SCOMM

#44:9

FY 81 budget
Staffers / DOT

STATE OF ALASKA

JAY S. HAMMOND, GOVERNOR

DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
RESEARCH AND DEVELOPMENT

P.O. BOX F
FAIRBANKS, ALASKA 99708

January 15, 1980

Representative Brian Rogers
Pouch V
Juneau, Alaska 99811

Dear Representative Rogers:

I have enclosed a revised summary of energy related projects currently underway in our section for your information. We have some requests for new project funding, and funding to continue other projects in the FY81 Administrative Budget. However, we made that budget up back in July when our program was very young. Since then we have learned a great deal and some new projects which we feel are very important have been identified. I have enclosed a discription of these supplemental projects and the money required to initiate them. The timing was such that we could not get them included in the Administrative Budget, although we are trying to get this accomplished. If we are unsuccessful I would like to explore with you our options.

I know you'll be busy from now on, but when you get the chance please give me a call at 479-2241.

Sincerely,
Laurence Soden
Acting Director

Lee Leonard
Acting Statewide
Research Manager

Enclosures

LEL/dw

A-T28LH

NEW PROPOSED PROJECTS
DOTPF Statewide Research Section
Energy and Buildings Research Program

Organic Rankine Cycle Power System $120,000

A research project was conducted over the summer and fall of 1979 by this office to identify and develop a highly reliable, low maintenance electric power supply system which was an appropriate alternative to the diesel-electric generator for powering runway lighting systems at rural Alaskan airports. What came out of that project was a system which utilized an organic Rankine Cycle turbo-electric generator as the primary component. The major advantages of this system are its high reliability, its minimal maintenance requirements, and its relatively long life cycle (twenty years). Also, we found that the generator permitted the use of a simple waste heat recovery system which greatly enhanced the overall efficiency.

It appears promising that a larger system of this type, properly designed and engineered, could be used in a rural State facility, such as a school, to supply all of the electrical load of the facility and all, or a substantial portion, of the heating load. If indeed such a system could be developed, significant cost and reliability advantages could be realized over conventional systems.

Since this particular energy conversion system is of the external combustion type it would be possible to utilize a variety of fuels; oil, gas, alcohol, wood, coal, hydrogen, geothermal heat and solar power could be considered.

We believe it would be most appropriate to conduct a research project for a building energy unit of this type as soon as funds can be approved.

Energy Retrofit of a BIA School $75,000

A recent energy audit of rural Alaskan school facilities has shown that fuel consumption to heating and electricity production often reach eight or ten times the appropriate amount for a given building size. While inordinately high energy consumption is a symptom of many rural facilities it is the older schools - many of them built during the BIA era - which pose the most acute problem. Many such facilities exist and will continue to be used in one form or another for many years. It follows that significant long-term savings could be realized if these facilities were suitably retrofit to conserve energy.

It happens that there exists on the Fairbanks campus of the University of Alaska, a three-room model of an older BIA school built several years ago and still used during the summer months as a training facility for rural teachers. This building has never been interconnected with the University utility system and remains in an independent state that is very similar to that of many older schools now used in the bush.

The University has requested that a joint project be undertaken between the DOTPF Statewide Research Section and the University to supply a complete energy retrofit to this building which would be a development model for future retrofits which will necessarily take place on similar bush facilities. The University would finance the materials and construction costs and DOTPF would furnish the design and provide for a monitoring system to evaluate the various modifications for effectiveness.

This type of project could be most valuable. For the University it would provide a year-round training facility which could also be used to demonstrate the advantages of energy retrofits to interested individuals and groups as a public service. For DOTPF it would provide a convenient laboratory to study and assess various design options for their effectiveness and application in an effort to develop useful design standards for future projects.

Fuels Research $70,000

Today Alaska is rich in conventional energy resources such as oil and gas, which can be readily processed into the fuels on which all of our State facilities depend. However, many State facilities which exist now or will soon be built may face the problem of converting to a new fuel source one day as conventional fuels become less readily available. In order to be prepared for that probability it is appropriate for DOTPF to research and develop the options and technology which can be adapted to Alaskan conditions. A project to investigate hydrogen storage methods appropriate to Alaska's needs is underway and requires additional funds to continue. Research into the production and distribution of other potentially useful fuels, such as alcohols and synthetic fuels, is also needed. Energy conversion equipment needed to utilize the alternative fuels must also be examined in critical investigations to assure compatibility with and adaptability to the unique Alaskan environment.

Continually examining the fuels question by engaging in several small projects permits us to keep abreast of the quickly developing technology and to provide the best advice at decision making points in an energy dependent economy.

Energy Discretionary Fund $35,000

Given the current energy crises atmosphere, the rapidly accelerating developments in alternative energy technologies, and the unique climate and logistical problems of Alaska, it is no small task to plan a well balanced, project oriented research and development program. The utter void of background research relevant to Alaska's particular needs leaves us with no well defined indicators to suggest a direction toward the solution of many energy problems.

The development of a program in its infancy is therefore trial and error. Some projects will lead to dead-ends while others will bring us to a proliferation of sound new ideas with direct applications waiting to be addressed.

This has already happened in the case of organic Rankine Cycle electric generators. Examination of one specific application has opened the door to several new and potentially valuable applications. When this occurs, or in general when a change in course is required from that originally planned, a project oriented program often becomes stalled until a new funding cycle releases the appropriations needed to adapt to changing priorities. This is common and often a valuable restraint on certain types of programs. However, in the case of developing energy alternatives under present conditions, time is of the utmost importance and a stalled program could result in serious implications.

We believe that the establishment of a block of discretionary funding, provided at each appropriation cycle to be used as needed to supplement existing projects and develop new ones as priorities change and opportunities are presented, would greatly strengthen the Energy and Buildings Research Program.

9 January 1980

Brian:

I promised a proposal to you for wind power work in the Interior, and near Fairbanks. I decided that instead it would be appropriate for our to-be-proposed "Energy Center". However, I enclose a preliminary over-view of what I would hope to do; I am concerned that the "Energy Center", even if established, might not be able to move fast enough to achieve out-door construction during 1980.

So, please consider this information not as a proposal outside regular channels, but for your advance planning, and possible comment. Thanks. Best regards,

Tunis

Tunis Wentink Jr.
(479-7607)

Brian Rogers: Not a proposal yet; for your advance information and possible comment. Good luck. Denis Wentink Jr.

