SB

13

Representative Steve Cowper
State of Alaska
Pouch V
Juneau, Alaska 99811

Dear Steve:

Mr. Bruce Boyd relayed your request for items significant in justifying SSSB 13 to operate a research facility for the study of surplus heat utilization at Fort Wainwright. The following points represent specific justifications for this appropriation:

1. At the present time, waste heat in the form of hot water from the steam operated electrical power plant at Fort Wainwright is dissipated in a cooling pond. This procedure adds water vapor to the atmosphere and generates substantial ice fog in the Fairbanks area during the cold winter months.

2. Consequently, the U.S. Army Cold Regions Research and Engineering Laboratory is currently constructing a system to dissipate the waste heat through pipes buried in the soil and for space heating in a greenhouse.

3. The U.S. Army is accomplishing the necessary engineering design and construction for this project, but does not intend to undertake the technological development necessary to utilize this system in the production of horticultural crops. Nevertheless, the system is ideally suited for this purpose.

4. The facilities would provide an excellent opportunity for the Alaska Agricultural Experiment Station to work cooperatively with this project in developing the necessary horticultural technology and application. SSSB 13 would provide an appropriation to the University of Alaska for the necessary personnel and materials to develop this technology and to provide a significant demonstration for the utilization of waste heat in other areas of Alaska. Without this appropriation the Agricultural Experiment Station will not have sufficient funds to accomplish the cooperative effort.

5. The horticultural industry in Alaska is particularly well adapted to utilize low grade waste heat in the +70°F to 80°F range that is available from power plants such as the plant at Fort Wainwright. Successful development of this technology would permit Alaska to produce high value, intensively cultured crops at world market prices and, more importantly, would provide these products for Alaskans.

6. If waste heat can be utilized in soil and greenhouse warming, Alaska will have a plant growth environment that is technically superior to areas at more southerly latitudes. The advantage is due to improved photosynthetic activity of leaves in sunlight and cool air conditions and the longer period of this advantage. The long day lengths from March 20 to September 20 and the better internal plant conditions for photosynthesis are advantages when low soil temperatures do not limit plant growth. Improved soil temperatures allow crops to take full advantage of long sunlight days, and and often higher yields are produced than in the best commercial production areas of the nation.

7. The U.S. Army has leveled the land adjacent to the power plant at Fort Wainwright, has added peat soil amendment to specifications supplied by the Agricultural Experiment Station, and is in the final stages of installing buried pipes to dissipate waste heat in experimental plots. In addition, plans are underway to construct greenhouse facilities heated by waste heat adjacent to the test plots according to technology transferred from greenhouse research at the Agricultural Experiment Station.

8. Specific tasks to be accomplished cooperatively by the Agricultural Experiment Station at these facilities if an appropriation is provided are as follows:

vegetables under a system of near optimum soil temperature.

b. To determine the extension of growing season that can be achieved both in the greenhouse and out-of-doors using heated soil.

c. To determine the proper fertility and irrigation practices necessary for these systems.

d. To examine the possibility of growing commercial cut flowers such as roses, carnations and chrysanthemums using soil warming in a greenhouse environment.

e. To detect and correct any disease or insect problems that may develop under these growing systems.

9. Successful development of this technology will demonstrate an effective system for dissipating waste heat from power plants in a manner that will substantially reduce ice fog pollution, and will provide the technology necessary to expand the horticultural industry in Alaska through a system of energy conservation. This work is an essential step in developing energy conservation in Alaska.

Additional details of this research are available in a proposal provided to the House Resources Committee.

Sincerely,

James V. Drew
Director, Agricultural Experiment Station
Fairbanks, Alaska

THE LEGISLATURE OF THE STATE OF ALASKA
TENTH LEGISLATURE

FISCAL NOTE

I. REQUEST
Bill/Resolution No. Senate Bill No. 13
Title "An Act Making a Special Appropriation To University of Alaska...for the study of ~~REDACTED~~ Surplus Heat Utilization..." Date January 26, 1977
REQUESTED BY Senator Kerttula

II. FISCAL DETAIL
Agency Affected University of Alaska
Program Category Affected Education
Budget Request Unit(s) Affected Agricultural Experiment Station/Organized Research

EXPENDITURES (Thousands of Dollars)

