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WIND SYSTEMS LIFE CYCLE COST ANALYSIS
A Description and Users Manual

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ABSTRACT

This report describes the LIFECC computer program developed at the U.S. Department of Energy Rocky Flats Wind Energy Research Center for the purpose of calculating the cost of energy produced by wind systems according to the principles of life cycle costing (LCC). Following a brief explanation of the LCC concept and its advantages, the report explains input variables to the program and their importance to various program users, including manufacturers and designers, utilities, various institutions and consumers. A detailed user's guide to the program is then provided, together with a sensitivity analysis which discusses the impact of key variables on wind system cost of energy and the importance of cash flow to the wind system purchaser. Sample cases of program output and an LIFECC program listing are provided in Appendices.

CONTENTS

GLOSSARY

(alphabetical listing of terms and definitions)

Annualized Cost of SWECS Energy (ACSE)	- The present-valued cost (or value) per kWh of the energy produced by the wind systems over its lifetime. This figure is presented in current-day dollars in this analysis.
Depreciation Methods	- For commercial applications, or for the portion of an application which is rated as commercial, three methods of depreciation are offered with the COE program: 1) straight depreciation; 2) declining balance depreciation; 3) sum of the years digits.
1) Straight Depreciation	- Annual straight depreciation is found by dividing the depreciation basis by the depreciation life.
2) Declining Balance	- The depreciation method which applies the same rate in each year on the declining balance of the depreciated amount.
3) Sum of the Years Digits	- A method utilizing a declining rate of depreciation based on the number of years remaining to depreciate.
Discount Rate (D Rate)	- A rate used to relate present and future dollars (costs or benefits) associated with an investment project. The rate is often referred to as an opportunity cost because it should represent the best alternative rate of return which an investor could obtain from a similar-risk investment (or opportunity).
Life Cycle Costing (LCC)	- An evaluation technique used to assess projects which have associated costs and/or benefits distributed over their useful lives.

Loan Payment - The annual principle and interest payments on the loan based on the month of the wind system installation.

Net Present Value (NPV) - The value of the SWECS project expressed in installation-year dollars. The value represents the present value of all life-cycle energy savings minus the present value of all life-cycle costs.

Opportunity Cost - See Discount Rate.

Present Value - The method of representing future dollars in terms of today's dollars. The concept is based on the premise that a dollar received today is worth more than a dollar to be received in the future. The rate used to equate the various year's dollars is the discount rate.

Sensitivity Analysis - Testing the outcome of an analysis by varying the value of one or more input variables from the initial values.

SWECS - Small Wind Energy Conversion System, the term used in the COE program to describe wind systems. While a SWECS is classified as a wind system rated at 100 kW or less, the program may also be used for larger systems.

Weibull Constant - The coefficient of the Weibull wind distribution equation which characterizes the winds frequency distribution at a given wind site.

NOMENCLATURE

ACSE - annualized cost of SWECS energy

COE - cost of energy

kW - kilowatt

kWh - kilowatt hours

LCC - Life Cycle Costing

mph - miles per hour

m/s - meters per second

OEM - operating and maintainance costs

PUC - Public Utility Commission

PURPA - Public Utilities Regulatory Policies Act

ROI - return on investment

RF - Rocky Flats Wind Energy Research Center

UBBF - utility buy back factor

SWECS - small wind energy conversion system

Y/N? - yes or no

w/o - without

% - percent

/ - per

1.0 INTRODUCTION

The purpose of this report is to present a Cost of Energy (COE) methodology which is computer interactive to allow an individual to determine the value of an investment in a wind system. This methodology has its base in Life Cycle Costing in order to take into account the time value of money and effects of inflation on an investment. This report will present the information from which an intelligent use of the computer program can be expected to result and will describe the variables that make up the costs and benefits which accrue with the purchase and use of a wind system. The influence of the variables which determine these costs and benefits is examined from the points of view of users, manufacturers, utilities, and various institutions.

2.0 WHAT IS LCC?

Life Cycle Costing (LCC) provides a method of economically evaluating alternative energy devices based on the principles of the "time value" of money so that a choice of products can be made on a comparable economic basis. The concept of LCC analysis has its roots in accounting principles used by all companies in analyzing investment opportunities. Any profit seeking entity seeks to maximize its return on investment by making an informed judgment on the costs and benefits to be accrued by the use of its resources. Capital represents a "resource" in a company. Many investment opportunities are competing for the use of that capital. An analysis of the different investment opportunities available to a company yields a ranked order of those opportunities based on the rate of return to be realized. An informed decision is then made to proceed with the selected investments within the capital limits of the company, in most cases based on the maximum return-on-investment (ROI) to be realized.

The purchase of a wind system can be treated in the same manner as any other investment, whether by a company, an individual, or an investment partnership. Each has access to a finite pool of capital, and will allocate that capital to reach the goal which he has set for himself. As with all investment opportunities, there are competing products to allow you to reach your stated goal. In an energy-related case for an individual, the "goal" is the use of electricity, and the competing "products" are the utility company and other electrical generating devices (which include wind systems).

Similarly, for a potential corporate user the "goal" of the company is maximizing profitability through the use of its resources. If an investment in an energy producing device such as a wind system can reduce a company's operating expenses and thereby produce an ROI that is competitive with other investment opportunities within the company, then it becomes an economically prudent decision to purchase a wind system.

3.0 LCC AS APPLIED TO COST OF ENERGY OF WIND SYSTEMS

In order to determine the value of an investment in a wind system the principles of life-cycle costing have been applied to the specific case of the costs and benefits associated with the wind system investment. There are two "costs" encountered with the purchase of a wind system. The first includes one-time expenses associated with the purchase, delivery, installation, hookup, and permits required for the wind system. The second includes variable costs such as O&M associated with the wind system through its lifetime of operation. There are, similarly, two "benefits" patterns which are associated with the economics of the wind system. The first of them deals with immediate tax benefits due to the current legislation involving renewable energy devices such as wind systems, and the second deals with the use of and/or sales of the energy produced by the wind system. Because both costs and benefits accrue through time in a variable manner, the principle of Life Cycle Costing may be applied to the economics of the ownership of a wind system in order to determine its value relative to some other investments while taking inflation into account.

The mechanics of inflation are well understood by individuals involved in investment decisions. Money can have a reduced value in time as inflation forces prices upward, making each dollar have lower purchasing power. Also, an amount of money can increase in quantity by earning interest from some investment. As long as the rate of inflation is equal to the return on investment for a fixed sum of money, purchasing power is not diminished. But, as is usually the case, if these two values are not equal then the sum of money can increase in value (if an investment return greater than inflation is realized) or decrease in value (if the inflationary pressures increase faster than the return on the investment).

LCC methodology takes this variability of inflation and interest applied to money and utilizes a mathematical model of the "time value of money" to allow the user to project a "present value" for his investment at any time in the future. Specifically, the model is represented by the following formula:*

$$PV = \sum_{i=1}^{N} \frac{C_i - B_i}{(1 + d)^m}$$

where:

PV = present value of the investment

N = lifetime of the investment in years

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*For an in-depth discussion of the equations from which this present value formula is derived, see Technical Report RFP-3120 SWECS Cost of Energy Based on Life Cycle Costing.)

C_i = sum of the financial costs for the year "i"
B_i = sum of the financial benefits for the year
d = discount rate (capital cost of money)
m = number of years from present until "i"

The application of this formula and LCC methodology in a computer has produced the cost of energy program (LIFECC) which this report describes.

4.0 INPUT VARIABLES - Their Importance to Program Users

The potential users of the COE analysis for wind systems are individuals and groups involved in the purchase, sale, manufacture, testing, and financing of, or policy making involving, wind systems. Their use of the analysis techniques is directed toward the same result, which is finding the value of the product. But the input variables to the program differ in importance to these individuals or groups based on their specific end use for the output of the LIFECC computer program.

Other methodologies have been developed for value analysis, but LIFECC is specifically tailored to the economics of wind systems. By isolating the variables of hardware performance, energy production and utilization, and economic variables, the program allows a user to economically describe his specific installation.

The 19 input variables to the program fall into four major categories: hardware factor, utility factor, economic factor, and tax factor. A description of these terms introduces the reader to the cost and benefit variables associated with a wind system, which are the inputs to the LIFECC program. The variables are as follows:

I. Wind Systems Hardware Factors

1. Hardware/Installation Cost - This represents all one-time costs associated with the purchase, delivery, installation, hookup and startup of the SWECS, including all permits, licenses or fees which are "one-time" costs.

2. Lifetime of SWECS - The expected operational lifetime of the SWECS (which usually is the design estimate by the manufacturer); or the expected useful life to the purchaser.

3. Yearly Availability - The percentage of time that the SWECS will be "on-line" and capable of generation. This value is not determined by the presence or absence of wind, but rather by ability to operate if sufficient wind is present.

4. Operating and Maintenance Costs - These represent all yearly costs associated with running, maintaining, insuring, and licensing the wind system. It includes insurance premiums, maintenance costs for repairs by the dealer, yearly hookup fees from the utility, land rental or permit fees to operate the wind system.

5. Replacement Costs - These represent major components such as blades and generators that need to be replaced on an intermittent basis and that add to the lifetime cost of the wind system. These costs need to be included in the expected year of occurrence.

6. Salvage Value - The expected value of all components as salvage at the end of the lifetime of the wind system.

7. Annual Energy Production - Given the wind resource, this value is the expected kWh output of the wind system. This output may be expressed or calculated in three ways as an input to the program:

   a. Annual output, in kWh.
   b. Monthly output, in kWh.
   c. Power curve for the wind system, and Weibull wind distribution factor for the wind regime.

II. Utility Related Factors

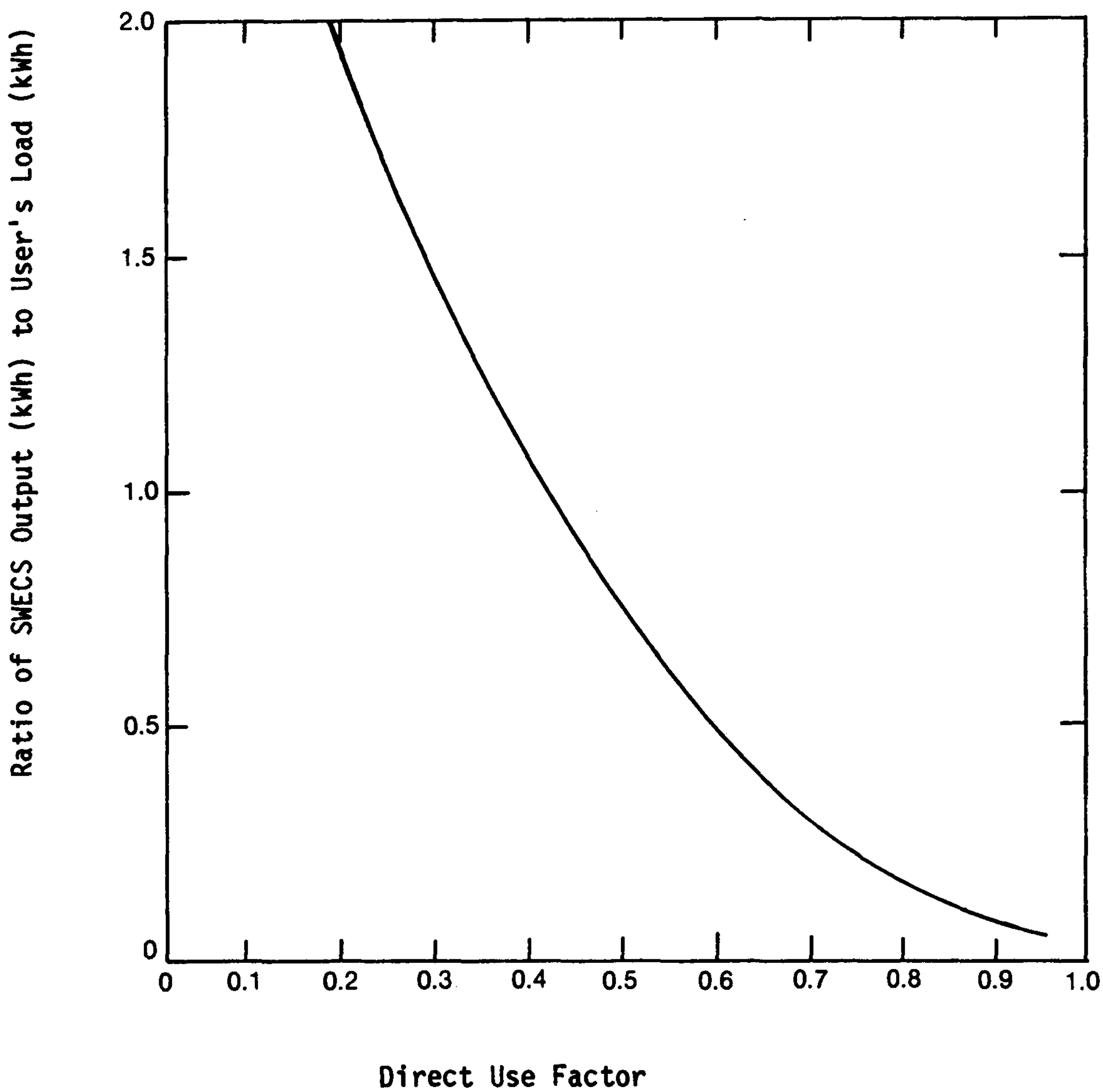
8. Grid Cost - The cost per kWh that the user currently pays for utility supplied electricity. In the event of declining block rates, in which the cost/kWh varies according to the quantity used, this figure represents the cost per kWh of the last kWh used.

9. Direct Use Factor - The percentage of the output of the wind system that will be used directly by the residence and thus not returned to the utility. In other work at RF, a direct use factor curve was developed (see Figure 1) for residential use in residences with monthly loads ranging from 200 kWh/month to 3,000 kWh/month.

   Figure 1 shows that the direct use factor increases dramatically when the wind system provides a smaller ratio of the user load. For example, a ratio of 2.0 (wind system energy output twice the user's energy requirement) gives a 0.2 (20%) direct use factor; while a ratio of 0.5 gives a 0.6 (60%) direct use factor. Selecting a wind system which provides a very small percentage of the load makes economic sense as long as buyback rates offered by the utility are low relative to the utility's price for electricity. If the buyback rate increases, a larger wind system would become economically viable.

Figure 1

Direct Use Factor for Utility-Interconnected Applications



$$F(x) = 3.08x^3 - 1.5x^2 - 4.23x + 2.88$$

(Relationship between direct use factor and SWECS output/load ratio.)

Based on Field Evaluation Program data from Rocky Flats collected between October 1979 and October 1981.

10. Utility Buyback Factor - The rate at which the utility company will purchase cogenerated electricity backfed into its lines. This number is expressed as a percentage of the user's grid cost, and is usually a rate set due to PURPA* mandated prices or in a written contract with the customer.

III. Economic Factors

11. Loan Amount - The dollar amount of the loan which a purchaser of a wind system borrows to help finance the purchase.

12. Loan Interest Rate - The simple interest rate at which the loan is being made by the banking institution.

13. Loan Term - The length of time for payback of the loan.

14. Grid Escalation Rate - The expected annual rate of inflation of the utility grid price over the lifetime of the SWECS.