WIND POWER

Wind is the motion of air heated by the sun, and as such wind energy is considered part of solar energy. However, since wind power shows great promise for Alaska, especially for an early pay-off and particularly in rural Alaska, it is treated as a separate topic. Wind power and wind characteristics related to useful application of windmills also called wind machines, wind-driven turbines, wind energy conversion systems (WECS, etc.) have been studied by the University of Alaska (mostly at the Geophysical Institute) since early 1973. These fund-limited activities should be expanded and soon.

The current status of applied wind power for Alaska can be described as follows:

1. An inventory of the wind resources of Alaska is quite well in hand, with the near-surface wind characteristics of some 140 locations known.
   (a) Much of these data are in the UACN computer files. A wind characteristics atlas is in preparation.
   (b) Some further critical evaluation of the data and new measurements are desirable. Wind prospecting of some known marginal sites and new sites should be done.
2. A continually up-dated computer-based file of the generating characteristics (e.g., Power vs. Wind speed) of various WECS is used with (1) above to predict the energy productivity of these machines. Accompanying economic studies showed

Brian: Please note in particular pages 2 and 3.

the potentially large cost benefits to users of wind power, especially in many of the Alaskan villages.

3. While some WECS are operational in Alaska, the low power involved (few kW) and the high failure rate indicate more careful evaluations in Alaska should be made to protect and guide Alaskans.

   (a) A test facility (or section with the "AC"*) should be established to evaluate WECS in very low temperature regimes. Continuous monitoring of the mechanical and electrical behavior is highly desirable.

Brian R. Please note →

   (b) Despite earlier pessimism on useful wind power for interior Alaska, especially around Fairbanks, new wind data indicate that a useful test facility can be located near Fairbanks. For instance, Murphy Dome has adequate winds, especially in the fall and winter! (Ester Dome is a possible alternative, but needs a wind survey first.)

4. Many considerations in the USDOE Wind Energy Program indicate that federal support for meaningful (sufficient power) wind power demonstrations and applications in energy-deficient villages will be slow in coming. The state needs to provide the necessary capital and manpower expenditures to accelerate the deployment of the WECS.

*"AC" stands for the acronymn of the actual name of the Center eventually chosen.

FIVE-YEAR OUTLINE OF WIND ENERGY PROGRAM

WIND ENERGY FIVE-YEAR PLAN

The objectives of the wind energy program are to supply reliable wind information for Alaskan planners and to evaluate and publicize suitable wind machines (or WECS) for Alaskan use. The ultimate goal is always to establish (through cooperative programs) operational wind energy systems in communities, with emphasis on rural and small villages. To achieve this, we propose to:

	Program Years
A. Revise and distribute the wind atlas data in regional formats (e.g., the Regional Corporation boundaries), for all communities within those boundaries (native or otherwise).	1-3
1. Establish (or guide others in) further measurement stations to fill wind data gaps.	1-3
2. Expand the present data base and resulting reports to include machine productivity predictions (presently not part of the wind atlas).	1-2
B. Establish and operate a wind machine test facility	1-5
1. Purchase, install and test two machines (10 kW and 40 to 60 kW rated), at a hill site near Fairbanks.	1-3
(a) When operational, provide training for visitors from Alaskan communities; e.g., teachers and village operators.	1-5

(b) Invite visiting manufacturers, utility representatives, private industralists and government agencies to use the facility (on a cooperating cost-sharing basis). 2-5

C. Install, in cooperation with others (recall B-2-b), machines (or clusters of machines) in communities to provide significant electric power for general use. 2-5

D. Test energy storage devices, developed by others (recall Solar Section above), adapted for WECS. 3-5

E. Prepare and distribute all results from the test facility for public use, especially in Alaska. 2-5

	BUDGET*
1st year	$260,000
2nd year	260,000
3rd year	185,000**, †
4th year	180,000**, †
5th year	180,000**, †
	$1,065,000 ($213,000/year)

*In 1979 dollars, not corrected for inflation or increase in UAF rates.

**Assumes any new WECS will be funded by manufacturer, special appropriation, or none-UA agencies.

†Assumes any WECS demonstrators outside the UAF test facility will be funded (including sub-contracts from industry, or local labor) by on-site users or special appropriations.

NEWS RELEASE NEWS RELEASE NEWS RELEASE NEWS RELEASE NEWS RELEASE

UNIVERSITY OF ALASKA-FAIRBANKS
Public Affairs, 7th Floor Gruening
Fairbanks, Alaska 99701 (907) 479-7581

RELEASE DATE: Immediate

"We are going to have to scramble for every bit of energy we can get." That's the opinion of Dr. Tunis Wentink of the University of Alaska-Fairbanks Geophysical Institute who also predicts continued price increases and shortages of fossil fuels.

In scrambling for energy, Wentink sees men returning to the use of water power as a partial solution to the energy shortage. He also sees the adaption of solar and geothermal energy, but he is really excited by windmills. Tunis Wentink is a devout windmill advocate. "I got particularly interested in them during the 1973 oil embargo ...I guess it is my Dutch background."

Alaska is a natural for wind power utilization according to the UAF professor. "It makes so much sense up here in Alaska, especially along the coast where we have a lot of people and a lot of wind," he said. Actually, wind power has a tradition of use in Alaska. People in Pt. Barrow used them extensively and abandoned windmills are found throughout the state.

Wentink thinks rural Alaska should once again install windmills. "In many, many villages, people using wind power can pay them off in five years or less through oil savings," he said. 'Electrification of rural villages--that's where I think the immediate payoff will be."

"It is never going to meet all of their energy needs. I still like to stress that it is a supplemental source, because the wind does not blow all of the time... Then you've also got the storage problems."

If a windmill is the only source of power generation, then a storage system, usually a bank of heavy-duty batteries, must be prepared for windless days. Without a storage backup, when there is no wind, there is no power.

-over-

In a supplemental system, the wind-powered generator is coupled with an existing power-generating system. On still days the existing system provides electrical power. On windy days the windmill takes over. Controlling the system is a synchronous inverter which Wentink described as "an energy traffic cop" directing which system is to provide power.

Such a paired system would eliminate the need for storage batteries and at the same time reduce fossil fuel consumption and, thus, costs.

Because of high fuel costs, which are severely aggravated by expensive transportation, electricity in some bush communities is now up to 35 cents a kilowatt hour. Depending on the village location, supplemental wind-powered generation "could knock that price down a factor of two-to-five...In many places that electricity could be produced for in the neighborhood of 10 cents a kilowatt hour," Wentink said.

