.

For the small scale farm or ranch digester supplied by 25 to 100 cows, a development program is necessary. At the present time, the most appropriate design for the Montana environment and farming practices is unknown.

Trade off studies followed by equipment development and testing need to be performed. Such questions as the relative benefits between insulation and digester heating during cold weather operations must be answered. The correct digester size as a function of feed and service time, fertilizer use, and methane gas need must be determined. Flexibility in digester loading is important so that variable output can be obtained from any one design. The number of designs and the interchangeability of components between designs must be considered so that advantage can be taken of mass production.

Information will be collected and analyzed from Montana farmers and ranchers to determine the appropriate design for maximum use in the state. From this information, a design will be developed that will emphasize minimum total system cost. The labor in feeding the digester series of digestors will be manufactured and tested, and during the course of the program three models will be made. Each succeeding model will include design improvements. Two digestors using the first design, five using the second, and finally twelve using the final design will be manufactured and tested. Farmers and ranchers will be asked to participate in all testing. The necessary test instruments and digestors will be provided at minimum cost for the first two models. Additional cost support will be expected from the farmers and ranchers who are selected for the twelve digestors made with the third design.

An important factor that must be considered is that the capability for commercial manufacture of the digester, once the best design has been determined, must also be developed during this program. In addition, design engineering capability in the state must be developed for the larger biogas systems through this program.

Additional Issues

The community size waste facility that generates and distributes methane from biomass and waste will be a "utility". Under the present state laws, this could be a problem.

There are research and development activities in biogas throughout the country and the world. This program must keep pace and make use of appropriate results from this extensive work.

Schedule and Cost

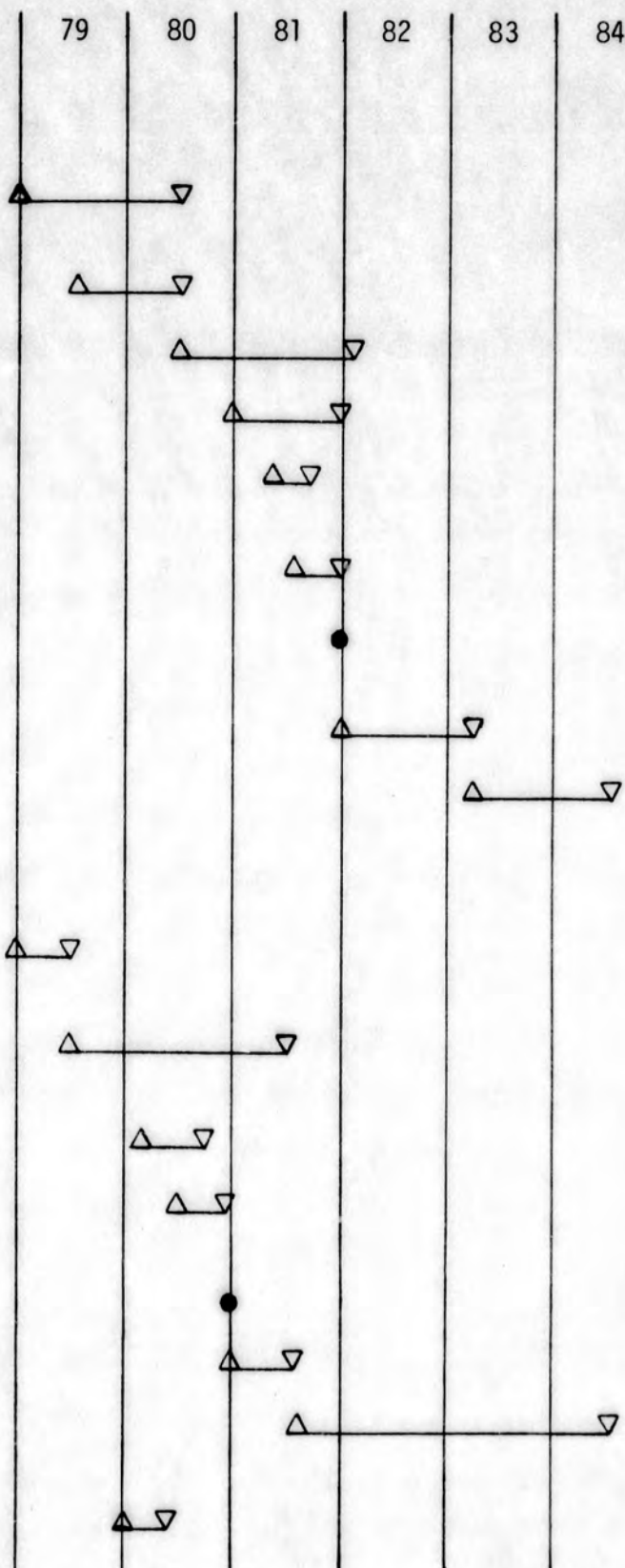
Schedule of Program Elements

1. Community methane generator

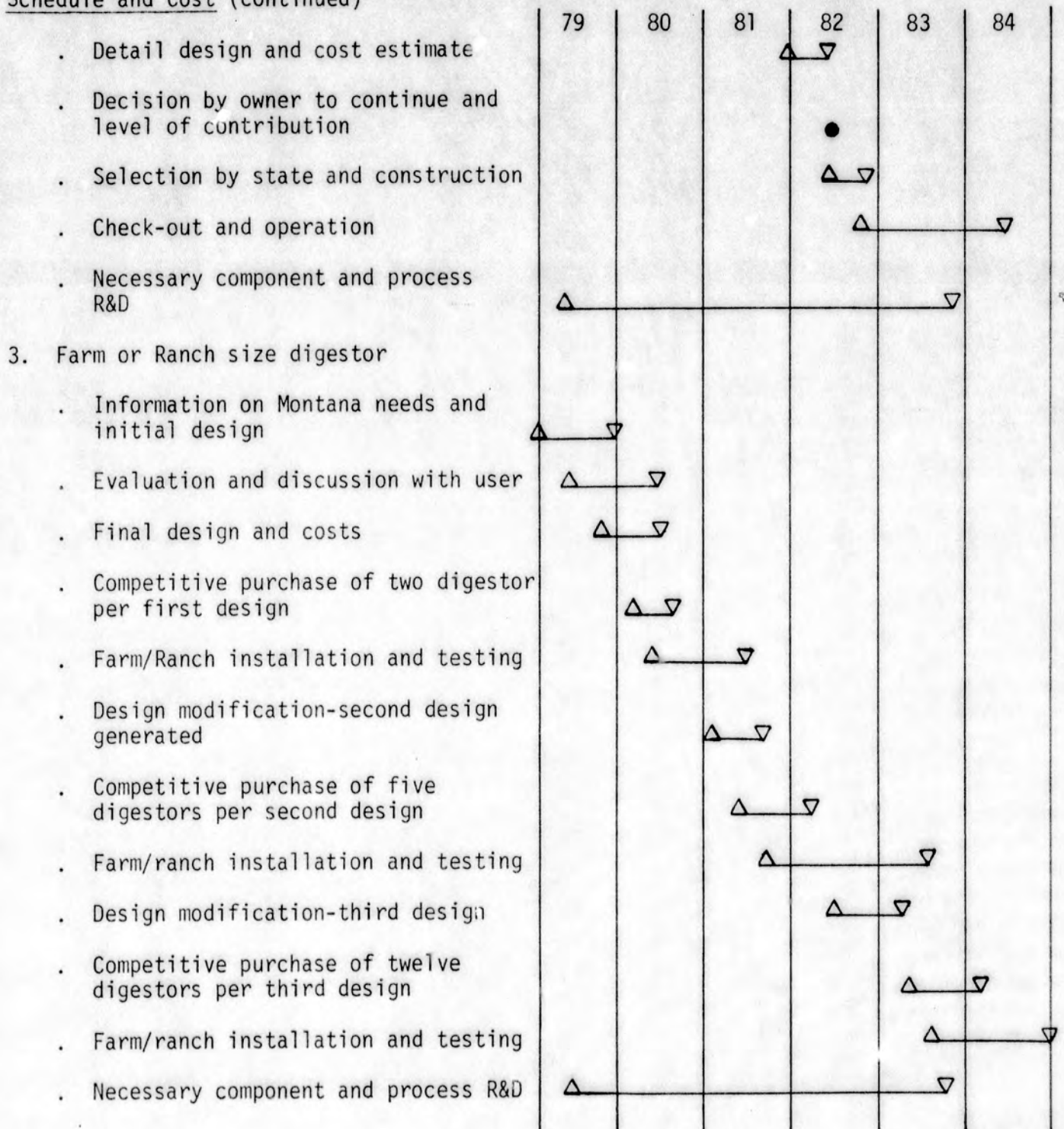
- . Survey of possible sites in Montana
- . Initial designs of possible sites, cost estimates
- . Community participation and input
- . Community design to continue
- . Selection of site by State
- . Final design and operational cost estimates
- . Community decision to continue
- . Construction of facility and distribution system
- . Check out and operation

2. Feed lot/dairy farm facility

- . Initial design of typical facility for Montana
- . Request by owners for biogas facility
- . Selection of two possible sites for first installation
- . Detail design and cost estimates
- . Decision by owners to continue and level of contribution
- . Selection by state and construction
- . Check-out and operation
- . Selection of two possible sites for second installation



Schedule and Cost (continued)



Costs (Dollars in Thousands)	79	80	81	82	83	84
1. Community methane generator	50	65	120	500	290	100
2. Feed lot/Dairy farm facility	75	85	155	190	205	200
3. Farm or Ranch size digester	75	150	175	210	190	300
Total Cost	200	300	450	900	685	600

WIND ENERGY SUBPROGRAM

Introduction

The Department of Energy's wind program has received increased funding during the past years and has \$60 M for FY79. The major objective of the national program is developing the technology for small and large wind generators and the methodology for wind energy assessment. Montana can benefit from the "base" provided by the national program, but in order to make wind generation a reality in Montana, much remains to be done. It is not realistic to expect private investment to cover all of the costs.

Presently, wind generators cost anywhere from \$300 to \$2,000 per rated kilowatt generated (depending upon rated output and design wind speed) plus installation costs. One important reason for this cost is the limited number of wind generators manufactured to date and the "handcrafting" of the components. During the past few years, less than 100 wind generators of greater than 15 KW capacity have been manufactured. Comparing the technology, individual components, and operating environment of a wind generator to that of other systems that are mass-produced, the present prices of the few available models seem higher than would be necessary under mass production. If generators were sold at \$200 per kilowatt, a 25 KW generator costing \$5,000 installed at Great Falls would generate \$2,000 in electricity @ 2¢ per KW/hour in an average year.