15. Operating and Maintenance Escalation Rate - The expected annual rate of inflation for the labor involved in servicing the SWECS and for procured parts for general maintenance.

16. Discount Rate - The "capital cost" of money, or the "opportunity cost" of the use of this money for this investment. In residential applications, this number represents the rate of return for the best alternate investment to the user that could be made over the life of the SWECS.

IV. Tax Considerations

17. Residential/Business Use of Wind Systems - The percentage of the costs and benefits of the wind system which will be allocated to a "residential" use. (The purpose of this allocation is to

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* The Public Utilities Regulatory Policies Act (PURPA) is a 1978 federal statute which mandates interconnection of small power producers and cogenerators and which requires Public Utility Commissions and unregulated utilities to establish rates for the purchase of power. The PURPA legislation spawned a boom in the development of avoided cost methodologies upon which rates can be based, and a wave of court cases challenging its constitutionality. Whether or not PURPA survives its court tests, it is evident that a rate-making procedure will emerge which will make SWECS a viable economic means for producing electricity in at least some settings.

determine tax credits and depreciation values, which are different for "residential" and "commercial" applications.)

18. Tax Rate - This value represents the income tax bracket which the user of the SWECS is in for the purpose of determining tax credits for Federal and State Income Tax. For combined residential/ commercial applications, use the tax rate of the business.

19. Tax Liability - In order to determine the amount of tax credit due an individual or business in the year of purchase of the wind system, the expected tax liability in that year must be known. The tax credit due, which is determined in the program at a fixed 40% of the first $10,000 for Federal credits and a user-generated amount for State credits, is applied against the tax liability for residential applications. A 10% business tax credit and 15% investment tax credit is allocated for commercial applications.

20. Depreciation Methods - If a wind systems installation is partially or completely a "commercial" venture (as defined by U.S. tax codes), then that portion of it which is commercial can be depreciated. The three methods used are staight line, declining balance, and sum-of-the-years digits. In all cases the user must specify the depreciation life in years, the salvage value of the wind system, and the choice of depreciation method. In all cases the depreciation basis (amount allowable for depreciation) is equal to the net of installed cost minus salvage value. The depreciation life is set by the user based on his tax advisor or recommendations.

The importance to the user of these variables which make up the LIFECC program is determined by his role in the commercial chain of wind systems involvement, either as a purchaser, manufacturer, or institutional entity. Because each group can affect some variables, and be primarily affected by some others, the relative importance of these terms to each group needs to be highlighted.

The purchaser of a wind system is affected by all of the 19 input variables to the COE program because the value of the wind system to him is determined by energy cost and benefit associated with the wind system.

A dealer or distributor of wind systems is affected by the hardware and installation costs directly since they affect his selling price, and by tax credits since they reduce the purchaser's cost (and hence increase the possibility of a sale).

A manufacturer is primarily affected by the hardware and installation costs since his goal in utilizing the program is to reduce those figures in order to make his product more competitive. Availability and system life are other important variables over which the manufacturer has a degree of control.

Financiers such as bankers and investors need to be assured of a return on their investment and are primarily affected by the initial cost (hardware and installation) of the wind system and the lifetime of the product.

Policymakers have an effect on wind systems by controlling the tax benefits of owning or investing in a wind energy device and by affecting utility rates through PUC's and legislation such as PURPA. Their primary interest would be the effect of their policies on the value of a wind system by the utility and tax-related variables.

Now that the variables have been introduced and the groups impacted by the variables identified, the user of this program needs to know the mechanics of performing a cost of energy analysis for his specific case.

Decision Making for Variables in the COE Program

In order to choose variables for input into the program, the user of this program can refer to the sample case studies in Appendix 1. A base case is presented and single variable changes are made to allow for an examination of the cash flow generated by each change. In addition, the sensitivity analysis included in this report, which was generated from incremental variances, allows the user to determine the relative importance of each variable.

As can be determined from each of those analyses, some variables have a much greater impact on the value of an investment in wind systems than others. Those variables which have a major influence are considered "key," and those are included in the sensitivity analysis so that purchasers, dealers, manufacturers, and institutional users can determine for their own application which ones they can impact.

A further analysis of the effect of variable changes as seen in the sample cases presented in the appendix and the sensitivity analysis presented in the next section of the report can lead one to a conclusion which may not appear obvious. Given beneficial conditions for wind systems, it is possible to arrive at a situation in which, over time, the cumulative benefits exceed the cumulative costs associated with the ownership of the wind system. In this case a positive cash flow is generated from the sale of electricity, and the income from the sale of electricity combined with the avoided cost of wind system output used directly exceeds the purchase and installation cost as well as O&M. This is reflected in the program output as a positive value in the "total cash flow" column, but as a negative number for "annualized cost of SWECS energy." (The reason for the negative number is that it is a cost, and a "negative cost" is in fact a positive benefit.) The implication is an encouraging one for manufacturers as well as users since the product would have the potential as an income producing investment given the set of conditions which would produce a positive cash flow.

5.0 SENSITIVITY ANALYSIS

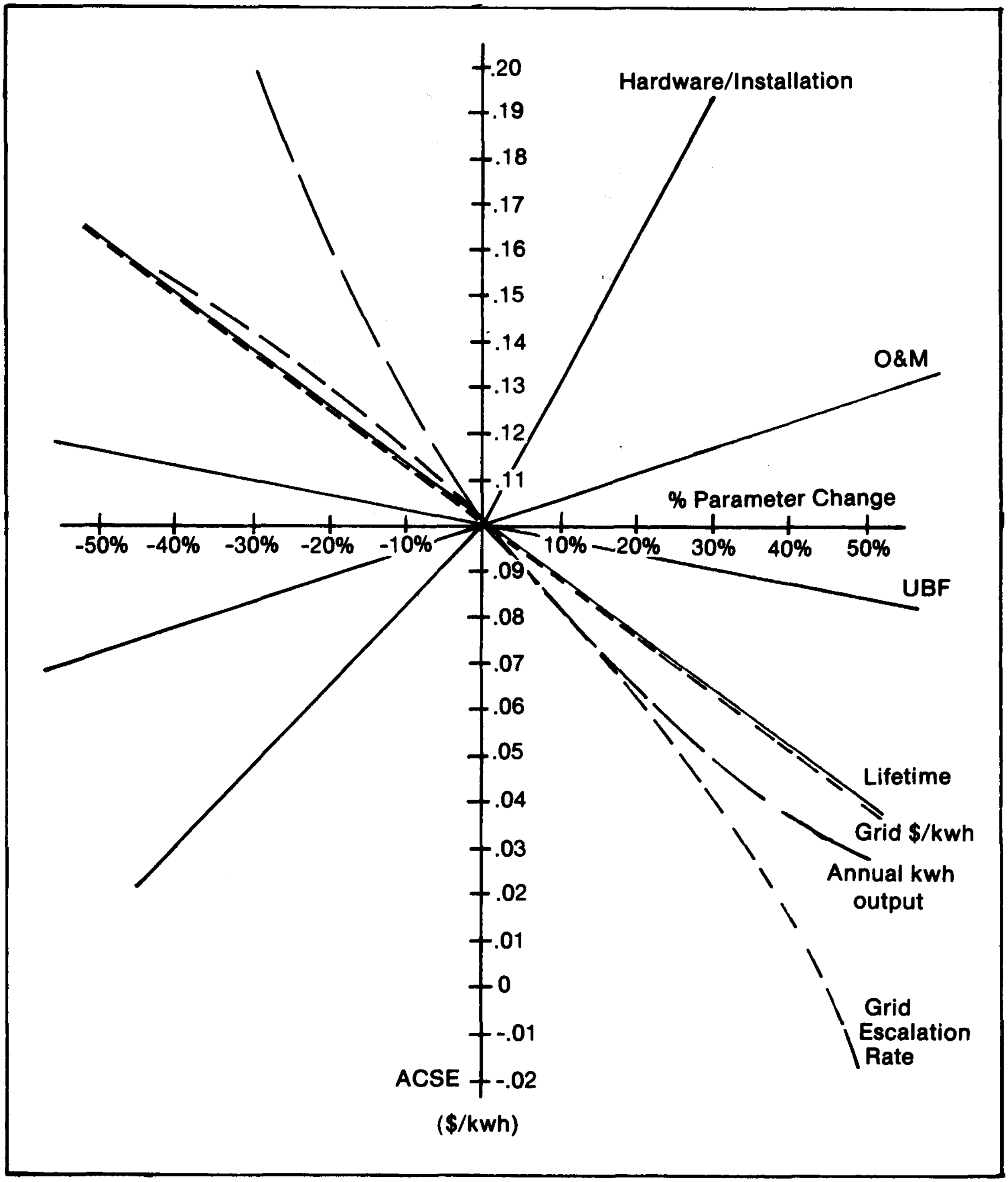
The results of the sensitivity analysis on the base case described in this report are presented in Figure 2. In this diagram, the greater the slope of the line, the greater the effect on the annualized cost of SWECS energy (ACSE). The figures along the vertical axis can be used to determine the change in COE (in costs per kilowatt hour) from a base case of 10 cents. The three major influences on the value of the wind system are the cost of the wind system and its installation, the output of the wind system, and the inflation rate for the cost of utility electricity. Lesser influences on the value of the wind system are initial cost of utility electricity, lifetime of the wind system, O&M, and the utility buyback factor. From this analysis, certain conclusions can be drawn:

1. The initial purchase price of the wind system and its installation is a key factor in the value of the wind system, as measured by the annualized cost of energy. The reason for this importance at the time of this report (1982) is the high inflation rate which allows for other investment opportunities with high returns competing for the investment dollar. The manner in which this initial investment can be reduced is by tax credit for renewable energy devices such as wind systems, or by reduced manufacturing and installation costs.

2. The output of the wind system provides the "value" which can be derived from ownership of the wind system. Maximizing this output is the next most important task to be addressed by manufacturers based on this sensitivity analysis. Output can also be affected by the dealers who select the installation site for the system.

3. The inflation rate for utility supplied electricity is an area that owners of wind systems should, obtusely, desire to have increase rapidly from the point of view of increasing the value of their wind system investment. This is a narrow viewpoint, of course, since a greater inflation rate creates greater expenses in other areas of an individual's life. The point to be taken is that should electricity continue to increase dramatically in price, then a wind system becomes an economically better investment since it produces electricity at a price previously determined by its purchase and installation cost.

Figure 2
Base Case Sensitivity Analysis



Sample Case Studies

In order to tie together the information presented thus far, a series of case studies are included in Appendix 1 which show the effect on cash flow of changing one or more variables in the input to the LIFECC program. The base case is selected from a scenario of the possible operation of a wind system selected from a mature marketplace and sited in a "typical" wind resource. From this base case the value of the wind system is determined and the cost of utility electricity is varied as simulated events are input into the program. This information is supplemental to the sensitivity analysis and provides the reader with an opportunity to examine the cash flow generated by varying inputs to the program. The values support the conclusions reached in the sensitivity analysis as to the importance of initial cost and output of the wind system and the subsequent influence on payback of the system as seen in the yearly cash flow figures. Cash flow is particulary important during the early years of wind system ownership, when the cost of each kilowatt produced may be very high relative to annual expenditures on loans.

Other conclusions about the value of a wind system to an individual, or the value of increasing (or decreasing) the cost or performance of some aspect of the design of a wind system to a manufacturer, require the exact figures for the application as an input into the program. As has been demonstrated in the sample cases presented and the sensitivity analysis, each case will bring a unique set of input variables into the program and as a result will have unique cash flow characteristics.

6.0 A USER'S GUIDE TO THE LIFECC PROGRAM

The User's Guide which follows is intended to provide the details necessary to perform Cost of Energy (COE) analyses of wind systems applications when the LIFECC program has been made operational on a computer. Use of the program requires some knowledge of wind energy concepts and (particularly when stand alone applications are involved) of basic energy and power concepts. It should be noted that the LIFECC program is only as accurate as the variables used in running it.

Note that in the computer input, care must be taken to enter the values required utilizing commas, decimal points, and letters exactly as defined in the description of the "prompt." In the program, any numbers relating to years or dollars are entered as integers, without decimal points. Any percentage is entered as the decimal equivalent, from .00 (0%)to 1.00 (100%). Any fractions of a dollar (as in utility grid cost) are entered as decimal equivalents [6 cents/kWh is entered as .06 (dollars/kWh)]. The only comma appearing in the input is to separate the month and year of the installation date (March, 1982 is entered as 03,1982).

Computer Coding

A listing of the FORTRAN V encoded program which performs the input, calculation, and output functions of the LIFECC program is included in the Appendix 2. The main program ("MAIN") accesses the 11 subroutines and performs the role of controller in calling subroutines for calculations of values used in the program. It then interfaces with the user through the terminal to allow for variable changes and presentation of the economic analysis, both on the terminal screen and on the line printer.

This program is resident at Rocky Flats on a Data General Eclipse S/250 mainframe and is written in Fortran V compatible with a Data General Fortran compiler. Some symbols and functions may require revision if the program is converted verbatim to a compiler on a different system. The storage (memory) size requirement is 32 K.

Running the LIFECC Program

1. Use a terminal tied in to the computer.*

2. Follow the computer "prompt" with the following code words:

	Prompt	User's Response
a)	- (cursor)	<CR>**
b)	User Name	L I F E C C <CR>
c)	Password	L I F E C C <CR>
d)	(Messages followed by) >	L I F E C C <CR>
e)	File Name	_ _ _ _ (1 to 4 letter word of your choice)
f)	Title of Analysis	_ _ _ _ _ _ (1 to 60 letter title which will appear on printout)

3. You are now logged onto the system. Next will be a series of prompts from the computer, and your responses to those prompts are the input values for the COE analysis. A definition of the inputs required and an example value follow.

Prompt	Description	Example Input
SWECS Installation Cost = $	The nonrecurring costs of a SWECS installation. These include purchase price of SWECS; installation cost; initial utility hookup charge; easements; engineering costs; any other one-time costs.	10000
Years of SWECS Life =	Enter the number of years which the SWECS is expected to operate, or the number of years desired for a "payback" analysis.	20

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* At Rocky Flats, the program is run on a Data General Eclipse S/250.
** <CR> means depressing the "return" key on a terminal.