Wentink believes there is the need but not the will for wildmill electrical generation. "The only thing holding back implementation of meaningful wind power in Alaska is money...Everybody thinks it is a great idea and no one is willing to spend money on it. And you can quote me on that in capital letters," he said.

Most people think of windpower as a free ride. It's not. "No kind of energy extraction device is going to be cheap," he said. Today's windmill construction costs run about $1,000 a kilowatt. Nuclear and fossil fueled plants are in the $500-600 a kilowatt range.

At this point there is no company in large-scale production. The economies of scale and mass production haven't been a factor in reducing production costs. The target production cost is about $750 per kilowatt in 1977 dollars. Wentink describes it as the old chicken vs. the egg problem. Windmills are too expensive because there is no market for them. There is no market because they are too expensive.

Still, as other energy costs soar, wind power will become a more viable energy source, Wentink feels. Before windmills can be installed, studies of site potential must be made and the results distributed. Wind records from as far back as World War II are being evaluated to provide data.

-more-

The research on the subject "has generated a lot of statistical analysis, a lot of numbers and a lot of mathematics. This is not what the guy in the bush needs. He needs tables, pictures and simple graphs at the most to answer the question, 'Can I use a windmill somewhere?' He needs the answers to real practical questions," Wentink said.

Under a grant from the Alaska Department of Transportation and Public Facilities Division of Energy and Building Research, he is preparing such a handbook. It will include applications and a map of high potential areas. The handbook is scheduled for completion after the first of the year.

With the handbook available and the economic pressure to find alternatives for fossil fuels increasing, Wentink sees nothing but increased utilization of wind power. He predicts no major technological breakthroughs and said none are necessary. All it will take for widespread, wind-powered, electrical generation is money and going out and doing it.

CONTACT: Dr. Tunis Wentink - 479-7607

SL/12-20-79/201

Demonstration

Priority 1980 #1
Budget 3 yr, $9,000,000

Conservation

Medium-sized Community Total Retrofit Program

It is estimated that 30% energy savings can be had by a (capital-intensive) well planned retrofit program. $2,000 per household will be disbursed for direct re-investment into house and auto conservation. Also, another [$2,000] per household will be invested in community-wide energy conservation projects and low cost loans to commercial users. No untested technologies will be used, only off-the-shelf products and technologies. Using Valdez, population 8,000, as a working example, about $4,000,000 will be spent on direct subsidies, another $4,000,000 on commercial and city-wide projects. A $1,000,000 overhead budget will bring the total to $9,000,000 over a three year period.

R & D

Priority 1980
Budget $40,000

Biomass

Biogas Feasibility in Alaska

This project will use the data on biogas feasibility from other regions and adapt the findings for the Alaskan climate. Special issues that need to be examined are the possible yields and costs for developing systems to handle cannery wastes, the effect of low ambient temperatures on net energy production, and the economics of energy at fairly remote cannery sites. This study should be a private contract of six months duration, with a budget of $40,000.

R & D

Priority 1980
Budget $40,000

BIOMASS

Alcohol Feasibility

This project will use the data generated in other states on the feasibility of alcohol production from biomass and adjust the economics for Alaskan conditions, using crops and yield per acre data consistent with the Alaskan agricultural and biomass situation. It will include possible future scenarios. Attention must be paid to the use of the high protein by-products of distillation.

This should be a private contract. Cost will be $40,000, and be completed in six months.

R & D

Priority 1980
Budget $40,000

Building Design

Passive Solar Feasibility for Alaska

This project would take the solar radiation and climate data available for 17 locations in Alaska, develop specifications for a non-solar standard house (Ashrae 90-75-R) and four passive solar/energy conserving houses, and compare their performance, including initial cost, energy savings, and dollar savings, based on current energy prices in the 17 locations. Cost for this project will be $40,000, for approximately 100 computer runs, plus analyst salary. This project will have a four month duration and be administered by private contract.

Outreach

Priority 1980

Budget '80 $142,000
'81 " "
'82 " "

Outreach

Renewable Energy Library.

The State should combine its existing alternate energy library with the one funded by D.O.E. through the Alaska Center for the Environment to provide a central library available on site or via mail order to anyone in the state. A permanent facility will be leased. A staff of two librarians and one clerk will be hired. Funding will also be necessary for purchase of books and materials. This library will also be the repository of all reports and project summaries of Renewable/Alternative Energy Projects in the state. Costs are: facility lease -- $12,000 per year, salaries, $60,000, overhead, $60,000, and materials purchase, $10,000, for a total of $142,000.

Outreach

Priority 1980 #1
Budget $44,000

Education

Community College Renewable Energy Program

This project will fund travel, salary, and per diem for two Renewable Energy Survey Seminars, three days each, to be given at each community college campus in the state. Each of the two seminars would cover different technologies. Economics as well as hardware will be addressed, with emphasis on references and where to go for further information. Each seminar will cost $2,000, including travel and per diem. There are 11 colleges, a total of 22 seminars, for a budget of $44,000. This should be a private contract through the University.

Outreach

Priority 1980 #1
Budget $70,000

EDUCATION

Outside Experts Seminars Project

Ten selected renewable energy experts from the Lower Forty-Eight will be brought up for one week each to meet with both Alaskan experts and the general public about their respective fields. Travel, per diem, plus stipend will be about $5,000 each. In addition, $20,000 for overhead and outreach will be needed, for a total of $70,000.

Priority 1980 #1
Budget $750,000

International Conference

International Conference on Renewable Energy for Cold Climates

This project will bring together 200 of the world's experts on cold climate renewable energy. It will be open to the public and other professionals as well.

This will be a first rank scientific conference. Total budget for participant travel, stipends, proceedings, and facilities will be $750,000. The State should budget the entire amount; however, matching federal funds may be available.

Outreach

Priority 1980 #2

Budget '80 $1,000,000
'81 " "
'82 " "

Local A.T. Centers

Grants for A.T. Local Non-Profit Self-Help Groups

This program will make $1,000,000 available as grants for local non-profit groups to help establish and run renewable energy/appropriate technology self-help groups similar to the Federation for Community Self-Reliance in Fairbanks. The funds may be used for education, staff funding, rent costs, demonstration projects, etc. It is estimated that 15 centers could be established with these funds.