	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82
100 PERSONAL SERVICES	4.2	40.7	43.9	-0-	-0-	-0-
200 TRAVEL	-0-	2.3	-0-	-0-	-0-	-0-
300 CONTRACTUAL	-0-	1.7	-0-	-0-	-0-	-0-
400 COMMODITIES	-0-	5.5	2.5	-0-	-0-	-0-
500 EQUIPMENT	-0-	0.5	-0-	-0-	-0-	-0-
600 LAND & STRUCTURES	-0-	-0-	-0-	-0-	-0-	-0-
700 GRANTS, CLAIMS, ETC.	-0-	-0-	-0-	-0-	-0-	-0-
TOTAL	4.2	50.7	46.4	-0-	-0-	-0-

FUNDING (Thousands of Dollars)

GENERAL FUND	4.2	50.7	46.4	-0-	-0-	-0-
FEDERAL FUNDS	-0-	-0-	-0-	-0-	-0-	-0-
OTHER (Specify)	-0-	-0-	-0-	-0-	-0-	-0-

POSITIONS

FULL TIME	1	1	1	-0-	-0-	-0-
PART TIME	-0-	-0-	1	-0-	-0-	-0-
TEMPORARY	1	1	1	-0-	-0-	-0-

III. ANALYSIS (See Fiscal Note Preparation Instructions, Section III)

See Attachment

IV. DATE January 27, 1977 PREPARED BY Dr. Donald H. Dinkel, Professor of Plant Physiology, Agricultural Experiment Station
AGENCY
PHONE 479-7652 University of Alaska

Original: Legislative Finance
cc: Budget and Management
Prime Sponsor (First Legislator Named)

Senate Bill No. 13
Project Summary Totals

100	Personal Services		$ 88,716.84
	FY 77	$ 4,209.97	
	FY 78	$40,655.95	
	FY 79	$43,850.92	
200	Travel		$ 2,350.00
	FY 77	$ 0	
	FY 78	$ 2,350.00	
	FY 79	$ 0	
300	Contractural Services		$ 1,700.00
	FY 77	$ 0	
	FY 78	$ 1,700.00	
	FY 79	$ 0	
400	Commodities		$ 8,040.00
	FY 77	$ 0	
	FY 78	$ 5,540.00	
	FY 79	$ 2,500.00	
500	Equipment		$ 500.00
	FY 77	$ 0	
	FY 78	$ 500.00	
	FY 79	$ 0	
		TOTAL	$ 101,306.84

Senate Bill No. 13
Analysis of Fiscal Note

FY 77 Costs

100 Personal Services $4,209.97

Senior Research Assistant (21A) $2,635.57

This position would be employed for one month prior to FY 78 to begin implementation of the research project. The Senior Research Assistant would be a specialist in horticulture technology and would be responsible for data analysis, background preparation, and other duties as assigned by the project head.

$1,895.00	Salary ($1,895.00 per month x 1 month)
301.31	Leave Allowance (15.9%)
$2,196.31	Subtotal
439.26	Staff Benefits (20%)
$2,635.57	Position Total

Horticulture Trainee (11A) (Temporary Help) $1,574.40

This position would be employed for one month prior to FY 78 to perform gardening functions and other tasks. This position would weed, care for harvest, weigh the garden products, and perform other labor duties.

$1,312.00	Salary ($1,312.00 x 1 month)
262.40	Staff Benefits (20%)
$1,574.40	Position Total

TOTAL FY 77 COSTS $4,209.97

100 Personal Services $40,655.95

Senior Research Assistant (21A) $31,209.55

This position would be needed for 12 months to develop the project. The person employed would be a horticulture specialist who would care for plants, calculate data documenting project accomplishments, and do other duties as assigned by the project head.

$22,440.00	Salary ($2,040.00 per month x 11 months)
3,567.96	Leave Allowance (15.9%)
$26,007.96	Subtotal
5,201.59	Staff Benefits (20%)
$31,209.55	Position Total

Horticulture Trainee (11A) $ 9,446.40
(Temporary Help)

This position would be responsible for performance of horticulture labor functions related to the project. The person would do maintenance duties of weeding, caring for plants, etc.