A relatively small amount of state funds can stimulate the wind electric generator industry in Montana and establish a leading position for the state in the manufacture of wind generators in the United States. Once

established, this manufacturing capability would have as its marketing area the northern Rocky Mountains and Great Plains region--an area in the United States that represents a significant wind energy region--and one which may be exploited first due to the existing land ownership patterns, established electrical grid network, and the large amount of hydroelectric generation.

Contributions to the wind program have been made by previous Department of Natural Resources and Conservation (DNRC) funded projects. Limited wind potential assessment, measurements, wind generator manufacturing, and small-scale wind generation operational experience has been gained. The U.S. Department of Energy's (DOE's) wind program has advanced to the point where Montana can take advantage of the program results. This coming year, 1979, is the time to expand the wind program in Montana because of the status of the federal program and the projected electric energy needs for Montana by the mid-1980's.

Resource Assessment

The United States DOE has estimated the average annual wind energy potential in Montana as 250 to 400 watts per square meter of wind.¹ Projecting this into electrical generation capacity and using only one percent of the land area in Montana, over 5,000 MW could be generated. As a comparison, the feasible extraction limit of wind energy within the United States for the generation of electricity has been estimated to be equal to the total energy used in the United States in 1977.²

¹ BNWL-2220 Wind 5, July 1977, Battelle Pacific Northwest Laboratories.

² "Wind Energy Resource Parameters," M. R. Gustavson, Proceedings: National Conference on American Wind Energy Association, March 1978.

The wind potential in Montana is divided into two general regions. Western Montana is characterized by high peaking winter winds; whereas, the winds in eastern Montana are more constant throughout the year. The western region wind energy will combine well with hydroelectric generation, which peaks in the summer, to provide a year-around renewable energy resource. In western Montana, existing and small-scale hydroelectric (either low or high head) projects for which the technology exists can be developed to match a portion of the wind-generated electricity. Significant wind energy exists in eastern Montana, although in general, the yearly average is less than for western Montana. As an example of the potential, Glasgow in northeastern Montana has approximately 70 percent of the wind energy potential of Clayton, New Mexico, the site where the DOE installed their first large generator. Wolf Point, Montana has almost 80 percent of the Clayton site. Current studies are underway by the Corps of Engineers to use hydroelectric generation as peaking electricity. This concept would work well with a large wind generation system.

The area along the Yellowstone River between Livingston and Big Timber has been rated by DOE as the number two area in the United States for wind energy potential. Whitehall and Great Falls are also rated in the top twenty-five in the United States.³ This rating was established by using data from weather stations and is limited to fourteen towns in Montana. Additional data from utilities and the USDA is also available. Information must be gathered from every county in Montana with suspected adequate wind

³ "Wind Power Climatology of the United States," Jack W. Reed, SAND74-0348, Sandia Laboratories Energy Report.

energy to generate electricity. This will be done early in the program to further expand the existing data base. Only the better sites will be selected initially for the installation of generators to provide a maximum available positive cost "cushion" for the first wind systems. Once design, fabrication, and operational improvements have been made, systems can be installed throughout Montana at sites with lower wind energy potential.

The table below gives the average annual wind energy from the 14 sites listed for Montana.

Montana Average Annual Wind Energy

<u>Site</u>	<u>Watts/Meter²</u>	<u>Maximum Month</u>	<u>Minimum Month</u>
Glendive	149.5	222.0	111.4
Miles City	115.2	161.9	87.8
Wolf Point	179.9	326.4	124.2
Glasgow	133.0	198.6	101.7
Billings	173.9	237.2	99.0
Livingston	500.5	1058.7	233.7
Lewiston	140.8	198.4	82.4
Havre	114.7	155.4	74.9
Great Falls IAP	304.5	509.4	136.3
Great Falls Malstrom	169.3	263.8	80.1
Helena	90.6	145.5	34.9
Whitehall	344.7	710.4	167.7
Butte	104.8	158.7	76.8
Missoula	50.1	75.8	19.5

The extreme western portion of Montana probably has low wind energy potential in the valleys but could have significant wind potential on mountain ridges or at elevated heights. These sites may not prove economical because of high siting costs.

Commercialization

It is important to understand what is meant by commercialization of wind or any other energy source.

Within the Northern Great Plains and Northern Rocky Mountain region there are projections for increased electric generation capacity of 5,000 to 20,000 MW and greater by the year 2,000.⁴ "Commercialization of wind" encompasses a plan and program that will enable wind-generated electricity to provide as much of this increased capacity as possible. To be competitive with other generating systems, the cost of wind generators at the factory must be close to \$300 per kilowatt in 1978 dollars since wind generators have a lower capacity factor than conventional generating facilities. A typical design objective for a wind generator would be to obtain a 40 percent utilization for a "standardized" average 12 mph wind.⁵ Higher capacity factors at lower average winds are possible, but the cost per kilowatt generating capacity would be higher. There are cost advantages for wind systems--low site construction costs, shorter construction periods, and no fuel cost--all of which will be needed in order to make these systems competitive, especially with mine mouth coal generating plants. Cost disadvantages include higher maintenance costs due to number of units and their dispersed locations and higher utility grid hook-up costs. The initial capital cost per kilowatt generating capacity must be low, and this can be greatly enhanced by mass production. As pointed out earlier, wind generation

⁴ BPA and Missouri River Basin Estimates.

⁵ Design Study of Wind Turbines, 50 KW to 3,000 KW, ERDA/NASA/9403-76/2, General Electric Company, December 1976.

couples best into a generation system that has a high percentage of hydro-generation. This coupling can enhance the relative value of both systems.

Thus, commercialization includes the establishment within Montana of the capability for wind energy assessment, manufacturing, installation, maintenance, repair, and energy utilization. This must be done in great part with private resources; however, the state can stimulate and support the critical early market for wind generators when the cost per machine is high and the generation is a marginal economic activity. In addition, commercialization includes establishing the acceptance of wind generators in Montana and encouraging the purchase of generators by individuals and utilities. If one assumes a figure of one man-year of manufacturing per 100 KW and one man-year of installation, control, maintenance, and repair per 10 MW generating capacity per year, along with the assumption that 5,000 MW would be manufactured and installed in Montana and neighboring states, then a significant economic return is possible. The manufacturing and support businesses for this number of wind generators would generate about 3,000 jobs that would continue through the year 2,000. The last element of commercialization is insuring the landowner benefits directly and adequately as a function of the generated energy value, and not simply for bearing the inconvenience of the generators on his land. A statewide generating system selling power throughout the region could generate revenue for Montana farmers and ranchers.

Technical Program

There are two major divisions in the technical program because of the wind generator size--a farm or ranch size $\sim$ 25 KW and a utility size from 250 KW to a few megawatts. The final size/sizes will, of course, be determined by those sizes that provide the highest economic return. One major objective of the program must be to determine the optimal sizes for these two major uses. The current U.S. DOE sponsored designs for 40 KW generators probably represent the largest size a farmer can install with minimal help and maintenance by himself. This size generator is similar in size and complexity to other farm equipment. The large utility size in the few hundred KW to megawatt capacity will also be heavily influenced by the advantages of mass production, installation costs, total wind farm reliability, and small crew maintenance costs. The important point to remember is that, while for each specific need and location there will be an optimum size, customized generators cannot be manufactured at low cost. What is the best for Montana must be determined early in the program.

Wind Energy Assessment

The DOE has collected and evaluated the recorded wind energy measurements from the National Weather Bureau and other government and private agencies. The result of this evaluation is that Montana appears to have a significant wind potential; however, these measurements are not of sufficient detail and accuracy to establish the good sites and the economic return from wind generators. A statewide effort to measure the wind energy in every county is needed. Twenty-five portable self-contained anemometer

systems, using 10 meter towers, will be purchased. These small towers will be moved around the state, and within a four-year period can map the wind energy potential with sufficient accuracy to establish the economic feasibility of farm and ranch size units. These stations will be installed by a combination of professional and local people with routine maintenance and data tape collection performed by local personnel. The high school science departments will be asked to participate in the program. All data will be reduced and evaluated at a central facility.

In addition to the 10 meter towers, five 30 to 50 meter towers, instrumented at two levels, will be installed at prime high wind sites across the state to determine the wind velocity profile and energy at potential utility wind farm sites. These towers will be installed and maintained by professionals, and this data will also be processed at a central facility. The first year of wind data will also be used in generator design and size selection.

Within four years, this mapping of the wind energy potential of Montana will provide the most comprehensive wind data base for any region in the world; however, it is just the minimum required to adequately assess the potential, design wind generators, and determine the essential electric generation economics for a region the size of Montana. In comparison with petroleum and coal exploration, projected costs for wind energy assessment are significantly less for the potential energy return.

Operational Objectives

No basic research program on wind generators is proposed because this is being done under the federal program. The federal program is also supporting the manufacture of wind generators from a few kilowatts to megawatt capacity. The Montana program objective is to use this base created by the United States DOE and address specific technical and operational problems in Montana so that the economics of electricity generation on the farm and ranch and by utilities can be established. At the same time the economics are being determined encouragement and support will be provided to industries in Montana, so that once the optimum configurations and sizes have been established, production can be initiated. It is felt that only by using mass production methods will wind electric generators ever become competitive with conventional generators and be used for any more than remote site operations.

As mentioned previously, one question that must be answered is the proper generator size for the individual Montana ranch. A single generator size is not essential, but the fewer the number of models, the higher the return from mass production. In addition to generating capacity, the size will be influenced by installation and maintenance costs. It is also important to determine what size generator can be handled by the farmer/rancher and his help. The maintenance expense is one of the high costs of wind when compared to conventional systems. If this can be done by the land owner, in addition to his other work, wind electricity generated on the farm or ranch can be more competitive. It is necessary to test various wind generator

systems in Montana in order to determine the correct sizes and the maintenance costs and requirements. The correct generator size for the utility wind farms is a similar problem and must be determined by considering the same factors. Experience in the Montana environment is essential to determine operating costs in Montana.

An equally important factor is to determine the utility interface requirements for safety, local monitoring, control, and switching. The degree of difficulty will be different for each utility, although many technical problems will be common. Collection and distribution problems of each rural utility and its supplier must be worked out. In the next ten years, wind generated electricity can become a significant part of the rural utilities source; however, it will not be the most important source. The existing sources will still be the most important; therefore, the wind electricity must be smoothly worked into the existing system. The conventional generating and interconnected distribution system, along with wind generators located at the other sites, will provide the back up or storage system when the wind is not blowing in a specific location.