Outreach

Priority 1980 #1
Budget $6,750,000
per year

Planning/Education

Community Energy Advisor Program

This program is designed to provide all communities in Alaska with populations greater than 2,500 with a full-time trained energy advisor to assess present energy resources and needs and to develop programs that will reduce fossil-fuel generated energy in both the public and private sectors. This program will have a three year duration in the approximately 20 communities of medium size, and permanently in the three largest communities of Anchorage, Fairbanks, and Juneau.

The salary, overhead, and expenses for the 20 three year positions will be about $100,000 each per year, or $6,000,000, total. The three larger cities would be budgeted at a higher rate, $200,000 per year for Fairbanks and Juneau, and $350,000 per year for Anchorage, for a yearly total of $750,000. The dollar savings to the city government and citizens should equal the cost of the program.

Outreach

Priority 1980 #1
Budget $75,000

Hardware/Design

"How to" plans for do-it-yourselfers

This project will develop a set of 15 "how-to" plans for energy conserving devices that can be constructed using simple tools and locally available materials. Included will be passive solar hot water heaters, passive solar wall collectors, water heater insulation jackets, shutters, flatplate collectors, air-to-air heat exchangers, savonius rotor pump, savonius rotor alternator efficient wood stove, stovepipe waste heat devices, et cetera.

Selection, construction, and plan development costs will depend on what existing plans can be used and what devices are chosen, but will be approximately $75,000. Printing and distribution costs will depend on demand. This project should be a private contract via the Energy Extension Service of the Division of Energy and Power Development.

R & D

Priority 1980 #1
Budget $80,000

Transportation

50% Auto Use Reduction Scenario Development

This project will choose an Alaskan community that is not integrated into the highway grid as an example for developing public transportation scenarios that would reduce private auto use by 50%. A budget should be developed for each scenario, including detailed energy economic studies. This project should emphasize new approaches and not be restricted by previous approaches or profit-making. This project would be a six month project via a private contract, with a budget of $80,000.

R & D

Priority 1980 #2
Budget $120,000

Planning

Solar Energy Conservation Planning Strategies for Anchorage, Juneau, and Fairbanks

Strategies to incorporate energy as a main planning constraint. This would include adapting existing subdivision and PUD guidelines or writing additional codes as deemed necessary by the investigator. There are several existing Municipal codes that may be used as models, to be adapted to the Alaskan climate and latitude. The main thrust will be to define basic lotting, streeting, and house orientation may be planned to save energy. Architectural features will not be addressed. The budget for each city will be $40,000, or a total of $120,000. This should be a one year private contract.

R & D

Priority '81 #1
Budget '81 $120,000
'82 $240,000

Building

Regional Energy Efficient Building Strategies

Using the Building Climate Zone Study as a baseline, strategies for building envelope design homes, including solar usage, will be developed. The number of strategies will depend on the number of climate zones defined. This study is envisioned as a synthesis of mechanical engineering, architectural, and computer knowledge using state-of-the-art programs to estimate and simulate the energy use of buildings in specific climate situations. The result will be rules-of-thumb guidelines that may be used to optimize energy conservation. Phase One, as outlined above, will cost about $120,000, with about $80,000 for salaries and subcontractors, $20,000 for computer, and $20,000 for overhead.

A second phase will be to develop the above into a set of energy building standards, and will be accomplished for about $40,000 per climate zone. Both phases of this project should be carried out under private contract.

R & D

Priority 1980 #1
Budget $40,000

Conservation

Village Generator Waste Heat Recovery

R & D

Priority 1980 #1
Budget $40,000

Integrated Systems

Wind/Hydrogen Electric Power Feasibility Study

A community with a population of 500-1,000 will be selected on the basis of, (1) energy economics and, (2) high wind-electric potential as a model for a wind generator farm. This wind farm will utilize hydrolysis of H_2O during periods of high wind to manufacture hydrogen, which will be stored and then utilized for electric generation during low wind periods. Special attention will be paid to (1) the amount of storage needed for hydrogen, (2) safety considerations, (3) life cycle costs for the wind and hydrogen systems, (4) effects of intermittent use of fuel-powered generators or batteries, and other storage methods.

Estimated cost for this project is $40,000. This should be accomplished as a private sector contract.

Baseline

Priority 1980 #1

Budget '80 $200,000
'81 $80,000
'82 $80,000

Climate

Solar Energy Measurement Program

There are currently six solar radiation measuring stations in Alaska. This should be increased to 15, and the existing stations updated to record solar radiation on a horizontal surface, a vertical surface, and at the latitude tilt of the station. This involves the purchase of 40 Eppley pyronometers, integrating and recording devices, and salary for a technician to install equipment, maintain the stations, and analyze the data. First year costs would be about $200,000, with additional years at about $80,000. This project could be farmed out under private contract, and supervised by the State Climatologist.

Priority 1980 #1

Baseline Data

Budget '80 $1,000,000
'81 $1,000,000
'82 $1,000,000

Planning

Local Energy Use and Resource Analysis Program

This program will provide several levels of service designed to assess the present energy needs and resources and develop energy plans of 200 communities in the state, with populations of 100 to 2,500. A specific program will then be developed for each community that will emphasize conservation strategies, ways of utilizing waste heat from generators, wind and solar applications, and that will analyze other locally available energy resources, such as micro-hydro or locally available natural gas. The study would then

It is estimated that the conservation and waste heat savings alone will cut energy use by 25 to 30 per cent.

A program designed to provide a minimum of three days and a maximum of two weeks field time per community and one week office time per community will require an active staff of about eight energy analysts, a project manager, an assistant manager, and three full-time clerical personnel. This staff will carry out all of the necessary field work and analysis in a three year period, with a budget of $3,000,000. This project could be handled by private contractor.

Baseline

Priority 1980 #1
Budget $75,000

Economics

Economic Considerations of Renewable Energies

Phase One will decide which economic issues need to be addressed. Examples include the effect of existing energy costs on the economic attractiveness of energy sources other than petroleum, large electric generators, using the reports being generated by the other projects, costs of various devices, mapping of areas where alternate energies are economically feasible, and other considerations. The report generated should indicate further research projects and budgets. Costs will be $75,000. This should be handled as an in-house project by the University.

Baseline

Priority 1980 #1
Budget $40,000

Hardware

Renewable Energy Hardware Availability Assessment

This project would identify all alternate energy devices available on the market, and via product literature assess their suitability for use in Alaska. Devices would include wood stoves, whole house energy plants, dual fuel source stoves, energy efficient heaters, appliances, wind generators, solar collectors, water heaters, shutters, heat exchangers, small hydro plants, and any other devices. This will be a "paper" research project only, with a followup project to purchase and test real products)see A.E. Testing Lab). This project would have a six month duration, and a budget of $40,000. It should be administered by the Energy Extension Service.