$7,872.00	Salary ($1,312.00 per month x 6 months)
1,574.40	Staff Benefits (20%)
$9,446.40	Position Total

200 Travel $ 2,350.00

Travel required to review waste heat agriculture projects in parts of United States, such as Minnesota, Oregon, Idaho, etc., to analyze various techniques for application in Alaska. $ 850.00

Iceland is one of the major countries that currently employes waste heat for industry uses. A review of its techniques would be done to examine for methods useable in Alaskan environment. $ 1,200.00

Three trips to and from Palmer would be necessary to build greenhouse facilities. Transportation to install equipment and appliances would be required. $ 300.00

300 Contractual Services

Photography services will be required to record results of study. Computer services will be needed to calculate and analyze data produced.	$ 500.00	
Publication of study to report findings of the projects. Printing and mailing costs are included in the figure.	$ 1,200.00	

400 Commodities — $ 5,540.00

Supplies necessary for waste heat research

a) Thermo Couple Wire	$ 175.00
b) Stakes, Tags, Bags Containers	200.00
c) Fertilizers and Growth Media	800.00
d) Shade Cloths and Alterations to Attach to This	725.00
e) Plants and Shipping	2,500.00
f) Special Tubing	250.00
g) Pots	325.00
h) Vexar Netting	145.00
i) Special Tools (Knives, pruning shears)	75.00
j) Insecticides	70.00
k) Connections for Steaming Soil	275.00
	$ 5,540.00

500 Equipment — $ 500.00

Special pumps and fertilizer injector are necessary for project.

FY 78 TOTAL $50,745.95

Senate Bill No. 13

FY 79 Costs

100 Personal Services $43,850.92

Senior Research Assistant (21B) $32,942.90

This position would be responsible for maintenance and completion of the project. The person would also prepare documentation for publication on the results.

$23,298.00	Salary ($2,118.00 per month x 11 months)
3,704.38	Leave Allowance (15.9%)
$27,002.38	Subtotal
5,940.52	Staff Benefits (22%)
$32,942.90	Position Total

Secretary (9A) $ 4,505.46

Secretarial services would be necessary for three months to type project results for publication and maintain files on project documentation.

$3,693.00	Salary ($1,231 per month x 3 months)
812.46	Staff Benefits (22%)
$4,505.46	Position Total

Horticulture Trainee (11A) $6,402.56
(Temporary Help)

This position would be necessary to perform maintenance and gardening functions and other tasks. This person would weed, care for harvest, weigh garden products and perform other labor functions.

$5,248.00	Salary ($1,312 per month x 4 months)
1,154.56	Staff Benefits (22%)
$6,402.56	Position Total

400 Commodities $2,500.00

Supplies necessary to continue waste heat research:

a) Fertilizers and Growth Media	$ 550.00
b) Pots	225.00
c) Plants and Seed	1,725.00
	$2,500.00

TOTAL FY 79 COSTS $46,350.92

(DRAFT)

Research Proposal

The Development of technology necessary to use "waste" heat for the enhancement of horticulture in Alaska and to reduce thermal pollution problems

University of Alaska
Agricultural Experiment Station
Fairbanks, Alaska 99701

D.H. Dinkel
Principal Investigator

Abstract

The purpose of this project is to develop the horticultural technology necessary to use the enormous quantities of excess heat that will be rejected in Alaska from power plants, refineries, pipeline pumping stations and geothermal sources. The use of waste heat for the production of horticultural crops in greenhouses and heated areas of soil outdoors is common to all wise proposals to completely utilize reject heat. The horticulture production part is necessary because the heat can be utilized during summer months and when less is required for space heating or other uses.

It is estimated that the quantity of excess heat that would be available from industry in Alaska could meet the heat energy requirements for hundreds of acres of high value vegetable and flower production.

In this project, both soil heating and "space" heating for greenhouses will be employed in conjunction with proven Northern Agricultural practice, with the dual purpose of improving agricultural production and reducing final output temperature and consequently thermal pollution from power plant cooling water.

The agricultural industry, and particularly the horticultural industry, is probably in the best position of many of the energy consuming activities to use low-grade heat from cooling waters discharged by industry. The Agricultural industry is also in the best position to utilize the high temperature excess heat from the pumping stations of the oil and gas pipelines.

Considering the magnitude and basic importance of agricultural production and the extent of its' energy use, a significant increase in efficiency of production would be obtained through the substitution of waste energy for nonrenewable resource-consuming energy. In addition, the increase in solar energy conversion to food and ornamental plants would be an important Alaskan and national gain.