The purchase and installation of generators must be so scheduled that it answers the technical and cost questions and supports the development of the manufacturing and supporting businesses required to establish a wind energy industry in the state. Therefore, the operational objectives cannot be separated from statewide business objectives. Preference will be given to Montana-manufactured machines, and thus, out-of-state manufacturers will be encouraged to establish facilities within the state. Tax and other incentives should also be considered.

The first systems purchased will be thoroughly instrumented and detail operational maintenance and performance records maintained. Overall performance and economic value will be evaluated. This information will be made available to the manufacturer for any necessary corrective action. A series of machines will be purchased over a three-year period so that the manufacturer can plan and make improvements from model to model. At the end of the three-year period, it is planned that sufficient model iterations and numbers will have been manufactured so that mass production designs and costs are known, and the manufacturers can go into mass production.

Farm/Ranch Program

Over the three-year period, 40 to 60 farm and ranch size wind generators will be purchased from at least two manufacturers. The initial generators will be purchased and installed using 100 percent state funds. By the end of the program, the landowner will be expected to pay a small portion of the purchase price and all of the installation cost. DNRC has already supported one Montana manufacturer, and his generator will be installed this fall on a ranch or farm in Montana. During the three-year period, three to four model iterations should be possible with each model becoming less expensive. After the operational tests, each generator will be evaluated on performance and cost. The manufacturers with the most successful generators will be funded for newer models. The poorer performing generators will have to be improved at the manufacturer's expense and will be tested again under the state program if requested by the manufacturer.

The state will be establishing and developing the product and market by the continued refinement of the operational and performance specifications

for the machines purchased. This is an extremely important responsibility since it will define the characteristics of the generator the manufacturers are in a position to mass produce at the end of the program.

The federal small wind generator program being conducted at Rocky Flats in Colorado includes the purchase, testing, and evaluation of generators in the one to 100 KW range. The winds of the Rocky Flats site are such that frequent high stress conditions are induced; however, sustained moderate winds are not typical. An expansion of this federal program will include the purchase of two machines per state for testing within each state. Montana will participate in and benefit from this program. It is not DOE's intent to solve all the state specific problems with such a limited program, but rather to provide public wind generator awareness and visibility. The federal funds are doing much to stimulate manufacturers across the country, the Montana program will do even more and may cause some to move to Montana.

Utility Program

The federal large wind generator program supports the manufacture and testing of 200 KW and 2 MW generators. Five of the 200 KW size generator sites have been selected and have been or will have generators installed soon and a two megawatt size is scheduled for testing. All of these are government purchased machines with utilities sharing the cost of operation and testing. The testing and demonstration of large wind generators in Montana must be coordinated with the federal program. At the present time, there are no federally funded programs for the testing of large wind generators in Montana.

The critical unknowns in any utility size wind generator "farm" concept is the operational cost and total system reliability. Under the present federal program, there are no plans to develop this information anywhere in the United States, much less in a region with an environment similar to Montana. The Bureau of Reclamation has a plan to install up to five 2 MW size generators at Medicine Bow, Wyoming in the 1985 time period. Information from this project will come too late to be used in satisfying Montana needs; it may not have the most cost effective size generator, and it will not have an adequate number of generators to determine true "farm" operational and maintenance costs.

There is a problem of how to determine the most cost effective large size generator for a utility system. The larger machines are quoted at a lower price per kilowatt, although only limited numbers have been manufactured. There may be an advantage in purchasing large generators; however, the expense to determine the representative wind farm operational costs will be very large if 20 large 2 MW generators are used. The "utility" program proposed is to install a couple of 2 MW generators to determine the operational characteristics in the Montana environment, and a larger number of 200 KW machines to determine the total wind farm system costs. A federal agency will be sought to finance a majority of the cost of this program element. Utility participation will also be encouraged.

A 5 MW size wind farm using 200 KW size generators is proposed so that answers to some of the critical questions may be determined. This is the size of generator currently being built by the DOE and the large size wind

generator with the largest number manufactured to date. In order to have the government participation in the first wind farm in Montana, the site selected should be associated with government electricity generation. Areas of greatest potential are Ft. Peck Dam, Gibson Dam, Tiber Dam, or Yellowtail Dam. Studies are underway at all four sites for expanded electric hydro-generation (Gibson and Tiber have none at the present time). The wind energy potential is known only for the Ft. Peck Dam area; although from the surrounding terrain and climate conditions, Gibson, Tiber, and possibly Yellowtail could have significantly greater wind potential. Installing 5 MW capacity using the 200 KW size machines can be done sooner and cheaper than the proposed Bureau of Reclamation Medicine Bow demonstration. An extensive effort will be made to interest the government into installing a 5 MW wind farm in Montana as the first step in the utility program. In addition, a request will be made in conjunction with Montana utilities to the DOE to install two of their 2 MW generators at known high wind potential sites in Montana.

Once production and operational costs have been established in the Montana environment, the utilities can be expected to show interest if these systems are competitive with conventional generating plants. Wind farms can be constructed, generator by generator, and therefore have a gradually increasing generating capacity which is an important construction cost advantage. The direct financial contribution that can be made to the utilities under this program to establish their own wind farm is limited to wind energy assessment and system studies; however, tax and rate incentives

to the utilities are surely of interest and should be considered. The utilities should be encouraged and assisted in establishing 200 to 250 MW of generating capacity by the 1983 time period. As electricity demand grows, new installations should follow quickly at the prime sites across the state once wind electric generation has been proven competitive.

Site Selection Methodology

Any major utility wind farm will come under the state Major Facility Siting Act, and utilities would be expected to comply with this act and the established procedures. The proposed small government wind farm will be located at a site selected by the participating government agency. The individual farm or ranch size wind generator program has different site selection problems and would not come under the Major Facility Siting Act. The initial wind generators will be located on farms or ranches with high wind energy potential and where the performance monitoring costs will be minimized. In the early stages, a significant amount of "professional" time will be required at these installations. The farmer will be expected to contribute some time in routine maintenance. Later in the program, lower wind potential sites will be selected, and more contribution by the land owner will be expected. In general, in the early phase, specific ranchers and farmers would be asked to allow wind generators on their ranches or farms, and toward the end of the program, interested farmers or ranchers would "bid" for wind generators by sharing in purchase and installation costs and in operational monitoring and maintenance.

Farmers and ranchers have been used throughout in the program description; however, it should be noted that all land owners would be equally considered.

Additional Issues

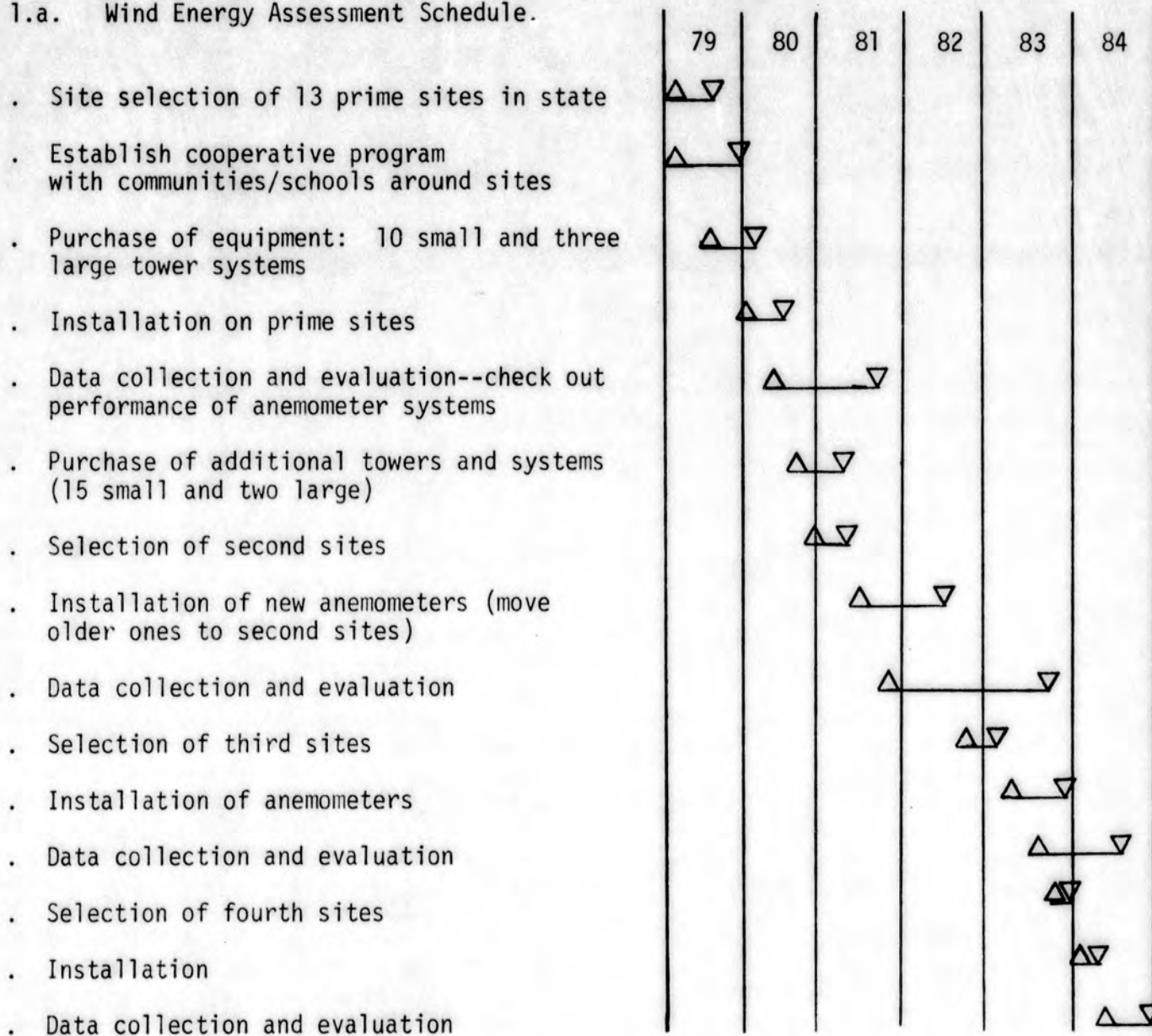
Certain legal, technical, and economic issues can significantly contribute to the wind program. These are:

1. Early identification and selection of the optimum size for the wind generators. This will focus the manufacturing effort which at the present time is considering generators from 1 KW to 3 MW.
2. Wind right laws. Who owns the wind; is it similar to sun rights or water rights?
3. Possible tax credit for wind generator electricity purchase and use.
4. Possible requirement for utilities to first purchase farmer or rancher generated electricity at a fair return to the landowners and at a fair price to the utility recognizing their real costs. Some specific rate structure for wind generated electricity might be considered.
5. What are the environmental effects, visual, etc.?