Prompt	Description	Example Input
Residential Use Fraction =	The percentage of SWECS output which is to be utilized for noncorporate uses, expressed as a decimal equivalent from 0.00 to 1.00.	1.00
Installation Date (MM,YYYY) =	The month, year in which the installation of the SWECS would be completed, expressed as a 2-digit month, a comma, and a 4-digit year.	01,1982
Loan Amount = $	The amount of money borrowed on time for the SWECS installation.	8000
Loan Term (Years) =	The number of years for which the loan payments are due.	10
Loan Interest Rate =	The fixed interest rate at which the money was loaned, expressed as a decimal equivalent from .00 to .99.	.12
"User's Discount (Opportunity Cost) Rate" =	Enter the expected return from your best alternative investment. Ideally the alternative investment should have a comparable risk factor. This is called an "opportunity cost" because investing in the wind turbine would prevent you from investing in an alternative project with those funds. Expressed as a decimal equivalent from .00 to .99.	.12
Utility Buyback Factor =	The fraction of the utility billing rate per kWh that the utility will pay you for co-generated electricity, expressed as a decimal equivalent from .00 to 1.00 (or larger for a buyback greater than 100%).	.5

Prompt	Description	Example Input
Availability Factor =	The percentage of time that the wind system will operate on a yearly basis, accounting for downtime, maintenance and repair; expressed as a decimal equivalent from .00 to 1.00.	.95
Utility Grid Cost = $	The cost of utility supplied electricity at the place of use.	.06
Utility Grid Cost Escalation Rate =	The annual rate at which utility costs are expected to inflate over the life of the wind system expressed as a decimal equivalent from 0.00 to 1.00.	.14
First Year Tax Bracket =	Your Federal tax bracket, expressed as a decimal equivalent from 0.00 to 1.00 which corresponds to the percentage of income paid in taxes.	.35
First Year Tax Liability (w/o SWECS) = $	Estimated tax bill for the year in which the wind system is installed. This is used in determining tax credits for the wind system. Enter "0" if you wish to figure COE without federal tax credits.	5000
Is direct use factor constant (Y/N)?	The direct use factor is that percentage of wind system-produced energy which is utilized by the owner in place of grid energy. If you want to vary this factor by year, enter "N" (no); otherwise, "Y" (yes) is entered. (In the event that "N" is entered, the computer will request that the direct use factor which the user wishes to use is entered for each	Y

Prompt	Description	Example Input
	year of the lifetime of the SWECS. The computer will prompt with the year, and accept your input from the terminal.)	
Direct Use Factor =	The value of the direct use factor is entered as a decimal equivalent from .00 to 1.00, (see Figure 1).	.5
Operating and Maintenance Costs for 1 year = $	The recurring costs associated with the operation of a wind system, including maintenance, utility monthly charges for interconnection, insurance premiums, land rental, and other constant costs.	100
O&M Escalation Rate =	The inflation factor for O&M costs, expressed as a decimal equivalent from .00 to 1.00.	.10
Do you wish to enter O&M costs by year (Y/N)?	If you anticipate yearly change in O&M beyond inflation, enter "Y" (yes); otherwise "N" (no). (If "Y" is entered, the computer will prompt you with each year in the lifetime of the SWECS, and the user should enter the O&M costs expected in that year.)	N
Do you have replacement costs to enter (Y/N)?	If you wish to enter non-recurring costs, such as replacing blades, in the operation of the wind system, enter "Y" and then enter the values in the years you expect them to occur; otherwise, enter "N."	N
Enter State Tax Benefits = $	Each state has a different tax structure regarding tax credits. Enter the amount that your	0

Prompt	Description	Example Input
	state will credit you for the installation of the wind system. (Note that federal taxes are computed automatically.)	
Depreciation Method	If you have a Residential Use Fraction less than 1, then there are corporate depreciation benefits. Determine which depreciation method you wish to use, and then answer the prompt for depreciation life or declining balance rate.	
1) Straight Depreciation	Annual straight depreciation is found by dividing the depreciation basis by the depreciation life. The program prorates depreciation for the first and last years of the depreciation life depending on the month of installation.	
2) Declining Balance	The depreciation method which applies the same rate in each year on the declining balance of the depreciated amount. Ratios up to 200 percent can be chosen to accelerate the depreciation.	
3) Sum of the Years Digits	The program calculates depreciation using sum of the years digits. For example for a five-year depreciation the first year would allow a deduction factor of (5/1 + 2 + 3 + 4 +5). The second year would allow (4/1 + 2 + 3 + 4 + 5), etc. Yearly depreciation is equal to the depreciation factor times the depreciation basis. Adjustments are automatically prorated for installations completed in any month of the year.	

Prompt	Description	Example Input
Salvage Value of SWECS = $	The salvage value of the wind system at the end of its lifetime (in present dollars). This value is difficult to estimate and, to be on the safe side, the user may want to enter only the scrap value of the machine.	0
Energy Production Method 1. Annual energy produced. 2. Energy produced by month. 3. Use SWECS power curve (and wind distribution) for annual average.		
Enter Energy Production Method	Enter the number 1, 2, or 3 which corresponds to the energy production method which you want to use for the wind system.	1
	Then enter the amount of energy produced or the parameters of wind system performance according to the "prompt" by the computer.	4400
	If "2" is entered, the computer will prompt you with the month, from January to December, and you should enter for each month the expected monthly kWh production from the wind system. If "3" is entered, the program enters a subroutine which takes input from the user for both power curve of the wind system in question, and the yearly average wind speed and Weibull "K" factor of wind variability. The user can enter 8 wind speeds (in m/s) and corresponding power output (in kW) of the wind	

Prompt	Description	Example Input
	system. For Weibull "K" factor, the user should enter a default of 2.0 (the Rayleigh distribution case) if the value is not known.	

Using these numbers yields an analysis of yearly cash flow and annualized cost of energy which is detailed in the first example in Appendix 1.

Stand Alone Applications

The LIFECC program is written specifically for utility-interconnected applications, but the program inputs can be varied to arrive at cost of energy values for stand alone applications as well.

The modifications and adjustments for various prompts are listed below.

Prompt	Modification/Adjustment
SWECS Installation Cost	Installed cost should reflect all costs associated with the stand alone system. Typical auxiliary equipment and other requirements can include storage batteries, inverter, a mechanical heating unit (heat churn), storage tanks, piping, insulation and heating system modifications.
Utility Buy Back Factor	Should be entered as "0."
Utility Grid Cost	This may be the utility power cost or the cost of an alternative or competing energy source. If the unit cost of the alternative source (diesel generator, gas or oil heat, or photovoltaic equipment) is not expressed in cents/kWh, it must be converted for the program to work.

Prompt	Modification/Adjustment
Direct Use Factor	This factor should reflect the percentage of the system's annual energy output the user expects to consume. This is particularly important for a stand alone system.
Replacement Costs	Unlike many components in wind systems, the useful life of storage batteries is well documented. The cost of new batteries should be entered at the appropriate time if the user expects to operate the system for many years.

APPENDIX 1

Sample Cases of LIFECC Program Output

INDEX

Sample Cases

BASE CASE

----------------initial variables--------------

SWECS Installation Cost = $ 10000.00
Years of SWECS life = 20.
Installation Date = 1/1982

Total amount of loan = $ 8000.00
Down payment on loan = $ 2000.00
Loan Term = 10. years
Loan Interest Rate = .120
Calculated annual loan payment = $ 1415.88

User's Discount(Opportunity Cost) Rate = .120
User's Tax Bracket = .350
First year tax liability (w/o swecs) = $ 7000.00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .060
Utility grid cost Escalation Rate = .140
Utility buy back factor = .500

----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $ 100.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate = .10

Availability factor = .95
Total direct use factor = .500
Salvage value of SWECS = $ .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $ 4000.00

Annual energy yield= 4400. kwh

-------------economic analysis---------------

Annualized cost of SWECS energy = $ .101
Annualized cost of grid energy = $ .085

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	4502.15	3515.88	986.28	986.28
1983	506.27	1525.38	-1019.61	-33.33
1984	511.34	1536.38	-1025.53	-1058.86
1985	517.56	1548.98	-1031.42	-2090.28
1986	525.12	1562.29	-1037.17	-3127.45
1987	534.28	1576.93	-1042.65	-4170.10
1988	545.32	1593.03	-1047.71	-5217.81
1989	558.59	1610.75	-1052.16	-6269.96
1990	574.47	1630.23	-1055.77	-7325.73
1991	593.41	1651.67	-1058.25	-8383.98
1992	615.97	259.37	356.59	-8027.38
1993	702.20	285.31	416.89	-7610.49
1994	800.51	313.84	486.67	-7123.82
1995	912.58	345.22	567.36	-6556.46
1996	1040.34	379.75	660.59	-5895.87
1997	1185.98	417.72	768.27	-5127.60
1998	1352.02	459.49	892.53	-4235.07
1999	1541.30	505.44	1035.86	-3199.21
2000	1757.08	555.98	1201.10	-1998.11
2001	2003.07	611.58	1391.49	-606.62
2002	.00	.00	.00	-606.62

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	4502.15	3515.88	986.28	986.28
1983	452.03	1362.39	-910.36	75.91
1984	407.64	1225.19	-817.55	-741.64
1985	368.39	1102.53	-734.15	-1475.78
1986	333.72	992.86	-659.14	-2134.92
1987	303.16	894.79	-591.63	-2726.55
1988	276.28	807.08	-530.80	-3257.35
1989	252.68	728.62	-475.94	-3733.30
1990	232.02	658.43	-426.41	-4159.70
1991	213.99	595.61	-381.62	-4541.32
1992	198.33	83.51	114.81	-4426.50
1993	201.87	82.02	119.85	-4306.65
1994	205.47	80.56	124.92	-4181.73
1995	209.14	79.12	130.02	-4051.71
1996	212.88	77.70	135.17	-3916.54
1997	216.68	76.32	140.36	-3776.18
1998	220.55	74.95	145.59	-3630.59
1999	224.48	73.61	150.87	-3479.72
2000	228.49	72.30	156.19	-3323.53
2001	232.57	71.01	161.56	-3161.96
2002	.00	.00	.00	-3161.96

INSTALLED COST DECREASED TO 8000

----------------initial variables--------------

SWECS Installation Cost = $ 8000.00
Years of SWECS life =   20.
Installation Date = 1/1982

Total amount of loan = $ 6400.00
Down payment on loan = $ 1600.00
Loan Term =   10. years
Loan Interest Rate =   .120
Calculated annual loan payment = $ 1132.70

User's Discount(Opportunity Cost) Rate = .120
User's Tax Bracket = .350
First year tax liability (w/o swecs) = $ 7000.00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .060
Utility grid cost Escalation Rate =   .140
Utility buy back factor =   .500

----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $ 100.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate =   .10

Availability factor =   .95
Total direct use factor = .500
Salvage value of SWECS = $ .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $ 3200.00

Annual energy yield=   4400. kwh

-------------economic analysis----------------

Annualized cost of SWECS energy = $ .067
Annualized cost of grid energy = $ .085

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	3634.95	2832.70	802.25	802.25
1983	442.90	1242.70	-799.80	2.45
1984	452.26	1253.70	-801.44	-798.99
1985	463.28	1265.30	-802.52	-1601.51
1986	476.22	1279.11	-802.89	-2404.40
1987	491.41	1293.75	-802.35	-3206.75
1988	509.20	1309.86	-800.66	-4007.41
1989	530.02	1327.57	-797.55	-4804.95
1990	554.37	1347.06	-792.69	-5597.65
1991	582.80	1368.49	-785.70	-6383.34
1992	615.97	259.37	356.59	-6026.74
1993	702.20	285.31	416.89	-5609.85
1994	800.51	313.84	486.67	-5123.18
1995	912.58	345.22	567.36	-4555.82
1996	1040.34	379.75	660.59	-3895.23
1997	1185.98	417.72	768.27	-3126.96
1998	1352.02	459.49	892.53	-2234.43
1999	1541.30	505.44	1035.86	-1198.57
2000	1757.08	555.98	1201.10	2.53
2001	2003.07	611.58	1391.49	1394.02
2002	.00	.00	.00	1394.02

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	3634.95	2832.70	802.25	802.25
1983	395.45	1109.55	-714.11	88.14
1984	360.54	999.44	-638.90	-550.76
1985	329.75	900.97	-571.22	-1121.98
1986	302.65	812.90	-510.25	-1632.23
1987	278.84	734.11	-455.27	-2087.51
1988	257.98	663.62	-405.64	-2493.14
1989	239.76	600.53	-360.77	-2853.92
1990	223.90	544.06	-320.16	-3174.07
1991	210.16	493.49	-283.33	-3457.40
1992	198.33	83.51	114.81	-3342.59
1993	201.87	82.02	119.85	-3222.74
1994	205.47	80.56	124.92	-3097.83
1995	209.14	79.12	130.02	-2967.80
1996	212.88	77.70	135.17	-2832.63
1997	216.68	76.32	140.36	-2692.27
1998	220.55	74.95	145.59	-2546.68
1999	224.48	73.61	150.87	-2395.81
2000	228.49	72.30	156.19	-2239.62
2001	232.57	71.01	161.56	-2078.05
2002	.00	.00	.00	-2078.05

INSTALLED COST INCREASED TO $12000

```
----------------initial variables--------------

SWECS Installation Cost = $  12000.00
Years of SWECS life =           20.
Installation Date =  1/1982

Total amount of loan = $   9600.00
Down payment on loan = $   2400.00
Loan Term =             10. years
Loan Interest Rate =   .120
Calculated annual loan payment = $   1699.05

User's Discount(Opportunity Cost) Rate =  .120
User's Tax Bracket =  .350
First year tax liability (w/o swecs) = $   7000.00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .060
Utility grid cost Escalation Rate =          .140
Utility buy back factor =                    .500

----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $    100.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate =           .10

Availability factor =      .95
Total direct use factor = .500
Salvage value of SWECS =      $       .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $   4000.00

Annual energy yield=      4400. kwh

-------------economic analysis---------------

Annualized cost of SWECS energy = $ .162
Annualized cost of grid energy  = $ .035
```

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	4569.35	4199.05	370.30	370.30
1983	569.64	1809.05	-1239.41	-869.11
1984	570.42	1820.05	-1249.63	-2118.74
1985	571.83	1832.15	-1260.32	-3379.05
1986	574.02	1845.46	-1271.44	-4650.50
1987	577.15	1860.10	-1282.95	-5933.45
1988	581.45	1876.21	-1294.76	-7228.20
1989	587.15	1893.92	-1306.77	-8534.97
1990	594.57	1913.41	-1318.84	-9853.81
1991	604.03	1934.84	-1330.81	-11184.62
1992	615.97	259.37	356.59	-10828.02
1993	702.20	285.31	416.89	-10411.12
1994	800.51	313.84	486.67	-9924.45
1995	912.58	345.22	567.36	-9357.10
1996	1040.34	379.75	660.59	-8696.50
1997	1185.98	417.72	768.27	-7928.24
1998	1352.02	459.49	892.53	-7035.71
1999	1541.30	505.44	1035.86	-5999.84
2000	1757.08	555.98	1201.10	-4798.74
2001	2003.07	611.58	1391.49	-3407.25
2002	.00	.00	.00	-3407.25

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	4569.35	4199.05	370.30	370.30
1983	508.61	1615.22	-1106.62	-736.32
1984	454.74	1450.93	-996.20	-1732.51
1985	407.02	1304.09	-897.07	-2629.58
1986	364.80	1172.83	-808.03	-3437.61
1987	327.49	1055.47	-727.98	-4165.59
1988	294.58	950.55	-655.97	-4821.56
1989	265.60	856.72	-591.12	-5412.67
1990	240.14	772.80	-532.66	-5945.33
1991	217.82	697.73	-479.91	-6425.23
1992	198.33	83.51	114.81	-6310.41
1993	201.87	82.02	119.85	-6190.57
1994	205.47	80.56	124.92	-6065.65
1995	209.14	79.12	130.02	-5935.62
1996	212.88	77.70	135.17	-5800.45
1997	216.68	76.32	140.36	-5660.09
1998	220.55	74.95	145.59	-5514.49
1999	224.48	73.61	150.87	-5363.62
2000	228.49	72.30	156.19	-5207.43
2001	232.57	71.01	161.56	-5045.86
2002	.00	.00	.00	-5045.86