The principle reason for agriculture's favorable position in Alaska is that growth rates are increased dramatically when soil temperatures are increased slightly or conventional greenhouses and temporary plastic canopies are used to improve air temperatures. These practices make possible in Alaska the use of solar energy that otherwise is not useable for food and other beneficial production. In some instances, lengthened growing seasons may permit additions of another crop, possibly doubling and tripling production of the land. Increasing Alaska's critically low soil temperature and using canopies and greenhouses creates a significantly better plant growth environment than found in most other areas of the U.S. because of the long sunlight days. This advantage should allow us to produce high value intensively cultured crops at world market prices, and more important provide these products to Alaskans.

Much of the basic information needed for the establishment of a horticultural industry using waste heat in Alaska is available in literature and from preliminary research in the state. What is most needed now is applications research, and the engineering and economic design required to demonstrate and incorporate what is known into development plans.

The proposed research will be done by the Agriculture Experiment Station, University of Alaska in cooperation with (CRREL) Cold Regions Research and Engineering Laboratory) and the U.S. Army.

The work will be done using existing greenhouse and crop facilities at the Fairbanks Agricultural Experiment Station and in facilities that are fortuitously being developed by the U.S. Army at Fort Wainwright to reduce thermal pollution and ice fog problems associated with the power generating facility.

The engineering and construction for much of this project is being done by the U.S. Army and Cold Regions Research and Engineering Laboratory (CRREL) at the Fort Wainwright South Power Plant. Heated "waste" water with temperatures of +70°F to +85°F in large quantities is available. Evaporation from the present large cooling ponds associated with this waste creates a severe ice fog problem in winter months. Efforts to reduce this thermal pollution problem are underway by dissipating the heat in soil by circulating the warm water through a buried grid of pipes. There would be a significant advantage to Alaska and the immediate community if these efforts could be used to conduct the developmental research necessary to demonstrate the use for the tremendous quantities of unused heat in the state.

Introduction

The primary energy source for modern agricultural food, fiber and ornamental production remains the sun; however, man has learned that he can increase productivity of his crops by modifying the plants' environment for maximum capture of sunlight. This environment modification is largely dependent upon the use of fossil fuels to supply the required technological materials such as machinery, plastics, pesticides and petroleum for heating, farming, drying, processing and transportation.

Much of the energy required to produce intensively cultured crops in Alaska is in the form of heat requirements. This energy is needed to heat greenhouses and warm soils. If these heat requirements are supplied in Alaska we then have a plant growth environment that is technically superior which should create an economic advantage even in regards to competing on world markets for commodities that can be shipped. The advantage is due to the improved photosynthetic activity of leaves in sunlight and cool air conditions (10), and the longer period of this advantage. An analysis of Alaska's climate shows that during a similar calendar period corresponding to May through mid-September, there are 430 to 550 more hours of sunshine in Alaska than there are at latitudes similar to Minneapolis, Minnesota and Chicago, Illinois. The advantage

of this extra sunshine for rapid growth of adapted crops has been amply demonstrated by the production of the well-known 70-lb Alaskan cabbage and by numerous research studies in Alaska (7). Thus, the longer period of sunlight from March 20 to September 20 and the better internal plant condition for photosynthesis are advantages to growth if soil temperature or other factor does not limit the activity.

It has been demonstrated that one of the most critical environmental factors that limits the growth of many crops in Alaska is the soil temperature (4,5,6,7). Soil temperatures that seldom rise above 13-18°C. at the 10 cm. soil depth during the growing season impede seed germination and severely limit the growth of certain economic plants. The optimum soil temperatures for most cultivated crops ranges from between 21 and 30°C. Increased soil temperatures resulting from the use of clear polyethylene on the soil, electric heating cables and buried styrofoam give greatly increased growth of crops and earlier maturation (7). Clear polyethylene mulches cause soil heating by solar radiation because of the entrapped layer of still air, reduced moisture evaporation and the lower transmission by polyethylene of the heat radiation from soil as compared to the high transmission of incoming solar radiation. The improved soil temperatures allow the crops to take full advantage of the long sunlight days, and often higher yields are measured than those produced in the best commercial production areas of the nation.

Research in climates such as Minnesota show that soil warming by waste heat does provide some improved growth rate and some extension of the growing season (1,2). Due to normally warm soils during mid-summer in Minnesota that are near optimum for plant growth, waste energy can only be used during the spring and again in the fall. Alaska, with the much colder soils throughout the year and the greater sunlight during the growing season, offers greater advantages for waste heat utilization for the production of high value crops.