Baseline

Priority 1980 #1

Budget 1980 - $900,000
1981 - $500,000
1982 - $500,000

Climate Data

Wind Energy Prospecting Program

A team of five field persons, one analyst, and a Project Manager will locate areas in Alaska where wind energy can be used to either supply entire communities with electric power or to supply power to an existing grid.

Since most sites will be remote, a highly sophisticated type of anemometer and recording device capable of being "read" by satellite is recommended. Each anemometer will be in place for one year. The 40 best sites will remain, and 40 others will be moved to new locations.

Five field persons could situate about 80 anemometers in the course of a year. The initial purchase cost for 80 anemometers would be about $400,000. Salaries, overhead, and expenses would run about $500,000 per year, the major portion being transportation costs to remote sites. This project could be carried out on a private contract basis.

Baseline

Priority 1980 #1
Budget $75,000

Building Design

Building Climate Zone Mapping

This program would analyze all factors of climate and topography as they relate to building energy-efficient structures. A series of maps will be developed that show the zones where similar building strategies will be effective. This study will be carried out from existing documents, using techniques developed by H.U.D. and various state energy administrations (e.g., California).

The information generated by this research will serve as a basis for developing regional building guidelines and architectural energy-efficient design competitions.

Estimated cost for a definitive study is $75,000. It is suggested that this be carried out by the private sector under contract through the Division of Energy and Power Development.

Solid Waste Incineration/Generation Feasibility Study

This project will use existing data on the state of the art in waste incineration for power generation and waste heat recovery to develop yield figures for Alaskan communities. Sample communities of several sizes will be selected for further feasibility studies, including electric yield and various uses for the recovered waste heat, including district heating, process heat for health facilities, and greenhouses that use the electricity for winter fluorescent lighting, and the recovered heat for space heating. This project should be under a private contract of six months duration, with a budget of $40,000.

Demonstration

Priority 1982
Budget $1,300,000

Integrated Systems

Hydrogen/Wind Demonstration Project

The Bush demonstration project will assemble three 100 KW hydrogen generators, couple them to a wind farm of multiple small wind electric generators and a storage system for hydrogen. The wind would provide electricity for the village, with the surplus electricity used for the production of hydrogen which would then be stored for running the diesel generators now used to power the village. The hardware costs for the wind generators will be about $300,000, and the hydrogen plant and storage will be about $1,000,000. This project will involve two private contracts, one for the hydrogen equipment and the other for the wind equipment and the electric interface. The total budget will be $1,300,000; funds from the Federal Department of Energy may be available for 50% of the cost.

Demonstration

Priority 1980#1

Budget '80 $200,000
'81 $40,000
'82 $40,000

Integrated Systems

Energy Efficient Greenhouse Demonstration Project

This project will select an area that is suitable for three season food production from a greenhouse and develop a site-specific greenhouse that will maximize energy efficiency. Special care will be paid to the envelope design and the space-heating and ventilating systems. An equation using standard greenhouse construction and operating costs will be used as a design constraint, with the energy efficient greenhouse construction and operating costs designed to equal the costs of a standard greenhouse over a 20 year period. The greenhouse will then be built, and a thermal monitoring system installed. Salary for a local greenhouse grower/manager will be paid for two years. After two years the facility should be turned over to the local community for use as it sees fit. Costs for design will be about $10,000. Costs for construction for a one-eighth acre greenhouse (5000 square feet) will be about $160,000, including a low cost monitoring system. Salary will be $40,000. Additional operating expenses will be $15,000. Profit generated from vegetable sale will be used for additional operating expenses. Total budget for the first year is $200,000, with additional years at $40,000.

Demonstration

Priority 1980 #1
Budget $680,000

Building Design

Energy Conservation/Passive Solar Housing Competition

Three regional competitions will be held, one for the Interior, one for South-East, and Anchorage, using energy use per square foot as judging criteria. A cash award of $25,000 will be given to the winner in each area. The houses will be bid on by local contractors and built under close supervision. Designer-owner-builders will be eligible. The cost of the competition will be $180,000including promotion, judging, administration and prizes. Construction will cost an additional $500,000.

Demonstration

Priority 1980 #1

Budget '80 $925,000
'81 $75,000
'82 $75,000

Total Systems

Model Urban Integrated Systems Retrofit Demonstration

This program will purchase one house in each of Alaska's five largest cities, and totally retrofit the house for energy conservation, renewable energy use, food production and waste resource usage. This will serve as a demonstration to the rest of the community of the state-of-the-art in retrofit, as well as the benefits of using the waste from one process as the base material for another process. An estimate of house purchase cost is $100,000 each, plus $20,000 each design costs, $50,000 each for retrofit measures, and a "stipend" of $15,000 for the resident, who will also maintain the plant and animal systems, and lecture visitors about the various features. Total cost, $925,000, plus $750,000 per additional year.

Demonstration

Priority 1980 #1

Budget '80 $580,000
'81 $350,000
'82 $350,000

Hardware

Alternative Energy Testing Laboratory

This project will provide side-by-side testing of devices located by the Assessment of Available Hardware Project under Alaskan conditions. The State will purchase, at cost, one of each device offered for sale in the state, and conduct standard engineering performance tests. A coastal site will be used for the generator tests and an interior site for the collector tests.

About $200,000 is required as first costs for testing equipment and facilities rental. Costs of $150,000 per year for purchase of wind generators and testing may be used as an approximation. The solar hardware for the project will cost about $60,000. The salary for two engineers and two technicians and clerical support would be about $170,000. This project should be administered via the University as an in-house, continuing project.

Demonstration

Priority 1980 #1

Budget '80 $960,000
'81 " "
'82 " "

Grants

Appropriate Technology Grants Program

The State shall establish a grant program similar to the federal appropriate technology program. Program shall be funded for $850,000 per year for grants, $110,000 for administration and judging.. Maximum awards shall be $60,000. The program should run for at least three years.

Demonstration

Priority 1980 #1

Budget '80 $500,000
'81 $70,000
'82 $70,000

Integrated Systems

Solid Waste Incineration/Greenhouse Demonstration

Using existing technology of solid waste incineration for electric generation, a demonstration project for a medium-sized Alaskan community will be constructed. Waste heat from the electric production will be used to heat a four season energy efficient greenhouse of at least 2,000 square feet. Electricity from the incinerator will be used to run plant gro-lights for the winter season. All excess electricity will be fed into the local power grid through arrangement with the local utility.