LIFETIME REDUCED TO 15 YEARS

----------------initial variables--------------

SWECS Installation Cost = $ 10000.00
Years of SWECS life = 15.
Installation Date = 1/1982

Total amount of loan = $ 8000.00
Down payment on loan = $ 2000.00
Loan Term = 10. years
Loan Interest Rate = .120
Calculated annual loan payment = $ 1415.88

User's Discount(Opportunity Cost) Rate = .120
User's Tax Bracket = .350
First year tax liability (w/o swecs) = $ 7000.00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .060
Utility grid cost Escalation Rate = .140
Utility buy back factor = .500

----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $ 100.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate = .10

Availability factor = .95
Total direct use factor = .500
Salvage value of SWECS = $ .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $ 4000.00

Annual energy yield= 4400. kwh

-------------economic analysis----------------

Annualized cost of SWECS energy = $ .138
Annualized cost of grid energy = $ .078

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	4502.15	3515.88	986.28	986.28
1983	506.27	1525.88	-1019.61	-33.33
1984	511.34	1536.88	-1025.53	-1058.86
1985	517.56	1548.98	-1031.42	-2090.28
1986	525.12	1562.29	-1037.17	-3127.45
1987	534.28	1576.93	-1042.65	-4170.10
1988	545.32	1593.03	-1047.71	-5217.81
1989	558.59	1610.75	-1052.16	-6269.96
1990	574.47	1630.23	-1055.77	-7325.73
1991	593.41	1651.67	-1058.25	-8383.98
1992	615.97	259.37	356.59	-8027.38
1993	702.20	285.31	416.89	-7610.49
1994	800.51	313.84	486.67	-7123.82
1995	912.58	345.22	567.36	-6556.46
1996	1040.34	379.75	660.59	-5895.87
1997	.00	.00	.00	-5895.87

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	4502.15	3515.88	986.28	986.28
1983	452.03	1362.39	-910.36	75.91
1984	407.64	1225.19	-817.55	-741.64
1985	368.39	1102.53	-734.15	-1475.78
1986	333.72	992.86	-659.14	-2134.92
1987	303.16	894.79	-591.63	-2726.55
1988	276.28	807.08	-530.80	-3257.35
1989	252.68	728.62	-475.94	-3733.30
1990	232.02	658.43	-426.41	-4159.70
1991	213.99	595.61	-381.62	-4541.32
1992	198.33	83.51	114.81	-4426.50
1993	201.87	82.02	119.85	-4306.65
1994	205.47	80.56	124.92	-4181.73
1995	209.14	79.12	130.02	-4051.71
1996	212.88	77.70	135.17	-3916.54
1997	.00	.00	.00	-3916.54

LIFETIME INCREASED TO 25 YEARS

----------------initial variables--------------

SWECS Installation Cost = $ 10000.00
Years of SWECS life = 25.
Installation Date = 1/1982

Total amount of loan = $ 8000.00
Down payment on loan = $ 2000.00
Loan Term = 10. years
Loan Interest Rate = .120
Calculated annual loan payment = $ 1415.88

User's Discount(Opportunity Cost) Rate = .120
User's Tax Bracket = .350
First year tax liability (w/o swecs) = $ 7000.00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .060
Utility grid cost Escalation Rate = .140
Utility buy back factor = .500

----------future costs/benefits----------------

Operating and Maintenance Costs for first Year = $ 100.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate = .10

Availability factor = .95
Total direct use factor = .500
Salvage value of SWECS = $ .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $ 4000.00

Annual energy yield= 4400. kwh

-------------economic analysis---------------

Annualized cost of SWECS energy = $ .069
Annualized cost of grid energy = $ .093

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	4502.15	3515.88	986.28	986.28
1983	506.27	1525.88	-1019.61	-33.33
1984	511.34	1536.88	-1025.53	-1058.86
1985	517.56	1548.98	-1031.42	-2090.28
1986	525.12	1562.29	-1037.17	-3127.45
1987	534.28	1576.93	-1042.65	-4170.10
1988	545.32	1593.03	-1047.71	-5217.81
1989	558.59	1610.75	-1052.16	-6269.96
1990	574.47	1630.23	-1055.77	-7325.73
1991	593.41	1651.67	-1058.25	-8383.98
1992	615.97	259.37	356.59	-8027.38
1993	702.20	285.31	416.89	-7610.49
1994	800.51	313.84	486.67	-7123.82
1995	912.58	345.22	567.36	-6556.46
1996	1040.34	379.75	660.59	-5895.87
1997	1185.98	417.72	768.27	-5127.60
1998	1352.02	459.49	892.53	-4235.07
1999	1541.30	505.44	1035.86	-3199.21
2000	1757.08	555.98	1201.10	-1998.11
2001	2003.07	611.58	1391.49	-606.62
2002	2283.50	672.74	1610.76	1004.15
2003	2603.19	740.01	1863.18	2867.32
2004	2967.63	814.01	2153.62	5020.94
2005	3383.09	895.41	2487.68	7508.62
2006	3856.72	984.95	2871.77	10380.39
2007	.00	.00	.00	10380.39

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	4502.15	3515.88	986.28	986.28
1983	452.03	1362.39	-910.36	75.91
1984	407.64	1225.19	-817.55	-741.64
1985	368.39	1102.53	-734.15	-1475.78
1986	333.72	992.86	-659.14	-2134.92
1987	303.16	894.79	-591.63	-2726.55
1988	276.28	807.08	-530.80	-3257.35
1989	252.68	728.62	-475.94	-3733.30
1990	232.02	658.43	-426.41	-4159.70
1991	213.99	595.61	-381.62	-4541.32
1992	198.33	83.51	114.81	-4426.50
1993	201.87	82.02	119.85	-4306.65
1994	205.47	80.56	124.92	-4181.73
1995	209.14	79.12	130.02	-4051.71
1996	212.88	77.70	135.17	-3916.54
1997	216.68	76.32	140.36	-3776.18
1998	220.55	74.95	145.59	-3630.59
1999	224.48	73.61	150.87	-3479.72
2000	228.49	72.30	156.19	-3323.53
2001	232.57	71.01	161.56	-3161.96
2002	236.73	69.74	166.98	-2994.98
2003	240.95	68.50	172.46	-2822.52
2004	245.25	67.27	177.98	-2644.54
2005	249.63	66.07	183.56	-2460.98
2006	254.09	64.89	189.20	-2271.78
2007	.00	.00	.00	-2271.78

O&M INCREASED TO $200/YEAR

----------------initial variables--------------

SWECS Installation Cost = $ 10000.00
Years of SWECS life = 20.
Installation Date = 1/1982

Total amount of loan = $ 8000.00
Down payment on loan = $ 2000.00
Loan Term = 10. years
Loan Interest Rate = .120
Calculated annual loan payment = $ 1415.88

User's Discount(Opportunity Cost) Rate = .120
User's Tax Bracket = .350
First year tax liability (w/o swecs) = $ 7000.00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .060
Utility grid cost Escalation Rate = .140
Utility buy back factor = .500

----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $ 200.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate = .10

Availability factor = .95
Total direct use factor = .500
Salvage value of SWECS = $ .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $ 4000.00

Annual energy yield= 4400. kwh

-------------economic analysis---------------

Annualized cost of SWECS energy = $ .156
Annualized cost of grid energy = $ .085

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	4502.15	3615.88	886.28	886.28
1983	506.27	1635.88	-1129.61	-243.33
1984	511.34	1657.88	-1146.53	-1389.86
1985	517.56	1682.08	-1164.52	-2554.38
1986	525.12	1708.70	-1183.58	-3737.96
1987	534.28	1737.98	-1203.70	-4941.66
1988	545.32	1770.19	-1224.86	-6166.52
1989	558.59	1805.62	-1247.03	-7413.55
1990	574.47	1844.59	-1270.12	-8683.67
1991	593.41	1887.46	-1294.05	-9977.72
1992	615.97	518.74	97.22	-9880.49
1993	702.20	570.62	131.58	-9748.91
1994	800.51	627.68	172.83	-9576.07
1995	912.58	690.45	222.13	-9353.94
1996	1040.34	759.49	280.85	-9073.09
1997	1185.98	835.44	350.55	-8722.54
1998	1352.02	918.98	433.04	-8289.50
1999	1541.30	1010.88	530.42	-7759.07
2000	1757.08	1111.97	645.12	-7113.96
2001	2003.07	1223.16	779.91	-6334.04
2002	.00	.00	.00	-6334.04

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	4502.15	3615.88	886.28	886.28
1983	452.03	1460.60	-1008.58	-122.30
1984	407.64	1321.65	-914.01	-1036.31
1985	368.39	1197.27	-828.88	-1865.19
1986	333.72	1085.91	-752.19	-2617.38
1987	303.16	986.18	-683.01	-3300.39
1988	276.28	896.83	-620.56	-3920.95
1989	252.68	816.77	-564.09	-4485.04
1990	232.02	745.00	-512.98	-4998.02
1991	213.99	680.64	-466.65	-5464.66
1992	198.33	167.02	31.30	-5433.36
1993	201.87	164.04	37.83	-5395.53
1994	205.47	161.11	44.36	-5351.17
1995	209.14	158.23	50.91	-5300.26
1996	212.88	155.41	57.47	-5242.79
1997	216.68	152.63	64.04	-5178.74
1998	220.55	149.91	70.64	-5108.10
1999	224.48	147.23	77.25	-5030.85
2000	228.49	144.60	83.89	-4946.95
2001	232.57	142.02	90.55	-4856.40
2002	.00	.00	.00	-4856.40

O&M DECREASED TO $50/YEAR

----------------initial variables--------------

SWECS Installation Cost = $ 10000.00
Years of SWECS life = 20.
Installation Date = 1/1982

Total amount of loan = $ 8000.00
Down payment on loan = $ 2000.00
Loan Term = 10. years
Loan Interest Rate = .120
Calculated annual loan payment = $ 1415.88

User's Discount(Opportunity Cost) Rate = .120
User's Tax Bracket = .350
First year tax liability (w/o swecs) = $ 7000.00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .060
Utility grid cost Escalation Rate = .140
Utility buy back factor = .500

----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $ 50.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate = .10

Availability factor = .95
Total direct use factor = .500
Salvage value of SWECS = $ .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $ 4000.00

Annual energy yield= 4400. kwh

-------------economic analysis---------------

Annualized cost of SWECS energy = $ .074
Annualized cost of grid energy = $ .085

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	4502.15	3465.88	1036.28	1036.28
1983	506.27	1470.88	-964.61	71.67
1984	511.34	1476.38	-965.03	-893.36
1985	517.56	1482.43	-964.87	-1858.23
1986	525.12	1489.08	-963.96	-2822.20
1987	534.28	1496.40	-962.12	-3784.32
1988	545.32	1504.45	-959.13	-4743.45
1989	558.59	1513.31	-954.72	-5698.17
1990	574.47	1523.05	-948.59	-6646.75
1991	593.41	1533.77	-940.36	-7587.11
1992	615.97	129.69	486.28	-7100.83
1993	702.20	142.65	559.55	-6541.28
1994	800.51	156.92	643.59	-5897.69
1995	912.58	172.61	739.97	-5157.72
1996	1040.34	189.87	850.47	-4307.25
1997	1185.98	208.86	977.12	-3330.13
1998	1352.02	229.75	1122.28	-2207.85
1999	1541.30	252.72	1288.58	-919.27
2000	1757.08	277.99	1479.09	559.82
2001	2003.07	305.79	1697.28	2257.10
2002	.00	.00	.00	2257.10

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	4502.15	3465.88	1036.28	1036.28
1983	452.03	1313.28	-861.26	175.02
1984	407.64	1176.96	-769.32	-594.30
1985	368.39	1055.16	-686.78	-1281.07
1986	333.72	946.34	-612.62	-1893.69
1987	303.16	849.10	-545.94	-2439.63
1988	276.28	762.20	-485.93	-2925.55
1989	252.68	684.55	-431.87	-3357.42
1990	232.02	615.14	-383.12	-3740.54
1991	213.99	553.10	-339.10	-4079.65
1992	198.33	41.76	156.57	-3923.08
1993	201.87	41.01	160.86	-3762.22
1994	205.47	40.28	165.19	-3597.03
1995	209.14	39.56	169.58	-3427.44
1996	212.88	38.85	174.02	-3253.42
1997	216.68	38.16	178.52	-3074.90
1998	220.55	37.48	183.07	-2891.83
1999	224.48	36.81	187.68	-2704.16
2000	228.49	36.15	192.34	-2511.81
2001	232.57	35.50	197.07	-2314.75
2002	.00	.00	.00	-2314.75

INCREASE OUTPUT TO 5600 KWH/YEAR

----------------initial variables--------------

SWECS Installation Cost = $ 10000.00
Years of SWECS life = 20.
Installation Date = 1/1982

Total amount of loan = $ 8000.00
Down payment on loan = $ 2000.00
Loan Term = 10. years
Loan Interest Rate = .120
Calculated annual loan payment = $ 1415.38

User's Discount(Opportunity Cost) Rate = .120
User's Tax Bracket = .350
First year tax liability (w/o swecs) = $ 7000.00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .060
Utility grid cost Escalation Rate = .140
Utility buy back factor = .500

----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $ 100.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate = .10

Availability factor = .95
Total direct use factor = .500
Salvage value of SWECS = $ .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $ 4000.00

Annual energy yield= 5600. kwh

-------------economic analysis---------------

Annualized cost of SWECS energy = $ .052
Annualized cost of grid energy = $ .085

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	4547.47	3515.88	1031.59	1031.59
1983	557.93	1525.88	-967.95	63.65
1984	570.23	1536.88	-966.64	-903.00
1985	584.69	1548.98	-964.28	-1867.28
1986	601.65	1562.29	-960.63	-2827.91
1987	621.53	1576.93	-955.40	-3783.31
1988	644.79	1593.03	-948.24	-4731.56
1989	671.98	1610.75	-938.77	-5670.32
1990	703.73	1630.23	-926.50	-6596.82
1991	740.78	1651.67	-910.89	-7507.71
1992	783.96	259.37	524.59	-6983.13
1993	893.71	285.31	608.40	-6374.72
1994	1018.83	313.84	704.99	-5669.73
1995	1161.46	345.22	816.24	-4853.49
1996	1324.07	379.75	944.32	-3909.17
1997	1509.44	417.72	1091.72	-2817.45
1998	1720.75	459.49	1261.26	-1556.19
1999	1961.66	505.44	1456.22	-99.97
2000	2236.29	555.98	1680.31	1580.34
2001	2549.37	611.58	1937.79	3518.12
2002	.00	.00	.00	3518.12

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	4547.47	3515.88	1031.59	1031.59
1983	498.15	1362.39	-864.24	167.35
1984	454.59	1225.19	-770.60	-603.25
1985	416.17	1102.53	-686.36	-1289.61
1986	382.36	992.86	-610.50	-1900.11
1987	352.67	894.79	-542.12	-2442.23
1988	326.67	807.08	-480.41	-2922.64
1989	303.97	728.62	-424.65	-3347.29
1990	284.23	658.43	-374.20	-3721.49
1991	267.13	595.61	-328.48	-4049.97
1992	252.41	83.51	168.90	-3881.07
1993	256.92	82.02	174.90	-3706.16
1994	261.51	80.56	180.95	-3525.21
1995	266.18	79.12	187.06	-3338.15
1996	270.93	77.70	193.23	-3144.92
1997	275.77	76.32	199.45	-2945.47
1998	280.69	74.95	205.74	-2739.73
1999	285.71	73.61	212.09	-2527.63
2000	290.81	72.30	218.51	-2309.13
2001	296.00	71.01	224.99	-2084.13
2002	.00	.00	.00	-2084.13