An early favorable resolution of these issues could certainly enhance and benefit the proposed program.

Schedule and Cost

1.a. Wind Energy Assessment Schedule.

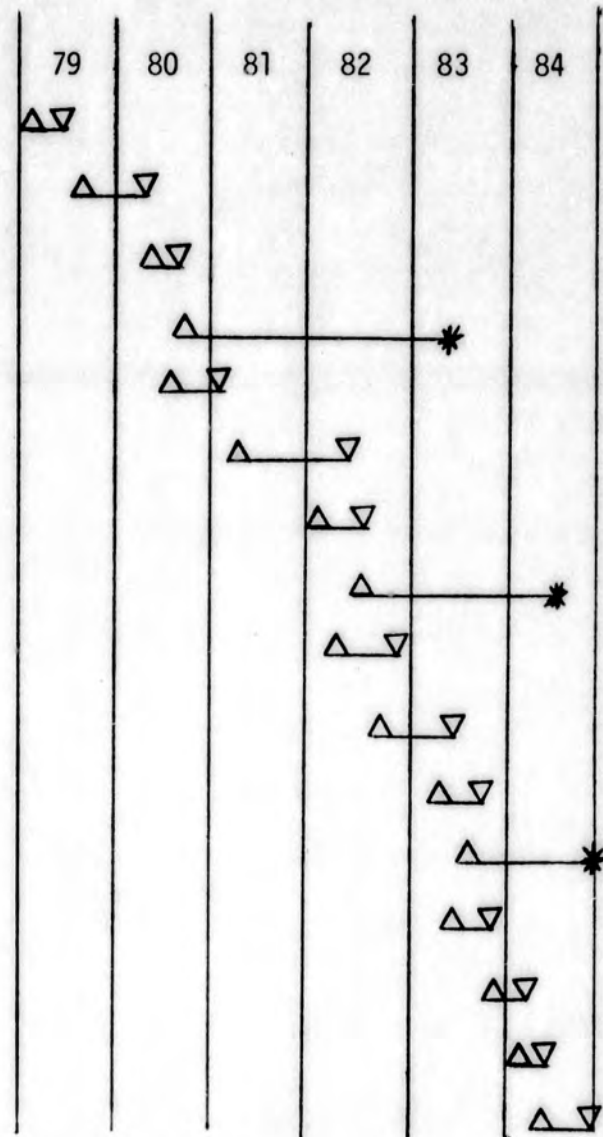


1.b. Wind Energy Assessment Cost. (Dollars in Thousands)

	79	80	81	82	83	84
Site selection, data collection and evaluation	90	140	200	200	200	60
Anemometer and tower equipment cost	105	100	90	0	0	0
Equipment installation and maintenance	40	40	110	150	100	40
1.b. Total Cost	245	260	400	350	300	100

2.a. Farm/Ranch Program Schedule.

- . Develop generator specifications
- . Purchase 5 generators (1st model)
- . Installation
- . Test and demonstration
- . Develop Specifications for 2nd model
- . Purchase 10 generators
- . Installation
- . Test and demonstration
- . Develop specifications for 3rd model
- . Purchase 20 generators
- . Installation
- . Test and demonstration
- . Develop specifications for 4th model
- . Purchase 20 generators
- . Installation
- . Test and demonstration



* indicates end of state funding support, land owner required to continue supplying performance data for two years.

2.b Farm/Ranch Program Costs
(Dollars in Thousands)

	79	80	81	82	83	84
. Develop specifications and monitor performance	60	120	150	200	250	50
. Purchase of wind generators	90	150	250	325	470	225
. Installation and maintenance	70	70	100	200	130	180
2.b. Total Cost	220	340	500	725	850	455

3.a. Utility Program Schedule

Montana Federal Site (5 MW @ 200 KW each)

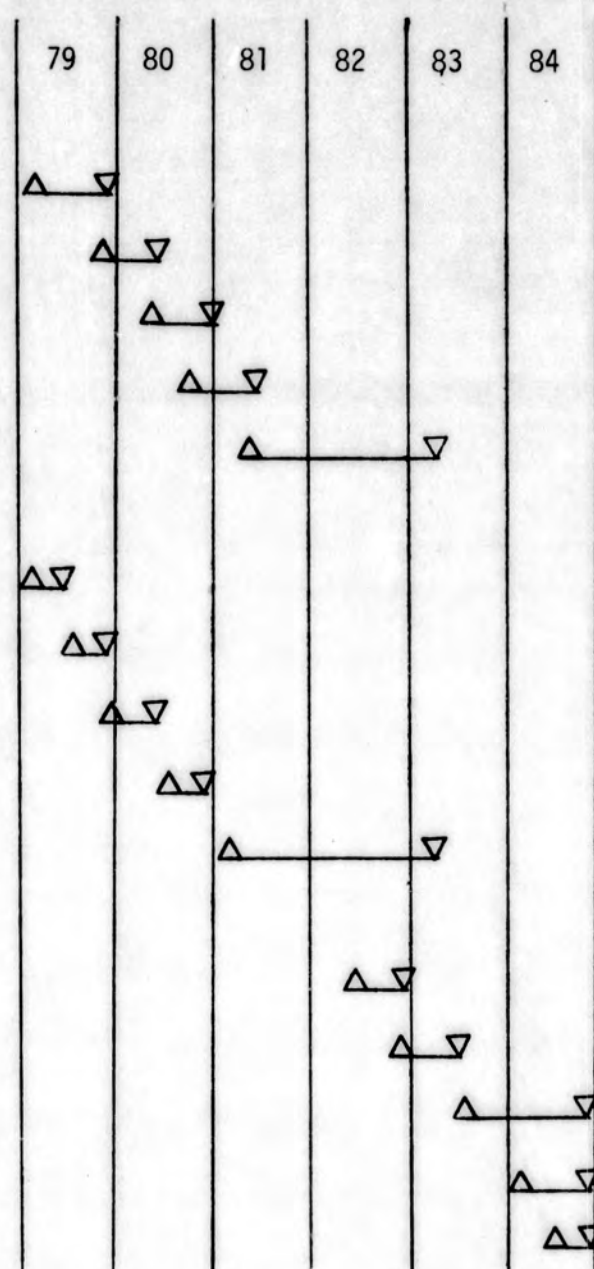
- . Site selection
- . Site design
- . Manufacture of generators
- . Installation
- . Testing

Montana Utility 2 MW Site

- . Site selection
- . Site design
- . Manufacture of generator
- . Installation
- . Testing

Montana Utility (25--200 MW Site)

- . Site and generator selection
- . System design
- . Manufacture of generators
- . Installation
- . Generation



3.b. Utility Program Costs (Dollars in Thousands) State Funds Only

- . Participation in site selection, design, and generator selection
- . Site evaluation

3.b. Total Cost

Total Cost 1.b. + 2.b. + 3.b.)

	79	80	81	82	83	84
. Participation in site selection, design, and generator selection	75	90	75	75	50	0
. Site evaluation	85	90	75	50	0	0
3.b. Total Cost	160	180	150	125	50	0
Total Cost 1.b. + 2.b. + 3.b.)	625	800	1050	1200	1200	555

GEOHERMAL SUBPROGRAM

Introduction

The use of geothermal heat, usually directly from hot water or steam, is considered to be a renewable energy resource. Whether or not this is true depends upon the source, the period of time, and the use rate. The heat content of the earth's near surface is certainly very large, and if the water resource is not depleted by use, the energy resource available is large compared to conventional nonrenewable resources.

The present United States Department of Energy (DOE) geothermal program is structured more closely to the needs of Montana than any of the other federal energy programs. There is an extensive effort in resource assessment and, even more significantly, in geothermal demonstrations. Use of geothermal hot water for space heating is widespread around the world, although not extensive in total amount of energy delivered. One of the earliest modern commercial residential systems is that of Boise, Idaho, which was established in 1890. This geothermal resource has been selected along with other across the United States (Warm Springs State Hospital in Montana) as a demonstration project for expanded use of geothermal resources. In addition to space heating, the DOE is interested in supporting demonstration projects in agricultural and industrial use of geothermal resources.

Montana possesses significant, known geothermal resources, and there is a high probability that larger resources are available across the state. The surface flow rates of the hot springs vary from a few gallons per minute to a thousand, with temperatures of up to 180°F. The potential for artesian hot

water wells is also high, especially in eastern Montana. There is need for continued assessment of the geothermal resource throughout the state.

In addition to assessment, there is a need for additional geothermal demonstrations of community space heating and agricultural or industrial applications. These demonstrations should be dispersed as widely as possible across the state; however, recognizing that the geothermal resource must be matched with a local use requirement, the Montana program objective is to select at least one community space heating and one agricultural or industrial use demonstration. In selecting sites, it is important to consider that a geothermal resource can be expanded by the use of direct biomass combustion, and therefore, the proximity of a biomass resource could be considered.

Demonstration Technologies

There are few technical unknowns that will require extensive research to support a geothermal demonstration. This does not imply that site specific experiments and tests are not necessary, especially in the area of material and geothermal water compatibility. Drilling and pumping (if necessary) technologies are well in hand as are those necessary for the heat distribution system. Heating and metering units are available for space heating requirements. The specific subsystems that would be required for any agricultural or industrial use may or may not be available; therefore, some R&D may be required.

Resource Assessment

The location of many hot springs are known in Montana with sufficient water flow and temperature such that they could be used for a low grade heat source. In addition to flow rate and temperature, another important parameter is the dissolved solid elements and amount. The surface conditions do not necessarily represent those present at distances below the surface, specifically the water temperature is considerably higher. This probable temperature increase significantly enhances the energy potential of a geothermal resource.