For a 10,000 square foot greenhouse plus a cogeneration plant and salary for a grower/researcher, the cost is estimated at $500,000 for the first year and $70,000 thereafter.

soft energy wish list (RD&D)

The following is Skip Roy's wish list prepared at our request. It will require a good deal of modification, and we should have some new numbers very soon.

Introduction

Goals for Renewable Energy Research and Development Program

The primary thrust of the Research and Development Program is to provide the needed information on renewable energy to Alaska's decision-makers, namely, legislators, professionals, public interest groups, and concerned individuals. This goal will be accomplished in two ways: first, a number of technical reports will be generated from field work/data gathering and literature reviews, such as the recommended project "Small Hydro Feasibility Study"; second, demonstration projects, such as the installation and testing of wind generators in various locations throughout Alaska, will develop the information necessary to choose appropriate forms of renewable energy for different regions of the state. Importantly, the recommended Research and Development Programs emphasize the ways in which renewable energy can be incorporated into the existing economic structure.

Existing Knowledge Gaps

The baseline data essential to renewable energy development is largely nonexistent in Alaska. The most important recommended projects are those which will generate numerical information on climatological and economic conditions in various regions of the state (e.g. "Sub-ice Hydrological Studies"). Also of great importance is the need for more design information on a variety of levels, such as building construction for cold climates and solar energy utilization, and the design of wind generators suitable for use in Arctic conditions. Finally, a great deal of hardware testing needs to be done in Alaska to ensure that the final application of renewable energy systems will be the most efficient and

effective method for a given location.

Demonstration

There are many technologies that are ready to be used today. The public needs to become familiar with them as working examples that are effective and readily available. The American way is to "kick the tires". Therefore, great emphasis should be placed on getting demonstration projects in place and functioning throughout the state as soon as possible.

Commercialization Problems

There are three points that need to be made about the problems inherent in the forthcoming commercialization of renewable energy systems. First, a major emphasis should be placed on retrofitting existing structures, in addition to developing new products and constructing new buildings; second, many renewable energy products now available in the Lower Forty-Eight are not yet off-the-shelf items in Alaska (for example, there are no active solar collectors available in Alaska, while there are over fifty varieties in the Lower Forty-Eight), and careful study will be required to determine which of these products will work effectively in Alaska; and third, it is of crucial importance to begin to structure the state's economy around renewables: for instance, tax credits must be established immediately to encourage private individuals and large corporations to invest in renewable energy alternatives; low interest loans must be made available to renewable energy firms, et cetera.

Outreach and Education

It cannot be over-stressed that the people of Alaska will need more information on renewable energy alternatives if renewable energy development is to receive priority of

state-wide action. Many of the recommended projects will disseminate information as a natural by-product of the program (e.g. wind demonstration projects), but some projects are specifically aimed at providing people with detailed and usable information on renewable energy alternatives, for example, by providing state residents with blueprints for making energy-saving devices.

Conclusion

Governor Hammond, the Future Frontiers Conference, and the Alternative Energy Conference have all made strong statements recently about the pressing need to establish renewable energy development as the immediate priority for state-wide action in Alaska. We can begin by recognizing that such large-scale energy projects like the Susitna Dam, if not eliminated entirely by the utilization of alternative renewable energy technologies, can be scaled down considerably with the power input from alternative energies. The current artificially cheap energy prices in Anchorage makes the adoption of alternatives to the Susitna Dam seem uneconomic, but the soundness of the long-term investment in renewable energy development justifies a short-term increase in prices.

Two final points need to be made. It takes from seven to ten years for the products of research and development projects to affect the market: legislation needs to be enacted now to steer Alaska toward a safe, dependable, and economic energy future. Finally, there is currently a lack of trained people in the area of renewable energy in Alaska. The program described below will require that Outside firms be hired to work on needed projects. Alaska should instantly address this talent pool problem via the recommended education and training programs.

Administrative

Priority 1980 #1
Budget $950,000

Oversight

This is the penultimate project: Department of Renewable Energy, Division of Energy and Power Development.

A new department within the Division of Energy and Power Development will be established to oversee all conservation and renewable energy projects. This department will consist of five contract administrators, one general administrator, two policy planners, and one ombudsperson. Total salaries, overhead, clerical, and other costs will be about $950,000 per year.

Baseline

Priority 1980 #1**
Budget $25,000

Economics

Statewide current energy economic assessment

This project would be to develop a detailed profile of 1978 energy usage in Alaska, breaking the data down into:

1) end-use in MBTU and $ for both rural and urban

2) source in MBTU and $ for both rural and urban

A comprehensive end-use analysis has not been done for Alaska. There will be no sound basis for rational decision-making on energy economics until these figures are in hand. This project should be the first project funded by the Legislature and should be carried out by The Institute for Social and Economic Research of the University of Alaska. Cost for a one month rush study will be $25,000.

Climate

Sub-Ice Hydrological Studies

Using the criteria developed by the small hydro-power feasibility study, rivers that might be used by small communities for low load hydro-electric projects will be identified. The rivers with winter freezing problems will be analyzed at the time of approximate maximum freezing, and their flow rates will be determined. Then, using prices for existing off-the-shelf technology, cost estimates and projected payback and life-cycle costing methods will be used to decide if any sites are viable choices for small hydro "farms". This project cannot be budgeted until the completion of the small hydro feasibility project.

R & D

Priority 1980 #2
Budget $40,000

Electricity Generation

Ocean Electric Feasibility Project

This project will assess existing technologies that utilize the ocean to make electricity. This includes tidal, temperature gradient, salinity gradient, wave, and air/water temperature gradient, and any other technologies. Using Cook Inlet and South East Alaska as working examples, six locations will be examined as to capital costs, energy output, and technical feasibility. This project will be a private contract for $40,000, with a six month duration.

Research

Priority 1980 #1

Budget 1980 $155,000
1981 $95,000
1982 $95,000

Building Design

Building Performance Monitoring Program

Phase One: Program Design

Current D.O.E. monitoring projects cost about $100,000 per building. It is felt that this is far too much money, and the resulting data is an order of magnitude more detailed than needed. A monitoring program will be designed so that short term (one month) data can be collected via a portable data-logging system. This system will be able to record 16 channels of inside and outside temperature, input energy usage, solar gain, and wind velocity. Data will be recorded on magnetic tape and software developed to reduce the data into usable graphic form. Cost of a monitoring system should be $15,000 or less. Phase One development cost will be $100,000.