DECREASE OUTPUT TO 3200 KWH/YEAR

```
----------------initial variables--------------

SWECS Installation Cost = $  10000.00
Years of SWECS life =           20.
Installation Date =  1/1982

Total amount of loan = $   8000.00
Down payment on loan = $   2000.00
Loan Term =             10. years
Loan Interest Rate =   .120
Calculated annual loan payment = $   1415.88

User's Discount(Opportunity Cost) Rate =  .120
User's Tax Bracket =  .350
First year tax liability (w/o swecs) = $   7000.00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .060
Utility grid cost Escalation Rate =          .140
Utility buy back factor =                    .500

----------future costs/benefits----------------

Operating and Maintenance Costs for first Year = $    100.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate =           .10

Availability factor =     .95
Total direct use factor = .500
Salvage value of SWECS =       $       .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $   4000.00

Annual energy yield=      3200. kwh

-------------economic analysis---------------

Annualized cost of SWECS energy = $ .187
Annualized cost of grid energy  = $ .085
```

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	4456.84	3515.88	940.96	940.96
1983	454.61	1525.88	-1071.27	-130.30
1984	452.45	1536.88	-1084.42	-1214.73
1985	450.42	1543.98	-1093.56	-2313.28
1986	448.58	1562.29	-1113.70	-3426.99
1987	447.03	1576.93	-1129.90	-4556.88
1988	445.86	1593.03	-1147.17	-5704.06
1989	445.20	1610.75	-1165.55	-6869.60
1990	445.20	1630.23	-1185.03	-8054.63
1991	446.05	1651.67	-1205.61	-9260.24
1992	447.93	259.37	188.60	-9071.64
1993	510.69	285.31	225.38	-8846.25
1994	582.19	313.84	268.35	-8577.90
1995	663.69	345.22	318.47	-8259.43
1996	756.61	379.75	376.87	-7882.56
1997	862.53	417.72	444.82	-7437.75
1998	983.29	459.49	523.80	-6913.95
1999	1120.95	505.44	615.51	-6298.43
2000	1277.88	555.98	721.90	-5576.54
2001	1456.78	611.58	845.20	-4731.33
2002	.00	.00	.00	-4731.33

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	4456.84	3515.88	940.96	940.96
1983	405.90	1362.39	-956.49	-15.53
1984	360.69	1225.19	-864.50	-880.02
1985	320.60	1102.53	-781.93	-1661.95
1986	285.08	992.86	-707.78	-2369.73
1987	253.66	894.79	-641.14	-3010.87
1988	225.89	807.08	-581.19	-3592.06
1989	201.39	728.62	-527.24	-4119.30
1990	179.81	658.43	-478.62	-4597.91
1991	160.85	595.61	-434.76	-5032.67
1992	144.24	83.51	60.73	-4971.94
1993	146.81	82.02	64.79	-4907.15
1994	149.43	80.56	68.88	-4838.27
1995	152.10	79.12	72.99	-4765.28
1996	154.82	77.70	77.11	-4688.16
1997	157.58	76.32	81.27	-4606.90
1998	160.40	74.95	85.44	-4521.45
1999	163.26	73.61	89.65	-4431.80
2000	166.18	72.30	93.88	-4337.92
2001	169.14	71.01	98.13	-4239.79
2002	.00	.00	.00	-4239.79

GRID COST INCREASED TO $.08/KWH

----------------initial variables--------------

SWECS Installation Cost = $ 10000.00
Years of SWECS life = 20.
Installation Date = 1/1982

Total amount of loan = $ 8000.00
Down payment on loan = $ 2000.00
Loan Term = 10. years
Loan Interest Rate = .120
Calculated annual loan payment = $ 1415.88

User's Discount(Opportunity Cost) Rate = .120
User's Tax Bracket = .350
First year tax liability (w/o swecs) = $ 7000.00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .080
Utility grid cost Escalation Rate = .140
Utility buy back factor = .500

----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $ 100.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate = .10

Availability factor = .95
Total direct use factor = .500
Salvage value of SWECS = $ .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $ 4000.00

Annual energy yield= 4400. kwh

-------------economic analysis---------------

Annualized cost of SWECS energy = $ .059
Annualized cost of grid energy = $ .114

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	4557.54	3515.88	1041.66	1041.66
1983	569.41	1525.88	-956.47	85.20
1984	583.32	1536.88	-953.55	-868.36
1985	599.61	1548.98	-949.37	-1817.72
1986	618.66	1562.29	-943.62	-2761.35
1987	640.92	1576.93	-936.01	-3697.36
1988	666.89	1593.03	-926.14	-4623.50
1989	697.17	1610.75	-913.57	-5537.07
1990	732.45	1630.23	-897.78	-6434.84
1991	773.52	1651.67	-878.15	-7312.99
1992	821.29	259.37	561.92	-6751.07
1993	936.27	285.31	650.96	-6100.11
1994	1067.34	313.84	753.50	-5346.60
1995	1216.77	345.22	871.55	-4475.05
1996	1387.12	379.75	1007.37	-3467.68
1997	1581.31	417.72	1163.59	-2304.09
1998	1802.69	459.49	1343.20	-960.88
1999	2055.07	505.44	1549.63	588.75
2000	2342.78	555.98	1786.79	2375.54
2001	2670.76	611.58	2059.18	4434.72
2002	.00	.00	.00	4434.72

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	4557.54	3515.88	1041.66	1041.66
1983	508.40	1362.39	-853.99	187.67
1984	465.02	1225.19	-760.17	-572.49
1985	426.79	1102.53	-675.74	-1248.23
1986	393.17	992.86	-599.69	-1847.93
1987	363.67	894.79	-531.12	-2379.04
1988	337.87	807.08	-469.21	-2848.26
1989	315.37	728.62	-413.25	-3261.51
1990	295.83	658.43	-362.60	-3624.11
1991	278.94	595.61	-316.67	-3940.78
1992	264.43	83.51	180.92	-3759.86
1993	269.16	82.02	187.14	-3572.72
1994	273.96	80.56	193.41	-3379.31
1995	278.85	79.12	199.74	-3179.58
1996	283.83	77.70	206.13	-2973.45
1997	288.90	76.32	212.59	-2760.86
1998	294.06	74.95	219.11	-2541.76
1999	299.31	73.61	225.70	-2316.06
2000	304.66	72.30	232.36	-2083.70
2001	310.10	71.01	239.09	-1844.62
2002	.00	.00	.00	-1844.62

DECREASE GRID COST TO $.04/KWH

----------------initial variables--------------

SWECS Installation Cost = $ 10000.00
Years of SWECS life = 20.
Installation Date = 1/1982

Total amount of loan = $ 8000.00
Down payment on loan = $ 2000.00
Loan Term = 10. years
Loan Interest Rate = .120
Calculated annual loan payment = $ 1415.38

User's Discount(Opportunity Cost) Rate = .120
User's Tax Bracket = .350
First year tax liability (w/o swecs) = $ 7000.00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .040
Utility grid cost Escalation Rate = .140
Utility buy back factor = .500

----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $ 100.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate = .10

Availability factor = .95
Total direct use factor = .500
Salvage value of SWECS = $ .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $ 4000.00

Annual energy yield= 4400. kwh

-------------economic analysis---------------

Annualized cost of SWECS energy = $ .143
Annualized cost of grid energy = $ .057

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	4446.77	3515.88	930.89	930.89
1983	443.13	1525.88	-1082.75	-151.85
1984	439.36	1536.88	-1097.51	-1249.36
1985	435.50	1548.98	-1113.48	-2362.84
1986	431.58	1562.29	-1130.71	-3493.55
1987	427.64	1576.93	-1149.29	-4642.83
1988	423.75	1593.03	-1169.28	-5812.11
1989	420.00	1610.75	-1190.75	-7002.85
1990	416.48	1630.23	-1213.76	-8216.60
1991	413.31	1651.67	-1238.36	-9454.96
1992	410.64	259.37	151.27	-9303.69
1993	468.13	285.31	182.83	-9120.86
1994	533.67	313.84	219.83	-8901.02
1995	608.39	345.22	263.16	-8637.86
1996	693.56	379.75	313.81	-8324.04
1997	790.66	417.72	372.94	-7951.11
1998	901.35	459.49	441.86	-7509.25
1999	1027.54	505.44	522.10	-6987.15
2000	1171.39	555.98	615.41	-6371.74
2001	1335.38	611.58	723.80	-5647.94
2002	.00	.00	.00	-5647.94

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	4446.77	3515.88	930.89	930.89
1983	395.65	1362.39	-966.74	-35.84
1984	350.26	1225.19	-874.93	-910.77
1985	309.98	1102.53	-792.55	-1703.32
1986	274.27	992.86	-718.59	-2421.91
1987	242.65	894.79	-652.14	-3074.05
1988	214.69	807.08	-592.39	-3666.44
1989	189.99	728.62	-538.63	-4205.07
1990	168.21	658.43	-490.22	-4695.29
1991	149.04	595.61	-446.57	-5141.85
1992	132.22	83.51	48.71	-5093.15
1993	134.58	82.02	52.56	-5040.59
1994	136.98	80.56	56.43	-4984.16
1995	139.43	79.12	60.31	-4923.85
1996	141.92	77.70	64.21	-4859.63
1997	144.45	76.32	68.13	-4791.50
1998	147.03	74.95	72.08	-4719.42
1999	149.66	73.61	76.04	-4643.38
2000	152.33	72.30	80.03	-4563.34
2001	155.05	71.01	84.04	-4479.31
2002	.00	.00	.00	-4479.31

INCREASE DISCOUNT RATE TO .14

----------------initial variables--------------

SWECS Installation Cost = $ 10000.00
Years of SWECS life = 20.
Installation Date = 1/1982

Total amount of loan = $ 8000.00
Down payment on loan = $ 2000.00
Loan Term = 10. years
Loan Interest Rate = .120
Calculated annual loan payment = $ 1415.88

User's Discount(Opportunity Cost) Rate = .140
User's Tax Bracket = .350
First year tax liability (w/o swecs) = $ 7000.00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .060
Utility grid cost Escalation Rate = .140
Utility buy back factor = .500

----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $ 100.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate = .10

Availability factor = .95
Total direct use factor = .500
Salvage value of SWECS = $ .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $ 4000.00

Annual energy yield= 4400. kwh

-------------economic analysis---------------

Annualized cost of SWECS energy = $ .111
Annualized cost of grid energy = $ .060

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	4502.15	3515.88	986.28	986.28
1983	506.27	1525.88	-1019.61	-33.33
1984	511.34	1536.88	-1025.53	-1058.86
1985	517.56	1548.98	-1031.42	-2090.28
1986	525.12	1562.29	-1037.17	-3127.45
1987	534.28	1576.93	-1042.65	-4170.10
1988	545.32	1593.03	-1047.71	-5217.81
1989	558.59	1610.75	-1052.16	-6269.96
1990	574.47	1630.23	-1055.77	-7325.73
1991	593.41	1651.67	-1058.25	-8383.98
1992	615.97	259.37	356.59	-8027.38
1993	702.20	285.31	416.89	-7610.49
1994	800.51	313.84	486.67	-7123.82
1995	912.58	345.22	567.36	-6556.46
1996	1040.34	379.75	660.59	-5895.87
1997	1185.98	417.72	768.27	-5127.60
1998	1352.02	459.49	892.53	-4235.07
1999	1541.30	505.44	1035.86	-3199.21
2000	1757.08	555.98	1201.10	-1998.11
2001	2003.07	611.58	1391.49	-606.62
2002	.00	.00	.00	-606.62

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	4502.15	3515.88	986.28	986.28
1983	444.10	1338.49	-894.39	91.88
1984	393.46	1182.58	-789.12	-697.23
1985	349.34	1045.52	-696.18	-1393.41
1986	310.91	925.00	-614.09	-2007.50
1987	277.49	819.01	-541.52	-2549.02
1988	248.44	725.77	-477.32	-3026.35
1989	223.23	643.72	-420.48	-3446.83
1990	201.39	571.50	-370.11	-3816.94
1991	182.48	507.91	-325.42	-4142.36
1992	166.15	69.96	96.19	-4046.17
1993	166.15	67.51	98.64	-3947.53
1994	166.15	65.14	101.01	-3846.51
1995	166.15	62.86	103.30	-3743.22
1996	166.15	60.65	105.50	-3637.71
1997	166.15	58.52	107.63	-3530.08
1998	166.15	56.47	109.69	-3420.39
1999	166.15	54.49	111.67	-3308.72
2000	166.15	52.58	113.58	-3195.14
2001	166.15	50.73	115.42	-3079.72
2002	.00	.00	.00	-3079.72

DECREASE DISCOUNT RATE TO .10

----------------initial variables--------------

SWECS Installation Cost = $ 10000.00
Years of SWECS life =   20.
Installation Date = 1/1982

Total amount of loan = $ 8000.00
Down payment on loan = $ 2000.00
Loan Term =   10. years
Loan Interest Rate =   .120
Calculated annual loan payment = $ 1415.38

User's Discount(Opportunity Cost) Rate = .100
User's Tax Bracket = .350
First year tax liability (w/o swecs) = $ 7000.00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .060
Utility grid cost Escalation Rate =   .140
Utility buy back factor =   .500

----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $ 100.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate =   .10

Availability factor =   .95
Total direct use factor = .500
Salvage value of SWECS = $ .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $ 4000.00

Annual energy yield=   4400. kwh

-------------economic analysis---------------

Annualized cost of SWECS energy = $ .090
Annualized cost of grid energy = $ .123

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	4502.15	3515.88	986.28	986.28
1983	506.27	1525.88	-1019.61	-33.33
1984	511.34	1536.88	-1025.53	-1058.86
1985	517.56	1548.98	-1031.42	-2090.28
1986	525.12	1562.29	-1037.17	-3127.45
1987	534.28	1576.93	-1042.65	-4170.10
1988	545.32	1593.03	-1047.71	-5217.81
1989	558.59	1610.75	-1052.16	-6269.96
1990	574.47	1630.23	-1055.77	-7325.73
1991	593.41	1651.67	-1058.25	-8383.98
1992	615.97	259.37	356.59	-8027.38
1993	702.20	285.31	416.89	-7610.49
1994	800.51	313.84	486.67	-7123.82
1995	912.58	345.22	567.36	-6556.46
1996	1040.34	379.75	660.59	-5895.87
1997	1185.98	417.72	768.27	-5127.60
1998	1352.02	459.49	892.53	-4235.07
1999	1541.30	505.44	1035.86	-3199.21
2000	1757.08	555.98	1201.10	-1998.11
2001	2003.07	611.58	1391.49	-606.62
2002	.00	.00	.00	-606.62