Three specific examples of hot springs in Montana are at Bozeman, Ennis, and Springdale. The surface output of these springs are:

<u>Place</u>	<u>Flow Rate</u>	<u>Temperature</u>	<u>Solid ppm</u>
Bozeman	30 gpm	130°F	436
Ennis	20 gpm	181°F	1030
Springdale	1315 gpm	139°F	268

For each of these springs, it is expected that there would be significant additional flow at increased temperature from wells drilled in the spring area. The projected available Btu output on a continuous basis for each of these three sites is over 10^8 Btu/hr which is equivalent to 700 gallons of gasoline per hour.

In addition to hot springs like these, there are known artesian hot water resources in the Madison formation in eastern Montana. Some gas and oil wells drilled in this region have been hot water producers. Insufficient detail information is known on the underground water resources and temperatures, although projections have been made that indicate a significant resource.

As an element of this program, detail evaluations of known sites and analysis of oil and gas well information across the state will be made. In regions with high potential and high possible use, exploratory wells should be drilled. The overthrust belt and Madison formations should be studied in depth.

Demonstration Projects

Once the statewide resource assessment has developed an adequate data base, conceptual studies will be made of at least two sites for a community heating and an agricultural or industrial application. From these studies, one site will be selected for each use. Beginning with the conceptual designs and throughout the project, participation by the community will be encouraged for the central heating concept. For the agricultural or industrial use, a company or individual will probably have to be identified. In both instances, a 10 percent minimum of in-kind or direct financial contribution to the project construction cost is required. As in the biomass projects, system design and costs are refined from step-to-step with the community or individual given the option of proceeding to the next step or dropping the project.

A brief listing of the step-by-step process proposed for geothermal development is given below. The concept and principle of community review, participation, and approval is carried through the program as in the Direct Combustion of Biomass Subprogram. The steps are not listed in the same detail as in the Biomass Subprogram; however, it can be seen that community

and state approval is required before any major commitment is made of the next funding increment.

1. Site resource assessment;
2. Preliminary design and initial capital and operating cost estimate;
3. Community (or company) and state decision to proceed;
4. Resource verification and development, if necessary;
5. Detail design of source, distribution, and end use systems. Up dated cost estimates;
6. Firming up of user commitments;
7. Community (or company) decision to proceed;
8. Construction of source, distribution, and end use systems; and
9. Check-out, user hook-up, operation.

Additional Issues

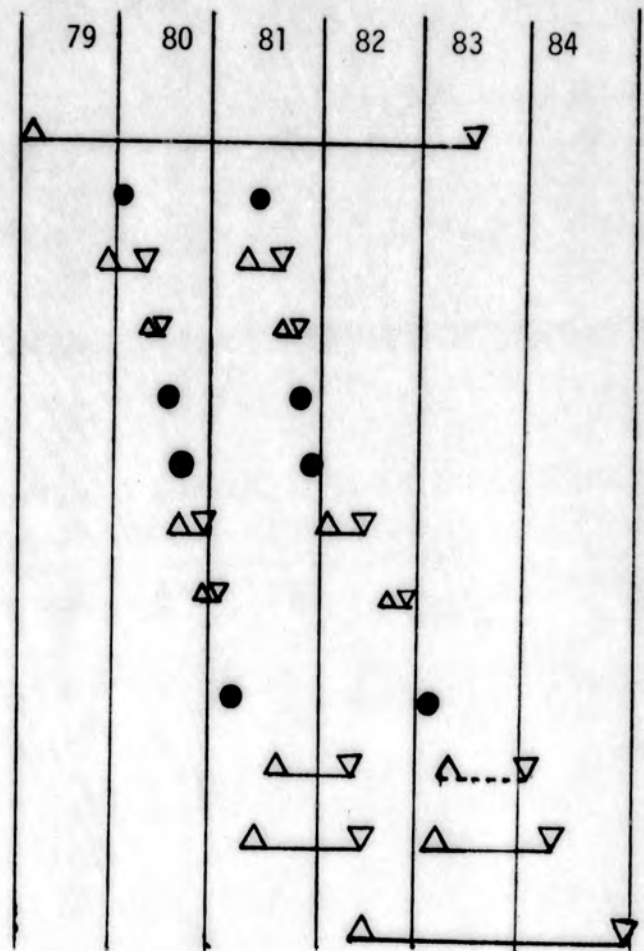
Hot springs locations in Montana have been known since the times of the Indians. The better sites have been under private ownership since the nineteenth century. Other sites, still within the public domain, can probably be found; however, the best approach may be to develop those sites already under private ownership.

Hot geothermal water is considered a water resource; therefore, water laws must be complied with. This could become a problem with any extensive use regardless of whether or not the water was reinserted into the ground. Other states, e.g. Oregon, consider certain geothermal resources as a mineral resource, making development easier.

Schedule and Costs

Program Element Schedule

- . Resources Assessment
- . Study Sites Selection (2 at each time)
- . Conceptual Designs
- . Initial Cost Estimates
- . Selection of Site by State (1 at each time)
- . First Approval by Community/owner
- . Detail Design
- . Final Construction and Operational Cost Estimates
- . Final Approval by Community/Owner
- . "Signing Up" of Customers
- . Construction of Facility and Distribution System
- . Check-out and Operation



Costs (Dollars in Thousands)

	79	80	81	82	83	84
. Resource Assessment	200	310	275	200	100	0
. Designs and Community Coordination	165	340	360	300	200	0
. Construction			1000	900	1600	400
. Check Out Initial Operation				100	100	150
TOTAL COST	365	650	1635	1500	2000	550

It is proposed that the yearly costs be shared between the state and federal government at a one-to-five ratio.

SOLAR SUBPROGRAM

Introduction

Since 1976, DNRC has supported demonstration projects utilizing solar energy. A review of these projects can be found in the Renewable Alternative Energy Program Report to the 1979 Montana Legislature. In addition, the Montana Energy Office published in May 1978 the Montana Solar Plan. These two documents cover the activities and interest in Montana in solar energy. In this section, a program is proposed that will complete the state support to solar energy use. Because of the past state support, this subprogram differs considerably from those proposed for the other renewable energies in that only a few major tasks remain, and no state funded large demonstrations are required.

Program Tasks

There are three major tasks remaining to be done in the solar program. The first is a task that is a portion of each subprogram but has not been specifically discussed in the other sections. This is the task of performance monitoring and evaluation of demonstration projects followed by information dissemination to the public. A selection will be made of the most appropriate projects around the state for instrumenting, and these will be monitored during the 1979 to 1980 winter period. The project performances will be analyzed, and the results will be published and made available to the public.

The second task is to promote the development, manufacture, and sale of low cost solar collectors for home size units. Design and material

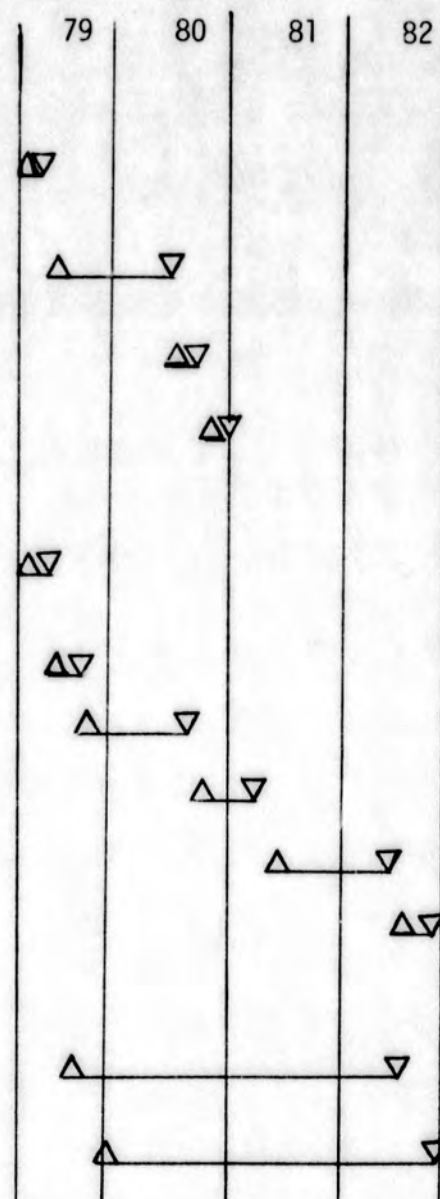
compatibility with the Montana environment must be established for low cost collectors that can be sold through local builders or hardware stores. A multi-award, competitive, phased contract program for Montana firms is proposed to accomplish this objective. At least two companies will be carried through the full program so that product selection options are assured for the consumer. Both air and liquid systems will be considered with emphasis placed on designs with low cost and mass production capability.

The last task is for the support of designs and cost evaluations of passive and active solar heating systems for private buildings and apartment complexes. No funds will be provided for the construction of demonstration projects; however, support will be given to projects interested in obtaining funding from federal agencies. There are numerous designs and projects across the United States from which valuable information can be obtained. This task will provide funds for Montana architects and consulting engineers to design and make cost estimates on solar-using facilities. The concept is to provide funds for the increase in design cost associated when solar use is considered. The present or new building owner is expected to pay all design costs associated with conventional facility design. The building owner pays all construction costs. This program provides the additional funds necessary to assess a solar option for a facility and, in addition, enhances the design skills of Montana architects and consultants in using solar energy for other customers.

Schedule and Costs

Program Element and Schedule

1. Solar demonstration evaluation
 - . Selection of solar demonstration sites for performance monitoring
 - . Instrumentation installation and measurement
 - . Site performance evaluation and analysis
 - . Publication of results
2. Solar Panel Development
 - . Development of solar panel characteristics objectives for Montana
 - . Multi-award phase one development
 - . Panel evaluation and selection for follow-on
 - . Multi-award phase two development
 - . Panel evaluation and analysis
 - . Publication of results
3. Solar "Building" use design assistance
 - . Continuing evaluation of design assistance requests
 - . Design assistance grants on selected projects



Costs (Dollars in Thousands)	79	80	81	82
1. Solar demonstration evaluation	40	50	60	50
2. Solar panel development	125	165	110	70
3. Solar "Business" use design assistance	50	65	100	85
TOTAL COST	215	280	270	205

Program ends in 1982.

SMALL SCALE HYDROELECTRIC SUBPROGRAM

Introduction

The use of water to generate electricity in Montana is widespread, and all of the possible large scale generation sites have plants or have been studied. There are many smaller dams used for irrigation or flood control which do not have generators. There exists adequate technical capability within the state to perform the required design and cost estimates to determine whether or not these sites could generate electricity economically. This program will not support this type study, but rather, it has as its objective the support of hydroelectric generators on small streams of a few kilowatt capacity for individual land owner use. The key criteria are that the maximum generating capacity is limited to 20 KW and that the electricity is for on-site consumption.