Phase Two: Building Performance Monitoring

The four monitoring units developed in Phase One will be purchased and installed in selected buildings in one community. A technician will remain in the community for the month to care for the machines. At the end of the month the machines would be removed to another community and the process repeated. Since the cold months are of interest, this would be a nine month program. A full time analyst would also be employed.

First year costs would be about $155,000, and additional years would cost $95,000; thus reducing the cost per monitored building to about $3,000. This project should be handled on a private contract via the University.

RENEWABLE ENERGY NEWSLETTER

A monthly newsletter on Renewable Energy shall be distributed through the Regional Library in Juneau. This newsletter will cover all renewable energy "news" in Alaska, as well as highlights of renewable energy activity in the rest of the nation and the world. The publication will be the mouthpiece for Alaska Citizens for Alternative Energy, a public interest group formed in November, 1979, at the Alaska Alternative Energy Conference. A mailing list will be developed from the core of the conference attendees. The yearly budget will be $40,000, with $20,000 earmarked for a two-third time staff person and $20,000 for publication costs.

Research

Priority 1980 #1
Budget $120,000

HARDWARE

"Technological Fix" Competition

An existing governmental agency will be funded to select five needed inventions that could lead to great energy savings in the state. A set of design criteria for each will be developed and made public, along with a notice of a $10,000 prize for the best submittal in each category; care will be exercized to insure that no prizes will be issued if no suitable entires are received. Total costs for the program will be $120,000, with $50,000 in prizes, $30,000 for administration, $20,000 for judging, and $20,000 for promotion and documentation. This project would have a year's duration and be administered by the Office of Northern Technology or its equivalent.

Outreach

Priority 1980 #1
Budget $250,000

Community Leaders

Renewable Energy Seminars for Housing Authorities, Native Groups, Legislators, and Mayors

This project will develop a renewable energy seminar directed to non-technical community administrators and leaders. Emphasis will be on economics, motivating communities, and funding sources, as well as technical information. The workshop will then be presented in four different communities in the state. Travel funds for 200 state leaders is included. Total budget is $250,000.

R & D

Priority 1980 #1
Budget 1980 $50,000
1981 *

Small Hydro-power Feasibility Study

Phase One: Determination of state-of-the-art. Existing world literature on small hydro-electric plants, especially those need low head plants will be researched, with special care paid to other countries. In turn, this data will be used to develop criteria for mapping small hydro potential in Alaska. The winter sub-ice flow rate will be determined for three sample drainages by site visit and used as a basis for generalization. (Further sub-ice prospecting is addressed in a separate project outline.) The final part of Phase One will be to use economic and other data to determine the location for three demonstration projects in geographically disparate sites. Budget will be about $50,000.

Phase Two: Phase Two consists of the engineering and construction of three model small hydro projects capable of supplying at least 50% of the electricity needed by the selected communities.

Outreach

Priority 1980 #1
Budget 570-720,000
one year

Training

Renewable Energy Apprentice Program

This program is designed to reduce the renewable energy talent pool problem within one year. There are not enough trained "soft path" energy technologists in Alaska to meet the present or continuing needs of the state. Much of the absolutely essential research proposed in the following pages will go to Outside contractors. By providing salaries for Alaskan professional engineers, architects, or semi-professional people for each project that goes to out-of-state firms, the State will ensure that a knowledgeable person will remain in the state after completion of the project, in addition to building a supply of Renewable Energy experts. It is estimated that 15-20 projects will need to be contracted to out-of-state firms the first year. A salary median of $30,000 yields a total direct salary budget of $450-600,000, with an additional $120,000 for oversight, for a total of $570-720,000.

Outreach

Priority 1980 #1

Budget '80 $860,000
'81 " "
'82 " "

2,580,000

Training

University Department of Renewable Energy

This program will establish a faculty, curriculum and student financial support for a department offering both two year and four year Renewable Resource majors. Six faculty members, four in Fairbanks, and two in Anchorage will be needed, plus clerical and research overhead. Salaries will be about $270,000, with an equal overhead, research and teaching equipment budgeted at $200,000, travel, $60,000, and student support, $60,000, for a total of $860,000 per year.

Outreach

Priority 1980 #1
Budget $180,000

Education

Curriculum Development for Schools

Renewable Energy should be a part of the science and economic training of all public school students. Specific lesson plans and short units will be developed for Grades 1-8. A one semester high school level course dealing with Renewable Energy will also be developed. This project should be a private contract on one year's duration. The budget will be $80,000 for salaries, $40,000 for duplication and outreach, $40,000 for overhead, clerical and graphics, for $160,000.

Outreach

Priority 1980 #1
Budget $113,000

Education

Media Outreach Program

The Energey Extension Service will develop a series of radio, TV, and newspaper programs to present usable information about Renewable Energy/Conservation in Alaska. A series of eight one-half hour TV programs can be produced for about $100,000, 16 15-minute radio shows for $8,000, and weekly syndicated newspaper articles for about $100/week or $5,200. These figures include all expenses and administrative costs, for a total of $113,000.

Outreach

Priority 1980 #1
Budget $70,000

Policy Development

Renewable Energy Players Conference

This project is modeled after the Ghost Ranch, New Mexico, conference that assembled the major appropriate technologists from all over the United States for an informal knowledge and policy sharing session. This project would select 25 of the most important renewable energy players in the state, fly them into a remote lodge facility, and provide them with a general framework for discussion. The formal discussions should be videotaped and worked into a public TV presentation. Goals would have to be established by the conferees, but might include: renewable energy implementation scenarios, needed legislation, needed inventions, and inter-discipline problem solving teams. This should be sponsored by the University, and will need a budget of $12,500 for actual food and lodging, $12,500 for transportation, $25,000 for stipends, and $20,000 for overhead, administration, and media, or $70,000.

Outreach

Priority 1980 #1
Budget $130,000

Education

Conservation/Renewable Energy Seminars for Builders, Architects, Engineers, Appraisers, Bankers, and Public Officials

A series of 15 three-day seminars on energy economics and state-of-the-art specific techniques will be held at 12 locations throughout the state. They will be presented free. The development and presentation costs will be approximately $130,000, with $70,000 for salaries, $35,000 for overhead, and $25,000 for travel.