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	4502.15	3515.88	986.28	986.28
1983	460.24	1387.16	-926.92	59.36
1984	422.60	1270.15	-847.55	-788.19
1985	388.85	1163.77	-774.92	-1563.11
1986	358.66	1067.07	-708.40	-2271.51
1987	331.75	979.15	-647.41	-2918.92
1988	307.82	899.23	-591.41	-3510.33
1989	286.65	826.57	-539.93	-4050.25
1990	267.99	760.52	-492.53	-4542.78
1991	251.67	700.47	-448.81	-4991.58
1992	237.48	100.00	137.48	-4854.10
1993	246.12	100.00	146.12	-4707.98
1994	255.07	100.00	155.07	-4552.91
1995	264.34	100.00	164.34	-4388.56
1996	273.96	100.00	173.96	-4214.60
1997	283.92	100.00	183.92	-4030.68
1998	294.24	100.00	194.24	-3836.44
1999	304.94	100.00	204.94	-3631.50
2000	316.03	100.00	216.03	-3415.46
2001	327.52	100.00	227.52	-3187.94
2002	.00	.00	.00	-3187.94

REDUCE TAX CREDIT TO $0

```
----------------initial variables--------------

SWECS Installation Cost = $  10000.00
Years of SWECS life =           20.
Installation Date =  1/1982

Total amount of loan = $    8000.00
Down payment on loan = $    2000.00
Loan Term =           10. years
Loan Interest Rate =   .120
Calculated annual loan payment = $   1415.98

User's Discount(Opportunity Cost) Rate =  .120
User's Tax Bracket =  .350
First year tax liability (w/o swecs) = $       .00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .060
Utility grid cost Escalation Rate =          .140
Utility buy back factor =                    .500


----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $    100.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate =           .10

Availability factor =     .95
Total direct use factor = .500
Salvage value of SWECS =      $       .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $       .00

Annual energy yield=      4400. kwh


-------------economic analysis----------------

Annualized cost of SWECS energy = $ .229
Annualized cost of grid energy  = $ .085
```

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	502.15	3515.88	-3013.72	-3013.72
1983	506.27	1525.88	-1019.61	-4033.33
1984	511.34	1536.88	-1025.53	-5058.86
1985	517.56	1548.98	-1031.42	-6090.28
1986	525.12	1562.29	-1037.17	-7127.44
1987	534.28	1576.93	-1042.65	-8170.09
1988	545.32	1593.03	-1047.71	-9217.79
1989	558.59	1610.75	-1052.16	-10269.95
1990	574.47	1630.23	-1055.77	-11325.71
1991	593.41	1651.67	-1058.25	-12383.97
1992	615.97	259.37	356.59	-12027.37
1993	702.20	285.31	416.39	-11610.48
1994	800.51	313.84	486.67	-11123.80
1995	912.58	345.22	567.36	-10556.45
1996	1040.34	379.75	660.59	-9895.36
1997	1185.98	417.72	768.27	-9127.59
1998	1352.02	459.49	892.53	-8235.06
1999	1541.30	505.44	1035.86	-7199.20
2000	1757.08	555.98	1201.10	-5998.09
2001	2003.07	611.58	1391.49	-4606.60
2002	.00	.00	.00	-4606.60

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	502.15	3515.88	-3013.72	-3013.72
1983	452.03	1362.39	-910.36	-3924.08
1984	407.64	1225.19	-817.55	-4741.63
1985	368.39	1102.53	-734.15	-5475.78
1986	333.72	992.86	-659.14	-6134.91
1987	303.16	894.79	-591.63	-6726.54
1988	276.28	807.08	-530.80	-7257.34
1989	252.68	728.62	-475.94	-7733.28
1990	232.02	658.43	-426.41	-8159.69
1991	213.99	595.61	-381.62	-8541.31
1992	198.33	83.51	114.81	-8426.49
1993	201.87	82.02	119.85	-8306.64
1994	205.47	80.56	124.92	-8181.72
1995	209.14	79.12	130.02	-8051.70
1996	212.88	77.70	135.17	-7916.52
1997	216.68	76.32	140.36	-7776.16
1998	220.55	74.95	145.59	-7630.57
1999	224.48	73.61	150.87	-7479.70
2000	228.49	72.30	156.19	-7323.50
2001	232.57	71.01	161.56	-7161.93
2002	.00	.00	.00	-7161.93

BEST CASE SCENARIO FOR ALL KEY VARIABLES

----------------initial variables--------------

SWECS Installation Cost = $ 8000.00
Years of SWECS life = 25.
Installation Date = 1/1982

Total amount of loan = $ 6400.00
Down payment on loan = $ 1600.00
Loan Term = 10. years
Loan Interest Rate = .120
Calculated annual loan payment = $ 1132.70

User's Discount(Opportunity Cost) Rate = .100
User's Tax Bracket = .350
First year tax liability (w/o swecs) = $ .00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .080
Utility grid cost Escalation Rate = .140
Utility buy back factor = .500

----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $ 50.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate = .10

Availability factor = .95
Total direct use factor = .500
Salvage value of SWECS = $ .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $ .00

Annual energy yield= 5600. kwh

-------------economic analysis----------------

Annualized cost of SWECS energy = $-.041
Annualized cost of grid energy = $ .195

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	550.76	2782.70	-2231.94	-2231.94
1983	574.92	1187.70	-612.78	-2844.73
1984	602.76	1193.20	-590.44	-3435.17
1985	634.85	1199.25	-564.40	-3999.57
1986	671.81	1205.91	-534.10	-4533.66
1987	714.38	1213.23	-498.85	-5032.51
1988	763.39	1221.28	-457.89	-5490.40
1989	819.79	1230.14	-410.34	-5900.74
1990	884.71	1239.88	-355.17	-6255.91
1991	959.38	1250.60	-291.21	-6547.13
1992	1045.28	129.69	915.59	-5631.53
1993	1191.61	142.65	1048.96	-4582.57
1994	1358.44	156.92	1201.52	-3381.05
1995	1548.62	172.61	1376.01	-2005.05
1996	1765.42	189.87	1575.55	-429.50
1997	2012.58	208.86	1803.72	1374.22
1998	2294.34	229.75	2064.59	3438.82
1999	2615.54	252.72	2362.82	5801.64
2000	2981.72	277.99	2703.72	8505.36
2001	3399.15	305.79	3093.36	11598.72
2002	3875.03	336.37	3538.66	15137.38
2003	4417.53	370.01	4047.52	19184.90
2004	5035.97	407.01	4628.97	23813.86
2005	5741.00	447.71	5293.30	29107.16
2006	6544.74	492.48	6052.26	35159.42
2007	.00	.00	.00	35159.42

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	550.76	2782.70	-2231.94	-2231.94
1983	522.65	1079.73	-557.08	-2789.02
1984	498.15	986.12	-487.97	-3276.99
1985	476.97	901.02	-424.05	-3701.03
1986	458.86	823.65	-364.80	-4065.83
1987	443.57	753.32	-309.75	-4375.57
1988	430.91	689.38	-258.47	-4634.04
1989	420.69	631.26	-210.57	-4844.61
1990	412.72	578.42	-165.69	-5010.31
1991	406.88	530.38	-123.50	-5133.81
1992	403.00	50.00	353.00	-4780.81
1993	417.66	50.00	367.66	-4413.15
1994	432.84	50.00	382.84	-4030.30
1995	448.58	50.00	398.58	-3631.72
1996	464.90	50.00	414.90	-3216.82
1997	481.80	50.00	431.80	-2785.02
1998	499.32	50.00	449.32	-2335.70
1999	517.48	50.00	467.48	-1868.22
2000	536.30	50.00	486.30	-1381.92
2001	555.80	50.00	505.80	-876.12
2002	576.01	50.00	526.01	-350.11
2003	596.95	50.00	546.95	196.84
2004	618.66	50.00	568.66	765.50
2005	641.16	50.00	591.16	1356.66
2006	664.47	50.00	614.47	1971.13
2007	.00	.00	.00	1971.13

WORST CASE SCENARIO FOR KEY VARIABLES

----------------initial variables--------------

SWECS Installation Cost = $ 12000.00
Years of SWECS life = 15.
Installation Date = 1/1982

Total amount of loan = $ 9600.00
Down payment on loan = $ 2400.00
Loan Term = 10. years
Loan Interest Rate = .120
Calculated annual loan payment = $ 1699.05

User's Discount(Opportunity Cost) Rate = .140
User's Tax Bracket = .350
First year tax liability (w/o swecs) = $ .00
Enter residential use fraction = 1.000

Utility Grid Cost for first year ($/kwh) = $ .040
Utility grid cost Escalation Rate = .140
Utility buy back factor = .500

----------future costs/benefits-----------------

Operating and Maintenance Costs for first Year = $ 200.00
Operating and Maintenance factor is constant.
Operating and Maintenance Escalation rate = .10

Availability factor = .95
Total direct use factor = .500
Salvage value of SWECS = $ .00
Economic utilization factor = .750
Total first year tax benefits (includes state)= $ .00

Annual energy yield= 3200. kwh

-------------economic analysis----------------

Annualized cost of SWECS energy = $ .637
Annualized cost of grid energy = $ .040

Cash flow

Year	Benefits	Costs	Yearly cash flow	Total cash flow
1982	483.76	4299.05	-3815.29	-3815.29
1983	472.06	1919.05	-1446.99	-5262.28
1984	459.19	1941.05	-1481.86	-6744.14
1985	445.02	1965.25	-1520.23	-8264.37
1986	429.45	1991.87	-1562.42	-9826.79
1987	412.35	2021.15	-1608.81	-11435.59
1988	393.57	2053.36	-1659.79	-13095.38
1989	372.97	2088.79	-1715.82	-14811.20
1990	350.40	2127.77	-1777.36	-16588.56
1991	325.69	2170.64	-1844.95	-18433.51
1992	298.65	518.74	-220.09	-18653.60
1993	340.46	570.62	-230.16	-18883.75
1994	388.13	627.68	-239.55	-19123.30
1995	442.46	690.45	-247.98	-19371.29
1996	504.41	759.49	-255.08	-19626.37
1997	.00	.00	.00	-19626.37

Yearly present value

Year	P.V. Benefits	P.V. Costs	Yearly P.V. change	Total NPV
1982	483.76	4299.05	-3815.29	-3815.29
1983	414.09	1683.38	-1269.29	-5084.58
1984	353.33	1493.58	-1140.25	-6224.82
1985	300.38	1326.49	-1026.11	-7250.94
1986	254.27	1179.35	-925.08	-8176.02
1987	214.16	1049.73	-835.57	-9011.58
1988	179.31	935.49	-756.18	-9767.76
1989	149.06	834.77	-685.71	-10453.47
1990	122.84	745.91	-623.08	-11076.54
1991	100.15	667.49	-567.34	-11643.88
1992	80.56	139.93	-59.37	-11703.25
1993	80.56	135.02	-54.46	-11757.71
1994	80.56	130.28	-49.72	-11807.43
1995	80.56	125.71	-45.15	-11852.57
1996	80.56	121.30	-40.74	-11893.31
1997	.00	.00	.00	-11893.31