Program Tasks

This program differs in that no state funds will be used for energy resource assessment. The first task will be the preparation of an information and "how to" report for individuals interested in assessing their own small scale "hydro" resource. This report will be made available to individuals in the state at their request. After reading the report and assessing their own resources, individuals may desire to make application to the state for assistance in establishing a small scale hydroelectric system. Program assistance is limited initially to design and total system cost estimates. After which, the state and individual must mutually agree that the construction of the proposed system would be beneficial to the state (from a demonstration

point of view) and to the individual. If the proposed system is not selected for additional funding support, the individual may use the information generated and proceed at his own expense. For those sites on which both the state and individuals agree, the program will provide construction funding support of up to 90 percent of the cost. The individual is expected to provide the additional construction costs and all costs for operation and maintenance. The state will provide limited direct on-site technical assistance if requested by the individual during the check-out and first few weeks of operation.

The individual will be expected to maintain a record of the system performance for one year after check-out. Bimonthly informal reports will be written by the individual for which he will receive \$150 per acceptable report. Any cost for special instrumentation required to monitor the system performance will be paid in full by the program.

The individual is expected to pursue all questions and legal expenses associated with water use and rights. The water rights situation at the proposed site must be explained in the initial request to the state for assistance. The water rights issue must be cleared up completely at the individual's own expense prior to any decision by the state to assist in system construction.

It is expected that request for consideration will be received from 50 to 60 sites, that 20 will be selected for design assistance, and that ten will be selected for construction assistance.

There exist commercial small scale hydro systems; therefore, only limited component development support will be required for Montana or site specific technical problems. Funds are provided to solve these problems as they develop.

Schedule and Costs

	79	80	81	82	83	84
. Small Scale Hydro Information Preparation	△▽					
. Design Assistance to Interested Individuals		△			▽	
. Construction and Check Out Assistance for Selected Sites			△			▽
. Performance Evaluation and Monitoring				△		▽
. Required Development Support of Components		△			▽	

Cost (Dollars in Thousands)

	79	80	81	82	83	84
. Information Packet Preparation	40	0				
. Request Evaluation and Design Assistance	0	50	60	85	40	
. Construction and Check Out Assistance	0	0	85	110	140	40
. Montana and Site Specific Development Support for Components	0	50	100	75	50	
TOTAL COST	40	100	245	270	230	40

DEPARTMENT OF RESOURCES AND CONSERVATION

SUPPORTING PROGRAMS

In support of the technology subprograms outlined in the proposed renewable energy program, the DNRC will have activity in the following four areas: Human Services, Incentives, Standards and Practices, and Program Management. The specific activities to be performed under each of these areas are described in detail in the DNRC January 4, 1979 Montana Alternative Renewable Energy Sources Program. What is included here is the recommended funding level for these areas required to support the expanded technology program proposed in this plan.

DNRC Program Area

	79	80	81	82	83	84
Human Services	85	105	210	220	250	210
Incentives	20	35	100	135	75	50
Standards and Practices	110	160	300	315	490	305
Program Management	140	210	345	405	460	490

TOTAL COST	355	510	955	1075	1275	1055
(Dollars in Thousands)						

This budget is not a percentage of the total program dollars but is determined from an estimate of the work required under each area. In addition to the management budget shown above, there are funds for management included in the budgets under each subprogram by the major subcontractor selected.

BUDGET SUMMARY

These figures are compiled from each of the subprograms described in the plan. (Dollars in Thousands)

	<u>79</u>	<u>80</u>	<u>81</u>	<u>82</u>	<u>83</u>	<u>84</u>	<u>Total</u>
Subprograms							
. Biomass	(2000)	(3155)	(3745)	(4750)	(6095)	(7800)	(27545)
Alcohol	1150	1500	1100	1400	1800	1800	8750
Direct Combustion	650	1355	2195	2450	3610	5400	15660
Biogas	200	300	450	900	685	600	3135
. Wind	625	800	1050	1200	1200	555	5430
. Geothermal	365	650	1635	1500	2000	550	6700
. Solar	215	285	270	205	0	0	975
. Small Scale Hydroelectric	40	100	245	270	230	40	925
. DNRC: Human Services Incentives, Standards and Management	355	510	955	1075	1275	1055	5225
TOTAL COST	3600	5500	7900	9000	10800	10000	46800
Proposed State Share	900	1100	1300	1500	1800	2000	8600
Proposed Federal Share	2700	4400	6500	7500	9000	8000	38200
Cost Sharing Ratio	3:1	4:1	5:1	5:1	5:1	4:1	4.43:1

The budgets are expressed in terms of 1979 dollars, and no adjustment has been made for inflation. The federal contribution increases in the first years as the program effectiveness is demonstrated. The federal contribution is reduced in the last year because the funds required to complete the program do not require a 5:1 federal match with the projected coal tax revenue.

The program assumes a February 1979 start but can be operated with a six month slip if the state funds become available in June and the federal funds become available in October of each year.

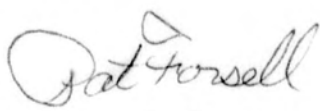
PLEASE NOTE: THE FOLLOWING PAGES WERE TREATED
AS A UNIT IN THE ORIGINAL DOCUMENT.

October 15, 1979

Dear Mr. Wittow:

I am enclosing the Montana Energy Conservation plan for your information.

If you have any questions or wish to discuss this, please contact our office at your convenience.


for J. D. Plunkett

Wittow

THE MONTANA ENERGY CONSERVATION PLAN

Draft Final Report

January 31, 1977

Submitted to the
Montana Energy Advisory Council

by

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PREFACE

Governor Thomas Judge set the tone for the Montana Energy Conservation Plan in his energy message to the 45th Legislative Assembly on January 18, 1977. In that message, Governor Judge made the following statement:

"During the last four years, Montana has become the nation's leader in design and enforcement of environmental safeguards. During the next four years, Montana should become the nation's leader in conservation of its energy resources and elimination of waste in their usage.

At this point in our history, government must demonstrate its determination to reduce consumption of all resources--fiscal as well as natural. The number one priority and the basic cornerstone of our energy policy must be reduction of energy demand; any other course is ultimately suicidal."

Simply stated, the intent of this project is to follow the lead of the Governor and create a plan which will make energy conservation the keystone of Montana's energy policy.

CAUTION

It must be noted at the outset that both energy savings and cost data for some of the program measures included in this plan are difficult to quantify. For some measures, accurate energy savings simply could not be calculated because specific data do not exist. Data on projected behavior modification due to education or incentives particularly is tenuous. In all cases when assumptions were made, we have attempted to be conservative and likely have underestimated actual energy savings in many cases. Program measure costs are speculative in some cases since the actual program scope and contents must be determined by the legislature. The program measure costs reported here include funding from all sources: state, local, and federal. Specific legislative appropriations for some program measures are not required.

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A. PLAN INTENT

INTRODUCTION

The constraints of increasingly scarce energy affect all parts of the United States. Montana, like other states with a relative abundance of energy resources, is no exception and today must face critical questions regarding future supply. The presence of vast reserves of coal in Montana creates an illusion that somehow we are exempt from the need to ponder the consequences of future energy shortfalls. Coal currently cannot be used in many sectors of Montana's energy economy, and its massive long-range development may have important negative consequences. Meanwhile, two major current sources of energy--natural gas and crude oil imports from Canada will be curtailed within a few short years. A sober assessment of this situation leads to the endorsement of conservation as immediately necessary if we are to attain energy self-efficiency and are able to bridge the gap to a non-fossil fueled energy future. Under strong executive leadership and with the broad support of the Montana legislature, the state intends to implement the strongest possible plan of energy conservation realizing that the example must come from a state whose non-renewable energy sources are in great demand.

This report focuses on specific methods of achieving an immediate reduction of energy use as a partial answer to a dwindling supply. It also recognizes the importance of building a long-range commitment to reliance upon renewable energy through acceptance of an ethic of energy conservation as a way of life for all Montanans. Thus, great emphasis is placed upon creating a comprehensive and coordinated plan for involving all elements of Montana society in saving energy in every sector of current use. When implemented, the elements of the energy conservation plan outlined in this

document will far exceed the requirements imposed in the Energy Conservation Policy Act (P.L. 94-163) which addresses energy conservation in five areas: lighting efficiency standards for public buildings; car pools, van pools, and public transportation; standards and policies for improving the energy efficiency of the procurement practices of the state and its political subdivisions; thermal efficiency standards for new and renovated buildings; and a traffic law which permits right turns on red after stop. The goal of the program is a 5 percent reduction in each state's projected 1980 energy consumption.

In Montana, the state's Energy Advisory Council is responsible for developing the state plan. The Montana Energy Advisory Council (MEAC) has decided to move well beyond FEA's five mandatory areas and study the possibilities for energy conservation in all sectors of Montana's economy-- both in the immediate and the long-term future. Montana's plan also will focus on replacing non-renewable with renewable energy sources to the maximum extent possible.

Since all Montana citizens will have to live with the energy conservation plan, public meetings were held throughout the state to review the plan as it was being developed. This report constitutes the Montana Energy Conservation Plan, based both on research and public involvement.

The methodology approach used in this study is similar to that developed by Amory Lovins (see Foreign Affairs, October 1976). We do not assume that Montana needs electricity, oil, or natural gas. Rather, we believe that Montanans want lights, warm homes, efficient and economical transportation, and other tangible things.

Once we have established what these real energy based needs are, we can ask the question "How do we best meet the needs?" Our first step was to analyze the waste associated with various energy uses. Eliminating this waste requires various kinds of conservation in our homes, businesses, cars, and factories which will allow us to perform functions better, more efficiently, and with less energy. The next step is to review our current and future energy needs. These can be divided into several categories:

- a. Low grade heat (under the boiling point of water) for space and water heating.
- b. Medium grade heat ($<250^{\circ}\text{C}$) for process steam and industry.
- c. High grade heat for industrial applications and electricity.
- d. Electricity for motors and lights.
- e. Liquid fuel for transportation.

When stated this way, it is easy to see exactly what needs must be met by what technologies. Space heating, for example, can be accomplished by using low grade heat from solar collectors or rejected heat from some industrial process. It does not make thermodynamic sense to burn valuable liquid fuel (vital for transportation) to provide heat with such low temperature requirements. This matching of energy quality to appropriate end use requirements utilizes the laws of thermodynamics. Maximizing thermodynamic efficiencies assures the best matching possible.