A test and certification program will be a part of the seminar. This should be administered as a private contract via the Energy Extension Service.

R & D

Priority 1980
Budget $75,000

Transportation

Lighter than Air Transportation Feasibility for Alaska

This project will examine lighter than air technology as practiced around the world today and in the past. Special attention will be paid to Siberian and other cold climate applications. State-of-the-art and potential technologies must be addressed, both in terms of economics and safety, with special regard to the dangers of Alaskan topography and climate. This project should be carried out within the Department of Transportation and public facilities as a six month study involving one engineer and support with a budget, including salary, travel, and overhead, of $75,000.

R & D

Priority 1980 #1

Budget $40,000

Planning

The Effects of Energy Conservation Planning on Future Energy Consumption in the 10 Major Growth Areas of Alaska

This project will address all aspects of energy conservation in land use planning, using baseline data developed in the passive solar potential and other studies, and develop predictions of the effects of the application of standard energy planning techniques for the selected cities. It is expected that special consideration will be required to adapt existing planning strategies from the Lower Forty-Eight to Alaskan conditions. Budget for this project is estimated at $40,000, and should be on private contract via the Division of Energy and Power Development.

Renewable Energy Future: An Alaskan Solution

The preceding proposals represent specific actions that, if taken, will begin to move Alaska toward the goal of 30-50% reduction of non-renewable energy use by 1990. The proposed program is not a complete plan for conversion to renewable energies; rather, it is a "let's study it now and act later" approach. No single project or series of projects recommended herein will result in significant state-wide reduction in energy use. Thus, it is now proposed that an Alaskan-scale solution be applied to the problem of how to convert the state to renewable energy in the next ten years.

Phase One:

A State-wide Task Force on Energy Conservation and Renewable Energy would be created, and, through a massive injection of capital, would work to reduce by 30% the space-heating and electricity needs of the state in a very short period, namely, one to three years. The Task Force would require $200,000,000 to weatherize all residential buildings in the state and to educate all state residents in energy conservation matters as they relate to Alaskan life. Annual monetary savings generated by state-wide weatherization would be approximately $120,000,000. Thus, about 50% of the cost of the program would be realized in savings to consumers by the end of the first year of the program, yielding a payback period of about two years. Nearly all the construction work would be carried out by local, private contractors.

An additional $100,000,000 would be made available for commercial owners to retrofit their buildings. This would be 0% interest loan money, to be repaid over a ten year period.

A similar program would be undertaken for state facilities at a previously estimated total cost of $200,000,000 for a ten year payback period.

Phase Two:

The Governor should immediately appoint a five-member Task Force to spend $2,000,000 in six months to work out the goals and structure of further capital-intensive energy conservation and renewable energy programs. This Task Force should include an economist, a conservation/renewable energy specialist, a transportation specialist, a consumer advocate, and a management/administration specialist. The report of this project will take the best available data and work out costed strategies, as well as management structures, for reducing hard energy use by 30-50% in 5-7 years.

Phase Three:

An additional $55,000,000, funded at the time of the Task Force's appointment, will be disbursed after acceptance of the final report. This money will be used for a quick start in implementing the recommendations. The money may be used for hiring staff, renting facilities, buying equipment, funding projects, or any other end deemed necessary.

Demonstration

Priority 1980 #1
Budget $540,000

WIND

Wind Demonstration Project

The first phase of this project will be to select 20 communities around the state where the average wind speed is 8 m.p.h. or greater. For each site a community-owned building will be selected for a wind generator. Average "bush" costs for installing a reliable 3KW machine suitable for the Arctic climate is about $22,000. Additional overhead and administration costs for the 16 projects will be about $100,000, for a total of $540,000.

Demonstration

Priority 1980 #1

Budget '80 $3,900,000
'81 $750,000
'82 $750,000

Integrated Systems

Urban "Ark" Demonstration Project

Totally integrated urban houses, similar to the New Alchemist "Ark" project on Prince Edward Island, should be designed and built in Fairbanks, Anchorage, and Juneau. These houses will feature 100% food production, including aquaculture, agriculture, waste usage, energy conservation, and solar heating. The Ark on Prince Edward Island has become one of Canada's most famous buildings and represents a highly visible approach to renewable resource living. The design and building of an Ark is estimated at $800,000 each, land costs of $200,000 for prime urban land, and an additional $200,000 each for salaries and research projects, including thermal monitoring. An additional $150,000 per year for documentation, outreach, and funded travel for "important" leaders from around the state. First year costs will be $3,900,000, with additional years at $750,000. These buildings could also be used to house libraries and other educational/demonstration facilities. Total budget for three years is $3,900,000, plus an additional $750,000 per year.

Demonstration

Priority 1981 #1
Budget *

Conservation

Solid Waste Incineration/Cogeneration Demonstration

Using the results of the solid waste feasibility study, the State power authorities should select all feasible Alaskan cities for solid waste demonstration projects. It is estimated that 15% of a community's electric needs and 7% of its space heating needs can be met by solid waste incineration/ cogeneration. The project cannot be costed until the completion of the feasibility study.

Demonstration

Priority 1980 #1

Budget '80 $300,000
'81 $3,500,000
'82 $500,000
'83 $500,000

Conservation

50% Non-renewable Energy Use Reduction for an Alaskan Village

This project will select an Alaskan village, study in detail its energy use and resources, and develop a plan to cut its non-renewable energy use in half. This includes all energy use - transportation, food, space heating, water pumping and heating, electric use, and all other energies. The plan will then be implemented as a demonstration.

Any village with a population between 250-1000 people may apply to be the site of the project.

Phase One:

Site selection and baseline energy use and resource project; projected cost: $100,000. This will document what the current energy picture of the village is and assess possible unused resources.

Phase Two:

Phase Two will develop strategies and budgets for reducing the non-renewable energy use to 50%. It is expected that many options will be explored and estimated cost vs. savings budgets developed. One combination of strategies will be chosen for implementation. Budget estimate $200,000.

Phase Three:

Implementation of the selected strategy will be by the public contract bid process. Special emphasis must be placed on educating the residents to operate their village in an energy-efficient manner, and on a public videotape outreach program. This phase cannot be cost estimated until the end of Phase Two, but a rough estimate is $7,500 per capita.

Phase Four:

Two year monitoring of results. A separate contractor will be chosen to monitor performance after the retrofit program and present the data to the public.

Phase One and Two cost $300,000

Phase Three - $3,500,000

Phase Four - $300,000