APPENDIX 2

LIFECC Program Listing

```
c       **********************************
c       *  COST OF ENERGY PROGRAM        *
c       *                                *
c       *       MAIN                     *
c       *                                *
c       *   JUNE 21, 1982                *
c       *                                *
c       **********************************
        include "input_variables"
 13     continue
        call getinput
 14     write(10,3904)
 3904   format(//,'do you wish to check input variables (y/n) ?',z)
        iunit=10
        jvar=0
        if(yn(idum).eq.1) call out(iunit,jvar)
        write(10,3906)
 3906   format(//,'do you wish to change the input variables (y/n) ?',z)
        if(yn(idum).ne.1) go to 19
c
 15     continue
        call chginput
        go to 14
 19     call loanpay
c
c       calculate first year tax benefits for residential user
c
        if(costin * frac .gt. 10000.) Go to 20
          rtaxbene = 0.4 * costin * frac
          go to 100
 20     rtaxbene = 4000
c
c
c       calculate first year tax benefits for commercial swecs
c
 100    ctaxbene = 0.25 * costin * (1. - frac)
c
c       calculate depreciation of swecs
c
        call deprec
c
c       add in state tax credit benefits
c
 110    ftaxbene = ctaxbene + rtaxbene
        if(ftaxbene.ge.taxliab) ftaxbene = taxliab
        ttaxbene = ftaxbene + staxbene
c
        aduf = duf
        if(duf.ne.-1) go to 260
        aduf = 0.
        do 901 i=1,ilife + 1
        if(i.ne.1) go to 200
          aduf = aduf + dufy(1)*(12-inmon+1)/12.0/life
          go to 901
 200    if(i.eq.ilife+1) go to 210
          aduf = aduf + dufy(i)/life
          go to 901
 210    continue
          aduf = aduf + dufy(i)*(inmon-1)/12.0/life
 901    continue
```

```
c
 260    continue
c
c       incrament life for uneven year
c
        ilife = ilife + 1
        omfy = 1.0
        do 902 i=1,ilife
        if(omflag.eq.1) omfy = future(i)
        if(i.ne.1) go to 270
          omcosty(i) = omfy*omcost*(1.-(inmon-1)/12.)*(1.+omrate)**(i-1)
          go to 902
 270    if(i.eq.ilife) go to 280
          omcosty(i) = omfy*omcost*(1.+omrate)**(i-1)
          go to 902
 280    omcosty(i) = omfy*omcost*((inmon-1)/12.)*(1.+omrate)**(i-1)
 902    continue
        sumpv = 0.0
        do 903 i=1,ilife
        tcosty(i) = omcosty(i) + rcosty(i) + lcosty(i)
        if(i.eq.1) tcosty(i) = tcosty(i) + downpay
        pvcy(i) = tcosty(i)/(1.+drate)**(i-1)
 903    sumpv = sumpv + pvcy(i)
        do 904 i=1,ilife
 904    gcosty(i) = gridcost*(1.+eerate)**(i-1)
x       write(12,666) (inyr+i-1, gcosty(i),i=1,ilife)
x666    format(" Grid cost"/100(1x,i4,3x,f10.2/))
c
c       get energy benefits
c
        call ecostben
c
        sumby = 0.0
        sumcoe = 0.0
        do 905 i=1,ilife
        spvby(i) = scbeney(i)/((1.+drate)**(i-1))
        coesum(i) = coeben(i)/((1. + drate)**(i-1))
        sumcoe = sumcoe + coesum(i)
 905    sumby = sumby + spvby(i)
        npv = sumby - sumpv
        pwn = sumpv - sumby
        sir = npv/(costin-(salvage/((1.0+drate)**life)))
        acge = gridcost * ((1.+eerate)/(1.+drate))**life
        acse = (pwn*(drate*((1. + drate)**life)))/
     1          (reliab*sagkwh*(((1.+drate)**life)-1))
        euf = aduf + (1.-aduf)*ubbf
        ilife = ilife - 1
c
C       CHECK TO SEE IF WANT TO SEE RESULTS ON SCREEN
C
        WRITE(10,3900)
 3900   FORMAT(//,1X,'do you wish to see the results on the screen (y/n) ?',z)
        if(yn(idum).ne.1)go to 910
          iunit=10
          jvar=1
          call out(iunit,jvar)
c
 910    write(10,3902)
 3902   format(/,1x,'do you wish to send the results to output (y/n) ?',z)
        iunit=12
```

```
      jvar=1
      if(yn(idum).eq.1) call out(iunit,jvar)
      write(10,3000)
3000  format('do you want to rerun analysis (y/n) ?',z)
      if(yn(idum).ne.1) stop
      go to 15
      end
```

```
      subroutine getinput
c
c     routine to get the initial variables
c
      include "input_variables"
      integer dtyp
c
c     Enter all variables for input
c
      do 902 i=1,100
      rcosty(i) = 0.0
      future(i) = 0.0
      dufy(i) = 0.0
      scbeney(i) = 0.0
      spvby(i) = 0.0
      tcosty(i) = 0.0
      omcosty(i) = 0.0
      pvcy(i) = 0.0
      qcosty(i) = 0.0
 902  continue
c
 10   write(10,1002)
 1002 format("Title OF analysis (60) = ",z)
      read(11,1001)ititle(1)
 1001 format(S60)
 12   accept "SWECS Installation Cost = $",costin
      if(costin.gt.0) go to 14
        type " Cost must be >0."
        go to 12
 14   accept "Years of SWECS life = ",life
      if(life.le.100.and.life.gt.0) go to 15
        type " life of SWECS can be no more than 100, re-enter "
        go to 14
 15   accept "Enter residential use fraction (0 TO 1.00)= ",frac
      if(frac.ge.0 .and. frac.le.1.0) go to 18
        type " Fraction must be between 0 and 1."
        go to 15
 18   accept "Installation Date (MM,YYYY) = ",inmon,inyr
      if(inmon.ge.1. .and. inmon.le.12) go to 182
        type " Invalid month, re-enter "
        go to 18
 182  if(inyr.ge.1975. .and. inyr.le.2000.) go to 20
        type " Invalid year, re-enter "
        go to 18
 20   accept "Loan Amount = $",loan
      if(loan.ge.0 .and. loan.le.costin) go to 19
        type "Invalid loan amount."
        go to 20
 19   downpay = costin - loan
      if(downpay.lt.0) type "Downpayment error"
 22   accept "Loan Term (years)= ",loant
      if(loant.gt.life) go to 2223
      if(loant.gt.0) go to 24
        type " Loan term must be longer than 0 years"
        go to 22
 2223 type "UNLIKELY...THIS IS LONGER THAN SWECS LIFE"
      go to 22
 24   accept "Loan Interest Rate = ",loanr
 26   accept "User's Discount(Opportunity Cost) Rate = ",drate
 28   accept "Utility Buy Back Factor = ",ubbf
```

```
 30     accept "Availability Factor = ",reliab
 32     accept "First year utility Grid Cost ($/kwh) = $",gridcost
 34     accept "Utility Grid cost Escalation Rate = ",eerate
 36     accept "User's Tax Bracket = ",taxbrac
 37     accept "Estimated first year tax liability (w/o swecs) = $",taxliab
 40     write(10,2000)
 2000   format("Is Direct Use Factor constant (y/n) = ",z)
          duf = -1                ;Set duf to -1 for not used
          ilife = life
          if(yn(idum).ne.1) go to 42
            accept "Direct Use Factor = ",duf
            go to 60
 42     do 43 j = 1,ilife + 1
          write(10,4202) j+inyr-1
 4202     format("Direct Use Factor for Year ",i4,"=",z)
          accept dufy(J)
 43     continue
C
C       End of input of initial variables
C ********************************************************************
C       Start of input of future costs
C
 60     accept "Operating and Maintenance Costs for 1 Year =",omcost
          if(omcost.ge.0) go to 62
          type "O&M costs must not be negative."
          go to 60
 62     accept "Operating and Maintenance Escalation rate =",omrate
 64     write(10,6401)
 6401   format("Do you wish to enter O%M costs by year (y/n) ?",z)
        omflag = 0
        if(yn(idum).eq.1) omflag = 1
          if(omflag.ne.1) go to 66
          iyear = life
          do 65 iu=1,iyear+1
            write(10,6402) iu+inyr-1
 6402       format("O&M factor for year ",I4," = ",z)
            accept futura(iu)
 65       continue
 66     iyear = life
        rpflag = 0
        write(10,6603)
 6603   format("Do you have replacement costs to enter (y/n) ?",z)
        if(yn(idum).ne.1) go to 966
        rpflag = 1
        accept "Replacement Escalation rate = ",rerate
        do 67 iu=1,life
          write(10,6602) iu
 6602     format("Estimated Replacement Costs for year ",I2," = $",z)
 69       accept rcosty(iu)
          if(rcosty(iu).ge.0) go to 68
            type "Replacement costs cannot be negative."
            go to 69
 68       rcosty(iu) = rcosty(iu) * (1.0+rerate)**(iu-1)
 67     continue
 966    continue
c
c       done with inputs for future costs
c
c       Start of inputs for future Benefits
c
```

```
72      accept 'Enter state tax benefits: ',staxbene
76      continue
        if(frac.eq.1.0) go to 80
        write(10,7602)
7602    format("Depreciation Method:",/,
    1           1x,"1) Straight Line Depreciation ",/,
    2           1x,"2) Declining Balance Depreciation ",/,
    3           1x,"3) Sum of the Years Digits Depreciation ")
        accept "      Depreciation Number = ",depmet
        if(depmet.lt.1.or.depmet.gt.3) go to 76
        if(depmet.ne.2) go to 78
          accept "Enter Declining Balance rate = ",dbrate
78      accept "Depreciation life (in years) = ",dlife
80      accept "Salvage Value of SWECS = ",salvage
        if(salvage.ge.0 .and. salvage.le.costin) go to 81
          type "Illegal salvage value"
          go to 80
81      write(10,1003)
1003    format("Energy  production method:"/
    1           1x,"1) Enter annual energy produced",/
    2           1x,"2) Enter energy produced by month",/
    3           1x,"3) Use SWECS power curve for annual average")
        accept "   Enter energy production method :",emet
        if(emet.le.0 .or. emet .gt.3) go to 81
        go to (82,84,86),emet
82      accept "Enter annual SWECS energy production (kwh) :",sagkwh
        go to 500
84      continue
        do 901 i=1,12
        write(10,1006) i
1006    format("Enter energy produced in month ",i2," = ",z)
        accept emon(i)
901     continue
        go to 500
86      continue
        open 7, "pcurve"
        do 1 i=1,NWINDS
1       read(7,1005) vtab(i),ptab(i)
1005    format(2f10.3)
        write(10,2006)
```

```
 2006   format("Starting power curve table"//,4x,"i",
     1  3x,"v(i)",3x,"p(i)"/)
        do 2 i=1,NWINDS
 2      write(10,2007)i,vtab(i),ptab(i)
 2007   format(i5,f6.1,f9.2)
        write(10,203)
 203    format("Do you wish to change this table (y/n)?",z)
        if(yn(idum).ne.1) go to 3
        call tabl(ptab,vtab)
 3      continue
        close 7
        accept "Enter average wind velocity = ",vbar
        accept "Enter Weibull distribution constant = ",rk
C
C       done with inputs for future Benefits
C
C ***************************************************************************
C
C
 500    return
        end
```

```
      SUBROUTINE DEPREC
C
C     ROUTINE TO DO DEPRECIATION OF SWECS BY EITHER OF THREE
C     METHODS:  1) STRAIGHT LINE DEPRECIATION
C               2) DECLINING BALANCE METHOD DEPRECIATION
C               3) SUM OF THE YEARS' DIGITS DEPRECIATION
C
      include "input_variables"
C
      do 903 i=1,100
 903  dep(i) = 0.0
      b = (1.0-frac)*(costin - salvage)        ;basis cost
      m = 12 - inmon + 1
      go to (100,200,300),depmet
c
 100  continue                    ;straight line
      z = 1
      dep(1) = b/dlife * (m/12.0)      ; from flowchart?
      do 901 i=2,dlife
 901  dep(i) = b/dlife
      if(m.ne.12) dep(dlife+1) = (b/dlife)*((inmon-1)/12.0)
      return
c
c     declining balance
c
 200  continue
      st = b/dlife
      if = 0
      dep(1) = ((dbrate/dlife)*b) * (m/12.0)
      pres = b - dep(1)
      do 902 i=2,dlife
      dep(i) = pres * (dbrate/dlife)
      if(dep(i).gt.st) go to 110
        if(if.ne.0) go to 120
          if = 1
          sbal = pres
          plife = dlife - i + 2 - (m/12.0)
x     type "decl bal debug",i,dlife,plife,inmon,sbal
 120    continue
        dep(i) = sbal/plife
        go to 902
 110  pres = pres - dep(i)
 902  continue
      go to 330
c
c     sum of years digits
c
 300  continue
      w = dlife
      if(inmon.eq.1) go to 350
      q = (dlife * (dlife+1)/2)
      iyrs = 1
      h = b/q
      g = dlife - iyrs + 1
      dep(1) = (g*h)*(m/12.0)
 320  continue
      iyrs = iyrs + 1
      dep(iyrs) = ((b*(w/q)*((inmon-1)/12.0))+ (b*((w-1)/q)*(m/12.0)))
      if(iyrs.ge.dlife) go to 330
      w = w - 1
```

```
      go to 320
330   continue
      sum = 0
      do 904 i=1,dlife
904   sum = sum + dep(i)
      if(sum.ne.b) dep(dlife+1) = b - sum
      return
c
350   continue
      h = b/(dlife*(dlife+1)/2)
      iyrs = 0
370   continue
      iyrs = iyrs + 1
      g = dlife - iyrs + 1
      dep(iyrs) = g * h
      if(iyrs.ge.dlife) return
      go to 370
c
      end
```

```
      subroutine loanpay
c
c     routine to calculate loan payments
c
      include "input_variables"
c
c     loanpmt = (loan * loanr* (1.0+loanr)**loant)/((1.0+loanr)**(loant-1.
      loanpmt = (((loanr*((1.0+loanr)**loant))/(((1.0+loanr)**loant)-1))
     1          *loan)
c
c
      do 101 i=1,100
 101  lcosty(i) = 0.0
c
      iup = loant+1
      zmprn = loan
      zmsum = 0.0
      do 100 i = 1,iup
        if(i.ne.1) go to 10
          lcosty(i) = (1.-(inmon-1)/12.)*loanpmt
      zmbal = lcosty(i) - loanr*zmprn*(1.-(inmon-1)/12.)
      zmint(i) = loanr*zmprn*(1. -(inmon-1)/12.)
      zmprn = zmprn - zmbal
      zmsum = zmsum + zmint(i)
          go to 100
 10     if(i.eq.iup) go to 20
          lcosty(i) = loanpmt
      zmbal = lcosty(i) - loanr*zmprn
      zmint(i) = loanr*zmprn
      zmprn = zmprn - zmbal
      zmsum = zmsum + zmint(i)
          go to 100
 20     lcosty(i) = ((inmon-1)/12.)*loanpmt
      zmbal = lcosty(i) - loanr*zmprn*((inmon - 1)/12.)
      zmint(i) = loanr * zmprn * ((inmon - 1)/12.)
      zmprn = zmprn - zmbal
      zmsum = zmsum + zmint(i)
 100  continue
c
      return
      end
```

```
      subroutine chginput
      include "input_variables"
      integer dtyp
 1    continue
      accept "Enter menu selection (5 for menu list):",item
      if(item.ne.5) go to 3
 2      write(10,3000)
        go to 1
 3    continue
 3000 format("<214>   Main menu"//
     1         "        1       Initial variables"/
     2         "        2       Future Costs"/
     3         "        3       Future SWECS benefits"/
     4         "        4       No further changes"/
     5         "        5       Display this menu"/
     6 //)
      if(item.le.0 .or. item.gt.5) go to 2
      go to (6,100,200,500,2) item
c
c     Initial variables section
c
 6    type "Initial variables section."
 7    accept "Enter number of item (19 for list) :", item
      if(item.ne.19) go to 9
 8      write(10,2001)
        go to 7
 9    continue
 2001 format("<214>Initial variables menu"//
     1         "        1       Title"/
     2         "        2       Installation cost"/
     3         "        3       SWECS life (years)"/
     4         "        4       Residential use fraction"/
     5         "        5       Installation date"/
     6         "        6       Loan amount"/
     7         "        7       Loan term (Years)"/
     8         "        8       Loan interest rate"/
     9         "        9       User discount rate"/
     x         "        10      Utility buy back factor"/
     1         "        11      Availability factor"/
     2         "        12      Utility grid cost (first year)"/
     3         "        13      Grid energy escalation rate"/
     4         "        14      Users tax bracket"/
     5         "        15      First year tax liability"/
     6         "        16      No further changes"/
     7         "        17      Return to main menu"/