Initially, it is necessary to define energy conservation and the methodological framework used to develop our preliminary analysis. We define energy conservation as the efficient utilization of energy. Energy conservation does not necessarily imply curtailment. We do not propose to conserve energy by closing Montana's industries or not heating Montana homes.

Instead, we propose to conserve energy by making equivalent amounts of energy do much more for us. This can be done by substituting another resource (capital, skilled labor, time, careful workmanship) for energy; it also can be accomplished either by consuming less of or a different mix of the goods and services requiring energy. We do not view energy conservation and renewable energy development as being counter to Montana's economic development plans. Energy conservation will create jobs. Both energy conservation and renewable energy development are labor intensive rather than capital intensive since their application primarily is in decentralized small-scale and individual use. Most of Montana's homes and businesses need more insulation and should be weatherized more fully. The state's industries can purchase more energy efficient equipment. Solar heating devices can be manufactured and sold in Montana. Energy conservation and renewable energy development present excellent opportunities for both Montana business and labor.

A sincere commitment to these principles will guarantee a marked reduction in total energy consumption within the state, while actually enhancing other goals such as economic development, employment, and environmental protection.

A fundamental assumption of this study is that energy conservation will be successful only if Montanans embrace the principle voluntarily and enthusiastically. To this end, major emphasis is placed upon programs of education and economic incentive. A significant responsibility ultimately is left with the private sector, under the assumption that Montanans will realize and will pursue energy conservation measures which assist them as individuals while contributing to the welfare of the entire state. Mandated measures

are limited and are extended principally to activities of governments within the state on the grounds that leadership by example is the best method of promoting compliance.

The basically easy availability and low cost of energy in Montana has allowed us to defer important decisions regarding energy production and utilization. Government, business, and citizens share this blinder vision. Now it is time to refocus together on the hard choices which confront us. We have vast quantities of coal but also unlimited supplies of wind and sun. Shall we choose to spend the energy principal of non-renewable resources or live off the energy interest of renewable resources? A commitment to intensive energy conservation practices today will provide us with a larger margin of error for reaching a decision on future alternative energy tracks. To this end, the following report details the components of Montana's energy conservation plan.

MONTANA'S ENERGY CONSUMPTION PATTERNS

According to the Federal Energy Administration (FEA), Montana consumed 340 trillion Btu's of energy in 1975. FEA projects that Montana's energy consumption will reach 370.5 trillion Btu's by 1980.

In 1974, Montana's gross per capita energy consumption was 440 million Btu's. This compares to a national per capita average of 340 million Btu's. Montana's high per capita consumption results both from the concentration of resource extractive industries within the state and Montana's large land mass and dispersed population. Per capita energy consumption in Montana grew at a rate of almost 3 percent per year in the 1960's. Between 1970 and 1973, Montana's per capita energy consumption grew at a 2 percent annual rate, and since 1973, energy growth has slowed to less than 1 percent per year. Following is a sectorial breakdown of the energy consumption patterns within Montana.

Residential

The residential sector consumes about 15 percent of the energy used in Montana. Eighty-eight percent of this energy is used for space and water heating. The remaining energy is used to power lights and electricity. Two thirds of the energy used in the residential sector comes from natural gas. The remaining energy use is broken down almost evenly between electricity and other sources such as propane and fuel oil.

Commercial

The commercial sector also accounts for about 15 percent of the energy used in Montana. Of this, only about 75 percent is used directly in commercial buildings. In commercial buildings, about 62 percent of the energy

used is for space heating and air conditioning. An additional 28 percent is used for lighting. Natural gas accounts for about 50 percent of the energy used in commercial buildings, electricity accounts for 35 percent, and the remaining energy is divided between fuel oil, coal, and propane.

Industrial

Over the past decade, energy consumption in Montana industry has grown faster than the energy consumption of any other sector. Montana industries currently consume 35 percent of the total energy used in the state. Montana industry consumes over 40 percent of all natural gas sold within the state as well as over 60 percent of all electricity. In 1974, Montana industry consumed over 36 billion cubic feet of natural gas. This energy use is concentrated in a few basic industries (mineral mining and processing, wood products and paper, oil refining, food products, and cement). For example, in 1974, the Anaconda Company and Hoerner Waldorf together consumed over 40 percent of all the natural gas distributed to industry.

Agriculture

The agriculture sector accounts for 4.4 percent of Montana's fuel and electric usage, including the natural gas and oil required to produce needed fertilizer and pesticides. The production of crops in Montana accounts for 95 percent of the energy used in agriculture, while livestock production requires 5 percent. Fertilizer and pesticides manufacturing consumes 44 percent of the total energy used in crop production, and field operations and farm vehicles account for 56 percent.

Transportation

Transportation presently accounts for about 25 percent of the nation's direct fuel consumption. An additional 18 percent of the U.S. energy budget

is used indirectly to build and maintain vehicles, construct roads, etc.

In contrast, Montana's transportation sector directly used 31 percent of the total energy consumed in the state in 1974. The use of motor gasoline in Montana has grown fairly steadily at an average annual growth rate of about 3 percent since 1950. The majority of the gasoline consumed in Montana in 1974 was produced at in-state refineries. Only 16 percent of the feedstock for Montana refineries was produced in Montana. Forty percent of the feedstock for Montana refineries currently is imported from Canada. This feedstock is scheduled to be eliminated in the 1980's, and replacement feedstocks have not been located yet. Gasoline consumption accounts for 73 percent of the energy used in the transportation sector, highway diesel fuel accounts for another 9 percent, and the remaining 18 percent is used by railroads.

Government

The final energy consuming sector in Montana is state and local government. Government operations generally are included within the commercial and transportation sectors; but since Montana government has total control over its own energy consumption, we decided to address government operations separately.

Energy consumption in Montana government operations is substantial. For instance, in fiscal year 1975, eleven Montana state government building complexes consumed over 1.7 billion cubic feet of natural gas. Warm Springs State Hospital, where natural geothermal waters flow to the surface, consumed 212 million cubic feet of this total. Montana state and local governments also operate several thousand motor vehicles. Each year, the various Montana political subdivisions spend millions of dollars in various energy consuming procurements.

Montana governments have authority in the area of solid waste management. In the state of Montana, the energy equivalent of 50×10^{12} Btu's is processed as solid waste and used for land fill annually. This resource includes paper, glass, metals, and plastics. In addition, another 1.7×10^{12} Btu's of fuel in the form of organic burnable wastes (food, grass clippings, etc.) is thrown away.

Montana state and local governments also are responsible for sewage treatment. The present system for sewage treatment considers sewage an undesirable waste product rather than a resource. In actual fact, the energy content of the sewage treated in Montana is about 1×10^{12} Btu's per year. This resource also has a fertilizer value in some applications.

The handling and purifying of these wastes require about 1.5 million Btu's per million gallons of sewage. For residential uses alone, the state of Montana consumes 3.2×10^{10} Btu's for sewage treatment. When industrial and commercial uses are considered, this figure triples. In addition, the technologies involved require great quantities of water which is in itself a scarce and valuable resource.

ENERGY CONSERVATION GOAL

The Federal Energy Administration (FEA) estimates that Montana will consume 370.5 trillion Btu's of energy during the calendar year 1980. The goal of the FEA energy conservation program is a 5 percent reduction in this projected consumption level. Thus, to participate in the FEA program, Montana should propose projected 1980 energy savings of at least 18.53 trillion Btu's. As was noted in the introduction, Montana has chosen to move well beyond the five FEA mandatory areas and investigate energy conservation and renewable energy measures applicable to all sectors of Montana's economy. While Montana's plan focuses on both short and long term measures, particular emphasis was given to those measures which would have a significant and fundamental long term impact. This plan was developed to make energy conservation and renewable energy a major long term energy supply technology, not specifically to save 5 percent of Montana's 1980 energy consumption. Even so, this plan will exceed FEA's 5 percent goal and save a projected 19.62 trillion Btu's in calendar year 1980.

*was Alaska
adopted to
FEA plan.*

B. PLAN SUMMARY

Table B1.--Continued

Program Measures	1980 Estimated Energy Savings (in trillion Btu's)	Estimated Cost of Implementation (in \$000's)			
		1977	1978	1979	1980
7. Conservation Loan Programs	1.8	50	50	55	55
8. Renewable Energy Tax Credit	.249	0	0	0	0
9. Public Utility Measures	1.14	100	50	100	100
10. Energy Conservation Education	5.83	204	172	230	230
Crude Oil Saving	.47				
TOTAL.	19.62	2,719.76	1,681.96	1,369.46	1,369.46

Table B1.--Plan Summary

Program Measures	1980 Estimated Energy Savings (in trillion Btu's)	Estimated Cost of Implementation (in \$000's)			
		1977	1978	1979	1980
1. State Building Code and Thermal Efficiency Standards	3.63	90	20	20	20
2. Lighting Standards for Public Buildings	1.36	costs of implementation are included in program measure 1.			
3. Procurement: Life Cycle Cost Analysis and Vehicle Fuel Efficiency Standards	.32	35	0	0	0
3a. Energy Managing, Auditing, and Retrofitting State Buildings	.753	200	500	250	250
3b. Renewable Energy Demonstration Project	Uncertain	-----Uncertain-----			
4. Right Turn on Red	Already in force no savings	0	0	0	0
5. Car Pool/Van Pool: Increase in Transit Level of Service	.048	1,226	206	6	6
5a. Public Transportation and Railroad Assistance Fund	.15	12.5	25.5	50	50
5b. Bikeway Construction	.003	202.26	58.46	58.46	58.46
5c. Enforcement of 55 M.P.H. Speed Limit	2.23	0	0	0	0
6. Weatherization	.29	600	600	600	600

C. DESCRIPTION OF PROGRAM MEASURES

Energy conservation will become an integral part of Montanans' daily lives only when its benefits are perceived clearly. Individuals must be made aware of the significant economic and environmental advantages of saving energy from traditional sources in the short run and of shifting to alternative energy supplies in the long term. Energy consumption patterns can be changed in three basic ways:

1. government can force compliance with standards, as in the case of fuel quotas, taxation for excessive use, or financial penalties;
2. incentives can be provided to alter use patterns, as in the case of low interest loans for insulation or tax credits for industrial retrofitting; and
3. educational programs can address the multitude of energy saving techniques in virtually every category of energy end use in Montana.