The feasibility for the use of low temperature waste heat for heating of greenhouses has been reported (3, 10, 11). A large greenhouse industry has developed in Iceland using warm water from geothermally heated springs for heating. A viable seasonal greenhouse industry has developed in Alaska using fossil fuels for a heat source. There is a significant need to expand this industry utilizing waste heat from industrial and geothermal sources. The rising cost and scarcity of fossil fuels to heat greenhouse units is a major threat to the stability and continuance of the nation's greenhouse vegetable and ornamental units. These factors appear to be blocking expansion and may actually terminate the greenhouse industry in areas where alternative methods of heating cannot be found.

Energy from industrial sources, usually in the form of hot water at temperatures from 21 to 70°C, is normally wasted by discharging it into the air or into bodies of water. These point sources of unused heat represent a poor stewardship of our resources and cause an environmental impact of considerable concern. A systematic approach to the utilization of unused heat suggest its' use in district heating of

houses, businesses and greenhouses, and in warming field soils for crop production.

Extent of unused heat: The efficiency of modern fossil fueled electrical generator plants is approximately 40%, while that of nuclear plants ranges between 30 and 33%. Thus, of the total energy available from the original fuel source slightly over one-third is presently used. The remaining two-thirds is rejected by being discharged into the environment. About 85 percent of the rejected heat is discharged into water bodies and 15 percent is discharged into the environment through the stack. Enormous quantities of very high temperature steam will be exhausted from the Energy Resources of Alaska refinery at North Pole, Alaska. Each pumping station along the trans-Alaska oil pipeline will exhaust large quantities of heat. It has been estimated that the 12 pumping station and liquefaction plant for a trans-Alaska gas line may exhaust approximately 36 million BTUs per second.

Facilities:

The Agricultural Experiment Station 40' x 90' existing greenhouse with attached head house will be used to produce test plants and for initiating the greenhouse work. One 30' x 40' section of the greenhouse will be slightly modified to simulate conditions that will be associated with a source of hot water.

The major plot work will be done at Fort Wainwright near the Power plant cooling pond. The U.S. Army and CRREL are concerned about the vapor pollution problems associated with the cooling pond and about the thermal waste. They have agreed to support a joint effort to the extent that they will provide engineering and most of the construction for the study site. The Agricultural Experiment Station wishes to cooperate by supplying the horticultural research effort.

CRREL has leveled the land adjacent to the site, added peat soil amendment to our specifications and are presently in the final stages of installing the distribution system and the piping to heat some test plots. There presently are 3 test plots 50' x 150' that will be heated with adjacent control plots. CRREL presently has plans to construct greenhouse facilities adjacent to these test plots to transfer the technology from the Agricultural Experiment Station greenhouse to an operational system.

Tasks:

To determine proper crop varieties and productive capacity of vegetables under the proposed system of near optimum soil temperature.

To determine the amount of season extension that can be achieved both in the greenhouse and out of doors using soil heating with and without plastic canopies.

To determine the proper fertility and irrigation practices necessary for this type of system.

To examine the possibility of growing commercial cut flowers such as roses, carnations and chrysanthemums by using a system that has heat provided in the soil and that would grow for 9 months and during the dark months of November, December and January would be held at a storage temperature of approximately 35°F. During the dark period the greenhouse would be modified with heat saving shields similar to those used in Europe so that heat loss could be reduced.

To determine if unusual disease and insect problems may develop as a result of the warmer environment.

Additional Project Objectives:

Concurrent with the horticultural objectives, data will be produced that will be useful for improving the collection and distribution system for waste energy in northern conditions.

Information will be gathered on thermal and vapor pollution abatement.

Personnel:

The Principle Investigator and leader for the Agricultural Experiment Station effort will be Dr. Donald H. Dinkel, Professor of Plant Physiology. The legislation is largely to provide research assistance to Dr. Dinkel.

The Principle Investigator and leader of the CRREL effort will be Dr. Terry McFadden.

Pertinent Questions and Answers on Subject - Waste Heat

By
D. M. Dinkel

Q. What is waste heat?

A. Waste heat is the term commonly used for energy that is rejected from various industrial sources. It usually results from the burning or other consumption of fossil fuels; however, it may also result from nuclear power plants or represent the unused heat from geothermal sources. The waste heat rejected from a process using fossil fuel usually exceeds the amount of the energy that is put to useful work such as the production of electricity. For example, most electrical power generation facilities that operate with fossil fuels have only a 30 per cent efficiency and the remainder is rejected as hot water or hot air.