Most of the specific implementation strategies involve either mandated or incentive programs or a combination of the two approaches. The following discussion provides definitions, examples, and rationales for the two basic categories.

Mandatory Programs

Fuel allocation programs, rationing, and forced reduction of energy consumption are effective in saving energy under conditions of crisis. Mandatory programs like these sometimes are required, but they should be used sparingly and in the proper circumstances. Mandatory programs may include direct compliance measures or severe tax sanctions, as in the case of greatly escalated gasoline taxes which could produce a shift to smaller automobiles. In either case, they run the risk of possible public antagonism and resistance which could damage the broader energy conservation program. For the most

✓ part, mandated measures have been confined to areas specifically required by the FEA and to other areas of government activity brought under direct control more easily.

Incentive Programs

↓
Examples of incentive programs include tax subsidy measures, direct assistance such as weatherization, low interest loans, state assistance for energy audits, permissive legislation which could allow communities to experiment with alternative energy systems, and provision of matching funds for acquisition of federal monies. Incentive programs are appropriate when they stimulate the self-interest economic motive on the part of individuals. They are advantageous when they have an economic multiplier effect, as in the stimulation of jobs with the weatherization program. This approach should be maximized where short term energy savings can be realized appreciably, as in the case of weatherization. Since public resources are involved, programs should be chosen which have minimal bureaucratic costs for compliance and have the greatest potential for private sector economic ripple effect.

For both mandatory and incentive programs, there are associated important educational effects. The full range of educational programs are discussed as one implementation strategy. The following summary identifies the discrete program measures according to their primary nature as mandatory, incentive, or educational.

Table C1.--Summary of Program Measures by Type of Program

Mandatory Programs

- No. 1 State Building Code and Thermal Efficiency Standards
- No. 2 Lighting Standards for Public Buildings
- No. 3 Procurement: Life Cycle Cost Analysis and Vehicle Fuel Efficiency Standards
- No. 3a Energy Managing, Auditing, and Retrofitting State Buildings
- No. 3b Renewable Energy Demonstration Project
- No. 4 Right Turn on Red
- No. 5 Car Pool/Van Pool: Increase in Transit Level of Service
- No. 5c Enforcement of 55 m.p.h. Speed Limit
- No. 9 Public Utility Measures

Incentive Programs

- No. 5a Public Transportation and Railroad Assistance Fund
- No. 5b Bikeway Construction
- No. 6 Weatherization
- No. 7 Conservation Loan Programs
- No. 8 Renewable Energy Tax Credit

Educational Programs

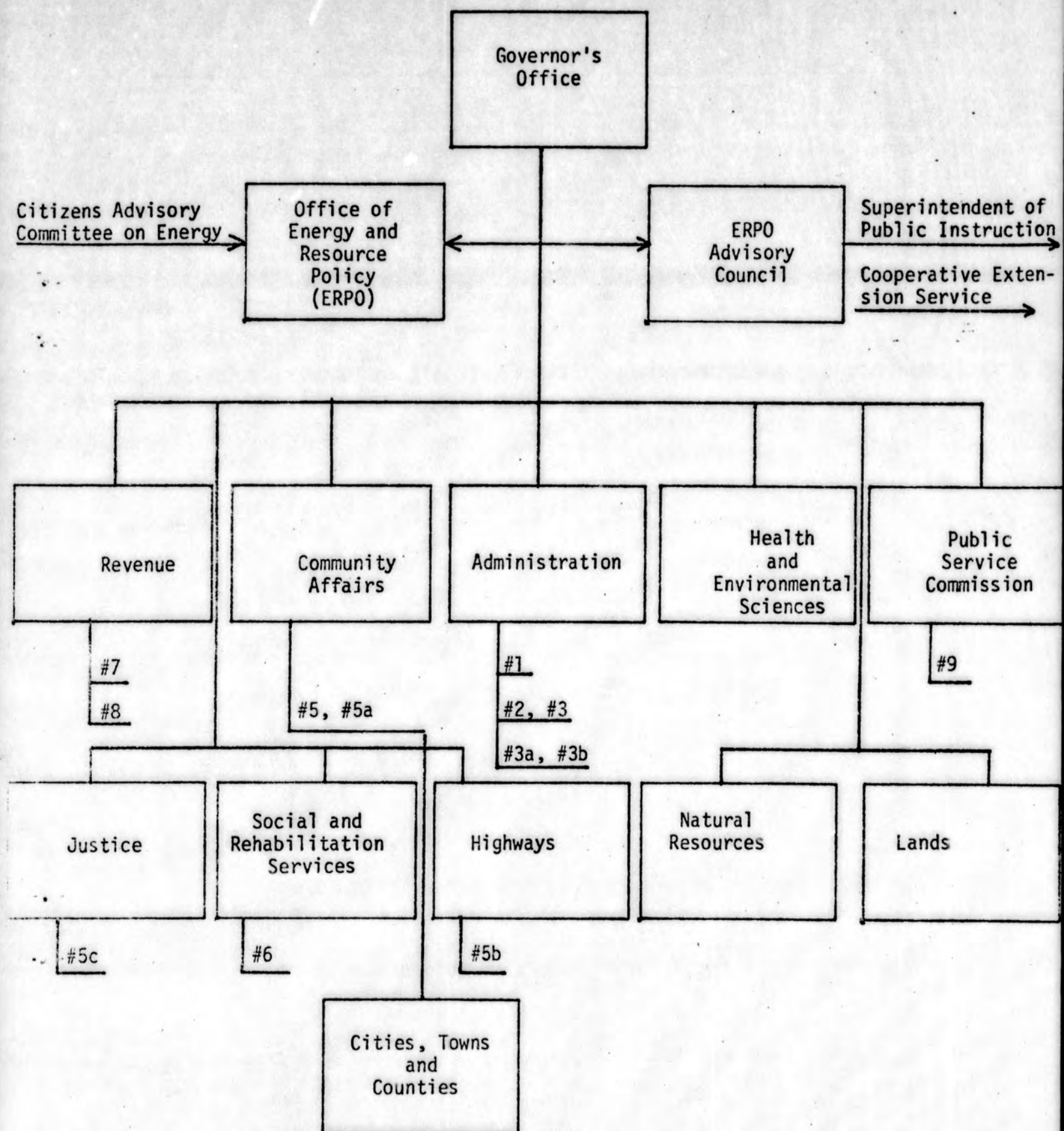
- No. 10 Energy Conservation Education

It also is useful to identify program measures according to the principal energy use sectors which they address (see next page for a summary of program measures by sector).

Table C2.--Summary of Program Measures by Type of Program

<u>Sector</u>	<u>Program Measure No.</u>
(1) residential	1, 6, 7, 8, 9, 10
(2) commercial	1, 2, 7, 8, 9, 10
(3) industrial	9, 10
(4) agricultural	9, 10
(5) transportation	4, 5, 5a, 5b, 5c, 5d, 10
(6) government	3, 10

Figure C1.--Agency Responsibility Interactions: By Program Measure



PROGRAM MEASURE NO. 1--STATEWIDE BUILDING CODE AND THERMAL EFFICIENCY STANDARDS

Narrative Statement

Montana already has in place the necessary authority to comply with the objective of energy savings through elimination of excessive heat loss in new and renovated buildings. State law contains building code requirements which call for building designs to take into account the efficient utilization of energy. An administrative mandate has been extended to the Department of Administration to adopt all or part of a nationally recognized building code. In compliance with FEA requirements, a 1977 legislative mandate will call for the immediate implementation of standards, at least as stringent as ASHRAE 90-75, to be in place in advance of the January 1, 1978 deadline. The building code council will be mandated to conduct a technical evaluation of appropriate revisions of ASHRAE 90-75 and other code models. These revisions should include consideration of upgraded insulation standards, thermal shutters, and direct solar gains as a minimum. Public hearings will be required for citizen input into the selection of standards and adoption of procedures for certification and enforcement. The Department of Administration is charged with fulfilling this and subsequent phases of the full implementation strategy.

Within four months of the passage of legislation, the Department of Administration will have drafted a code meeting the minimum standards but suited to Montana's particular weather conditions. Consultation with the Department of Health and Environmental Sciences is mandated to insure consideration of environmental and health consequences of materials used for insulation. Following adoption of the code, the Department of Administration will develop a program of training and information for local building code officials prior to January 1, 1978. Consultation with the Department

of Community Affairs in encouraged to utilize existing channels of interaction with local officials.

Estimated Energy Savings for Calendar Year 1980

Using FEA supplied methodology and regional data, we calculate that 1980 energy savings from implementing thermal efficiency standards equivalent to ASHRAE 90-75 for new and renovated buildings in the residential and commercial sector amounts to 2.44 trillion Btu's. We assume that the building code will have been in effect for 3.25 years by the end of 1980, and then it will apply to 25 percent of the residential renovations and 50 percent of the commercial renovations.

The Ecotope Group of Seattle, Washington, in calculations developed for this study, has determined that the implementation of ASHRAE 90-75 likely will save on the order of 0.8 trillion Btu's in 1980 in the residential sector and that the combined lighting and building code standards for the commercial sector will save 2.6 trillion Btu's in 1980. They indicate that a more stringent standard in the residential sector (1" to 2" additional insulation in walls, 8" additional ceiling insulation, 6" floor insulation, storm window caulking, and weatherstripping) could save approximately 1.2 trillion Btu's of additional energy. The major reasons for the slight discrepancy in results of the ASHRAE calculations is due to the fact that Ecotope has determined that new residential construction in Montana already nearly meets ASHRAE 90-75 and that Montana in general is not growing as rapidly as the rest of the western United States.

To be internally consistent, we are attributing the energy savings calculated to this program measure using the FEA methodology. We note that an

Table C3
MILESTONE CHART

Milestones	FY77					FY78					FY79					FY80												
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O
Legislative enactment of deadline for building code revision. -																												
Administrative adoption of building codes containing a minimum of ASHRAE 90-75 standards.																												
Completion of training and information for local building code inspectors.																												
Ongoing revision, monitoring, and upgrading of energy conservation aspects of the building code.																												
Ongoing revision, monitoring, and upgrading of energy conservation aspects of the building code.																												

additional 1.19 trillion Btu's of energy will be saved in 1980 by adopting more stringent standards in the residential sector.

Table C4.--Costs of Implementation
(includes costs for program measure No. 2)

1977	\$20,000	Draft code
	\$70,000	Training of Code inspectors
1978	\$20,000	Monitor code
1979	\$20,000	Monitor code
1980	\$20,000	Study code for possible revision