Q. What is the extent of unused heat in Alaska?

A. The quantity is enormous at the present time and it will increase greatly as the pipelines, refinery and other power plants are placed into operation. It is estimated that each pumping station along the Trans-Alaska Pipeline could heat 2000 homes. The estimate for the North Pole Petroleum refinery is that 10,000 homes could be heated. Canadian sources estimate that each pumping station associated with their Mackenzie Valley Pipeline will produce enough clean waste heat to meet the requirements for 15 to 20 acres of greenhouse vegetable production. However, there has not been an inventory made of the present and future status of the waste heat that will be rejected and that could be used in the state.

Q. What are some proposed uses?

A. Agriculture, fisheries and aquaculture, forestry, processing and district heating in commercial and domestic areas. High temperature waste heat also may be useful in some cases for the generation of electricity where uses can be found for the remaining lower temperature heat so that vapor and thermal pollution is not a problem. For example, it would be technically possible to generate electricity from the high temperature waste from the North Pole Petroleum refinery. However, if this is done the reject energy would be in a form that could not be injected into the upper atmosphere and would create a vapor or ice fog problem during winter months. Agriculture and district heating could provide a use for this remaining low temperature reject energy.

Agriculture

The high temperature reject heat could be useful for forage and grain drying and may provide the necessary component that would make potato processing feasible in the state and therefore, expand potato production.

Heat energy consisting of hot air, hot water or steam and at temperatures ranging from 80°F to 800°F would be useful for greenhouse

production and vegetable and plant production in areas that would support horticulture crop production resulting from soil warming. The use of the heat in greenhouses and then during the summer months in the soil for crop production is necessary to all wise proposals that suggest a near total use for the energy. This crop use is probably necessary because it can utilize the low temperature energy and would utilize the heat as less is needed for other uses. It appears to be an important part of every systems approach to utilizing this resource because the near total use of the resource will make the collection and distribution more economical for each use.

Aquaculture, Forestry Processing and District Heating

The use of heat to improve production of fisheries through hatchery rearing and in fish production ponds is suggested. The heat requirement for forestry, processing industries and in district heating of homes and businesses is obvious if the heat can be collected and distributed. The more complete use that would result by greenhouse and soil heat use would provide a better economic picture for the above uses.

Q. Is our environment suitable for the types of intensive crop production that is suggested?

A. During the four summer months it is superior to most other areas of the nation. The northern latitudes are recognized to have the highest photosynthetic production rate in the world during these four summer months. If the season can be lengthened and/or the soil warmed, the productive capacity can be further increased, and this photosynthetic advantage further exploited.

Q. Why hasn't the greenhouse industry developed without the waste heat use?

A. It is one of Alaska's major agricultural industries at the present time, but it has been developed through the use of fossil fuels which are even higher in cost than they are in the rest of the nation.

Q. There are indications that hundreds of acres of greenhouse and soil heated vegetable production is possible. Could all of these products be marketed in Alaska?

A. No. Besides providing Alaskans with vegetables and ornamental plants, it would be necessary to market cut flowers such as roses, carnations, chrysanthemums and etc. on national and world markets. It is proposed that this could be done competively during 5-6 months of the year because of Alaska's superior environment for greenhouse production and through the use of waste energy.

Q. Why do you feel that it is important to examine national and world markets for cutflowers?

A. Because it appears to be necessary at the present time in order to make more complete use of our unused resource. It also would add to the stability of our economy to have a renewable resource such as this contributing to the state's economy. It would also decrease the nation's consumption of fossil fuels now used for this purpose in the present greenhouse growing areas.

Q. What will be the temperature of the Waste Heat?

A. The temperature of the reject heat energy will vary with the type of industry and will range from about 80°F to above 800°F. It will be exhausted as hot air, hot water or steam.

It is expected that not all reject energy could be utilized at this time because of accessibility problems, the lack of adjacent growing areas and the lack of technology. A systems approach with agriculture as a major user appears to give the best potential.

Q. What is the urgency in the legislation now in process?

A. We must promote the use or it will not happen. The potential for use must be designed into the system in the beginning in order to develop the most economical recovery system. For example the oil pipeline pumping stations were not designed with reject heat use in mind, and, therefore, it will cost more to recover the heat.

Although the technology appears to be available at the present time to make economical use of the energy, it is necessary to demonstrate this and to improve this technology.