     8         "        18      Redisplay this menu"/
     x /)
      if(item.le.0 .or. item.gt.19) go to 8
      go to (10,12,14,15,18,20,22,24,26,28,30,32,34,36,37,500,1,8) item
c
 10   write(10,1002)
 1002 format("Title of analysis (60) = ",z)
      read(11,1001)ititle(1)
 1001 format(S60)
      go to 7
 12   accept "SWECS Installation Cost = $",costin
      if(costin.gt.0) go to 7
        type " Cost must be >0."
        go to 12
 14   accept "Years of SWECS life = ",life
```

```
      ilife = life
      if(life.le.100.and.life.gt.0) go to 7
        type "life of SWECS can be no more than 100, re-enter "
        go to 14
 15   accept "Enter residential use fraction = ",frac
      if(frac.ge.0 .and. frac.le.1.0) go to 7
        type "Fraction must be between 0 and 1."
        go to 15
 18   accept "Installation Date (mm/yyyy) = ",inmon,inyr
      if(inmon.ge.1. .and. inmon.le.12) go to 182
        type "Invalid month, re-enter "
        go to 18
 182  if(inyr.ge.1975. .and. inyr.le.2000.) go to 7
        type "Invalid year, re-enter "
        go to 18
 20   accept " Loan Amount = $",loan
      if(loan.ge.0 .and. loan.le.costin) go to 19
        type "Invalid loan amount."
        go to 20
 19   downpay = costin - loan
      if(downpay.lt.0) type "Downpayment error"
      go to 7
 22   accept " Loan Term = ",loant
      if(loant.gt.0) go to 7
        type "Loan term must be longer than 0 years"
        go to 22
 24   accept "Loan Interest Rate = ",loanr
      go to 7
 26   accept "User's Discount(Opportunity Cost) Rate = ",drate
      go to 7
 28   accept "Utility Buy Back Factor = ",ubbf
      go to 7
 30   accept "Availability Factor = ",reliab
      go to 7
 32   accept "First year utility grid cost ($/kwh) = $",gridcost
      go to 7
 34   accept "Utility grid cost escalation rate = ",eerate
      go to 7
 36   accept "User's Tax Bracket = ",taxbrac
      go to 7
 37   accept " Estimated first year tax liability = $",taxliab
      go to 7
c
c     Future costs section
c
 100  continue
      type "Future costs menu."
 101  accept "Enter item number (8 for list) :",item
      if(item.ne.8) go to 103
 102    write(10,4000)
        go to 101
 103  continue
 4000 format("<214>   Future Costs"///
    1          "      1      Operating and Maintenance costs"/
    2          "      2      Operating and Maintenance escalation rate"/
    3          "      3      Operating and Maintenance factors"/
    4          "      4      Replacement Costs (by year)"/
    5          "      5      Replacement escalation rate (only if there ar
    6          "      6      No more changes"/                    rep. costs)"
    7          "      7      Return to main menu"/
```

```
    8           "         8         Redisplay this menu"/
    9  //)
       if(item.le.0 .or. item.gt.8) go to 100
       go to (60,62,64,66,68, 500,1,102) item
c
C ***********************************************************************
C      Start of input of future costs
C
 60    accept "Operating and Maintenance Costs for first Year = $",omcost
         if(omcost.ge.0) go to 100
         type "O&M costs must not be negative."
         go to 60
 62    accept "Operating and Maintenance Escalation rate =",omrate
       go to 100
 64    write(10,6401)
 6401  format(" Do you have O&M factors to enter (y/n) ?",z)
       omflag = 0
       if(yn(idum).eq.1) omflag = 1
         if(omflag.ne.1) go to 100
         iyear = life
         do 65 iu=1,iyear+1
           write(10,6402) iu+inyr-1
 6402      format(" O&M factor for year ",I4," = ",z)
           accept future(iu)
 65      continue
       go to 100
 66    iyear = life
       rpflag = 1
       do 67 iu=1,life
         write(10,6602) iu
 6602    format(1X,"Estimated Replacement Costs for year ",I2,"= $",z)
 69      accept rcosty(iu)
         if(rcosty(iu).ge.0) go to 680
           type "Replacement costs cannot be negative."
           go to 69
 680     rcosty(iu) = rcosty(iu) * (1.0+rerate)**(iu-1)
 67    continue
       go to 100
 68    accept "Replacement Escalation rate = ",rerate
       do 901 i=1,life
         rcosty(i) = rcosty(i)*(1.0+rerate)**(i-1)
 901   continue
       go to 100
c
c      Future benefits section
c
 200   continue
       type "Future benefits section."
 201   accept "Enter item number to change (13 for list):",item
       if(item.ne.13) go to 203
 202     write(10,5000)
         go to 201
 203   continue
 5000  format("<214>  Future benefits section"///
    1           "         1         Unused"/
    2           "         2         Direct use factor"/
    3           "         3         SWECS energy production"/
    4           "         4         State tax credit"/
    5           "         5         Depreciation method and rate"/
    6           "         6         Depreciation life"/
```

```
    7           "        7        Salvage value"/
    8           "        8        Energy production model"/
    9           "        9        Average wind velocity (if power curve used)"/
    x           "        10       Weibull distribution constant (if power curve
    1           "        11       No more changes"/                             ed)
    2           "        12       Return to main menu"/
    3           "        13       Redisplay this menu"/
    4    //)
         if(item.le.0 .or.item.gt.13) go to 202
         go to (600,40,70,72,76,78,80,81,90,92,500,1,202) item

         go to 200
40       write(10,2005)
2005     format("Direct Use Factor is constant (y/n) = ",z)
           duf = -1                  ;Set duf to -1 for not used
           if(yn(idum).ne.1) go to 42
             accept "Direct Use Factor = ",duf
             go to 200
42       do 43 j = 1,ilife + 1
           write(10,4202) j+inyr-1
4202       format(1X,"Direct Use Factor for Year ",i4,"=",z)
           accept dufy(J)
43       continue
         go to 200
70       accept "Net SWECS Energy Production (KWH) = ",sagkwh
         go to 200
72       accept "Enter state tax benefits:  ,staxbene
         go to 200
76       continue
         write(10,7602)
7602     format("Depreciation Method:",/,
    1           1x,"1) Straight Line Depreciation ",/,
    2           1x,"2) Declining Balance Depreciation ",/,
    3           1x,"3) Sum of the Years Digits Depreciation ")
         accept " Depreciation Number = ",depmet
         if(depmet.lt.1.or.depmet.gt.3) go to 76
         if(depmet.ne.2) go to 200
           accept "Select Declining Balance rate = ",dbrate
```

```
      go to 200
 78   accept "Depreciation life (in years) = ",dlife
      go to 200
 80   accept "Salvage Value of SWECS = ",salvage
      if(salvage.ge.0.and. salvage.le.costin) go to 200
        type "Illegal salvage value."
        go to 80
 81   write(10,1003)
 1003 format("Energy production method:"/
     1          1x,"1) Enter annual energy produced",/
     2          1x,"2) Enter energy produced by month",/
     3          1x,"3) Use SWECS power curve for annual average")
      accept " Enter energy production method :",emet
      if(emet.le.0 .or. emet .gt.3) go to 81
      go to (82,84,86),emet
 82   accept " Enter annual SWECS energy production (kwh) :",sagkwh
      go to 200
 84   continue
      do 902 i=1,12
      write(10,1008) i
 1008 format("Enter energy produced in month ",i2," = ",z)
      accept emon(i)
 902  continue
      go to 200
 86   continue
      open 7, "pcurve"
      do 910 i=1,NWINDS
 910  read(7,1004) vtab(i),ptab(i)
 1004 format(2f10.3)
      write(10,1005)
 1005 format("Starting power curve table"//,4x,"i",
     1 3x,"v(i)",3x,"p(i)"/)
      do 911 i=1,NWINDS
 911  write(10,1006)i,vtab(i),ptab(i)
 1006 format(i5,f6.1,f9.2)
      write(10,1007)
 1007 format("Do you wish to change this table (y/n)?",z)
      if(yn(idum).ne.1) go to 912
      call tabl(ptab,vtab)
 912  continue
      close 7
      accept " Enter average wind velocity = ",vbar
      accept " Enter Weibull distribution constant = ",rk
      go to 200
 90   accept " Enter average wind velocity = ",vbar
      go to 200
 92   accept " Enter Weibull distribution constant = ",rk
      go to 200
C
C     done with inputs for future Benefits
C
C ***************************************************************************
C
C
 500  return
      end
```

```
      SUBROUTINE POWER(P,V,PTAB,VTAB)
      DIMENSION PTAB(8),VTAB(8)
      NTAB=8
      NSTOP=NTAB-2
      IF(V.LE.VTAB(1))GO TO 2
      DO 1 I=1,NSTOP
1     IF(V.GT.VTAB(I))INT=I
      X1=VTAB(INT)
      X2=VTAB(INT+1)
      X3=VTAB(INT+2)
      Y1=PTAB(INT)
      Y2=PTAB(INT+1)
      Y3=PTAB(INT+2)
      P=(V-X2)*(V-X3)*Y1/(X1-X2)/(X1-X3)
      P=P+(V-X1)*(V-X3)*Y2/(X2-X1)/(X2-X3)
      P=P+(V-X1)*(V-X2)*Y3/(X3-X1)/(X3-X2)
      IF(V.GT.VTAB(NSTOP+2))P=0.0
      GO TO 3
2     P=0.0
3     CONTINUE
      RETURN
      END
```

```
      SUBROUTINE TABL(PTAB,VTAB)
      DIMENSION PTAB(8),VTAB(8)
      NTAB = 8
1     CONTINUE
      WRITE(10,200)
200   FORMAT("ENTER NUMBER TO CHANGE(<=0 TO STOP) :",Z)
      ACCEPT I
      IF(I.LE.0) GO TO 10
      WRITE(10,201)
201   FORMAT("ENTER VTAB(I),PTAB(I) :",Z)
      ACCEPT VTAB(I),PTAB(I)
      GO TO 1
10    CONTINUE
      REWIND 7
      DO 2 I = 1,NTAB
2     WRITE(7,202) VTAB(I),PTAB(I)
202   FORMAT(2F10.3)
      RETURN
      END
```

```
      subroutine ecostben
      include "input_variables"
c
c     subroutine to calculate energy yield of a swecs
c     given the swecs power curve and the parameters
c     for a weibull wind distribution
c
c     the program fits a cubic polynomial to six p,v
c     points to represent the power curve.  v(1) is
c     taken as cut-in speed, v(6) is taken as cut-out.
c
      ntab=NWINDS
      do 901 i=1,100
 901  scbeney(i) = 0.0
c
      go to (100,200,300) emet
c
 100  continue
      xduf = duf
      do 902 i=1,ilife
      if(duf.eq.-1.0) xduf = dufy(i)
      cde = reliab * sagkwh * gcosty(i) * xduf
      cee = reliab*sagkwh*gcosty(i)*(1.0 - xduf)*ubbf*(1.0 - taxbrac)
      db = dep(i) * taxbrac
      ave = cde * taxbrac * (1.0 - frac)
      scbeney(i) = cde + cee + db - ave + zmint(i)*taxbrac
      coeben(i) = db + zmint(i)*taxbrac
      if(i.eq.1) scbeney(i) = scbeney(i)*(1.0-((inmon-1)/12.0)) + ttaxbene
      if(i.eq.1) coeben(i) = coeben(i)*(1.0-((inmon-1)/12.0)) + ttaxbene
      if(i.eq.ilife) coeben(i) = coeben(i) * ((inmon-1)/12.0) + salvage
      if(i.eq.ilife) scbeney(i) = scbeney(i) * ((inmon-1)/12.0) + salvage
x     write(12,4000)i,cde,cee,db,ave,scbeney(i)
x4000 format(i5,1p5e15.5)
 902  continue
      return
c
 200  continue
c
c     first year
c
      sumf = 0.0
      do 903 i=max(1,inmon-1),12
 903  sumf = sumf + emon(i)
      xduf = duf
      if(duf.eq.-1.0) xduf = dufy(1)
      cde = reliab * sumf * gcosty(1) * xduf
      cee = reliab* sumf *gcosty(1)*(1.0 - xduf)*ubbf*(1.0 - taxbrac)
      db = dep(1) * taxbrac
      ave = cde * taxbrac * (1.0 - frac)
      scbeney(1) = cde + cee + db - ave + zmint(i)*taxbrac
      scbeney(1) = scbeney(1)*(1.0-((inmon-1)/12.0)) + ttaxbene
      coeben(1) = db + zmint(i)*taxbrac
      coeben(1) = coeben(1)*(1.0 - ((inmon-1)/12.0)) + ttaxbene
x     write(12,4000)1,cde,cee,db,ave,scbeney(i)
      sagkwh = 0.0
      do 904 i=1,12
 904  sagkwh = sagkwh + emon(i)
      xduf = duf
      do 905 i=2,ilife-1
      if(duf.eq.-1.0) xduf = dufy(i)
```

```
      cde = reliab * sagkwh * gcosty(i) * xduf
      cee = reliab*sagkwh*gcosty(i)*(1.0 - xduf)*ubbf*(1.0 - taxbrac)
      db = dep(i) * taxbrac
      ave = cde * taxbrac * (1.0 - frac)
      scbeney(i) = cde + cee + db - ave + zmint(i)*taxbrac
      coeben(i) = db + zmint(i)*taxbrac
x     write(12,4000)i,cde,cee,db,ave,scbeney(i)
 905  continue
      suml = sagkwh - sumf
      xduf = duf
      if(duf.eq.-1.0) xduf = dufy(ilife)
      cde = reliab * suml * gcosty(ilife) * xduf
      cee = reliab* suml *gcosty(ilife)*(1.0 - xduf)*ubbf*(1.0 - taxbrac)
      db = dep(ilife) * taxbrac
      ave = cde * taxbrac * (1.0 - frac)
      scbeney(ilife) = cde + cee + db - ave + zmint(i)*taxbrac
      scbeney(ilife) = scbeney(ilife) * ((inmon-1)/12.0) + salvage
      coeben(ilife) = db + zmint(i)*taxbrac
      coeben(ilife) = coeben(ilife) * ((inmon-1)/12.0) + salvage
x     write(12,4000)ilife,cde,cee,db,ave,scbeney(i)
      return
c
 300  continue
      c=vbar*(1.081+0.068*alog(rk))
      const=1.
      sagkwh=0.0
      emax=0.
      hmax=0.
      v=vtab(1)
      dv=0.05
      do 7 n=1,1000
      call power(p,v,ptab,vtab)
      hours=8760.*(exp(-const*(v/c)**rk)-exp(-const*(
     1 (v+dv)/c)**rk))
      delen=p*hours
      if(delen.lt.emax)go to 8
      emax=delen
      vmaxe=v
 8    if(hours.lt.hmax) go to 9
      hmax=hours
      vmax=v
      pmax=p
 9    continue
      sagkwh=sagkwh+delen
      v=v+dv
      if(v.gt.vtab(ntab))go to 10
 7    continue
 10   continue
x     write(10,208) vbar,rk,c
x 208 format(" Weibull distribution parameters"/
x    1 5x,"Vbar= "f5.2,"     k= "f4.2,"    c= "f4.1)
x     write(10,210) sagkwh
x 210 format(" Annual energy yield= "f10.0," kwh")
      pbar=sagkwh/8760.
x     write(10,211) pbar
x 211 format(" Annual average power output= "f10.2," kw")
x     write(10,212)vmax,pmax,vmaxe
x 212 format(/5x,"Most probable wind speed= "f5.1,
x    1 /5x,"Most probable power output= "f6.2,
x    2 /5x,"Wind speed for maximum energy density= "f5.1)
```

```
c
      xduf = duf
      do 910 i=1,ilife
      if(duf.eq.-1.0) xduf = dufy(i)
      cde = reliab * sagkwh * gcosty(i) * xduf
      cee = reliab*sagkwh*gcosty(i)*(1.0 - xduf)*ubbf*(1.0 - taxbrac)
      db = dep(i) * taxbrac
      ave = cde * taxbrac * (1.0 - frac)
      scbeney(i) = cde + cee + db - ave + zmint(i)*taxbrac
      coeben(i) = db + zmint(i)*taxbrac
      if(i.eq.1) coeben(i) = coeben(i)*(1.0-((inmon-1)/12.0)) + ttaxbene
      if(i.eq.ilife) coeben(i) = coeben(i)*((inmon-1)/12.0) + salvage
      if(i.eq.1) scbeney(i) = scbeney(i)*(1.0-((inmon-1)/12.0)) + ttaxbene
      if(i.eq.ilife) scbeney(i) = scbeney(i) * ((inmon-1)/12.0) + salvage
x     write(12,4000)i,cde,cee,db,ave,scbeney(i)
 910  continue
      return
      end
```

```
      subroutine out(iunit,jvar)
      include "input_variables"
      jlife = life + 1.
      write(iunit,900) ititle(1)
900   format(1h1,s60/)
      write(iunit,2224)
2224  format("-----------------initial variables--------------")
      write(iunit,999)
      write(iunit,901) costin
901   format(" SWECS Installation Cost = $",f10.2)
      write(iunit,930) life
930   format(" Years of SWECS life =",9x,f5.0)
      write(iunit,936) inmon,inyr
936   format(" Installation Date = ",i2,"/"i4)
      write(iunit,999)
999   format(1h0)
      write(iunit,907) loan
907   format(" Total amount of loan = $", f10.2)
      if(jvar.eq.1) write(iunit,906) downpay
906   format(" Down payment on loan = $", f10.2)
      write(iunit,938) loant
938   format(" Loan Term = ",7x, f5.0, " years")
      write(iunit,939) loanr
939   format(" Loan Interest Rate = ",1x,f5.3)
      if(jvar.eq.1) write(iunit,923) loanpmt
923   format(" Calculated annual loan payment = $", f10.2)
      write(iunit,999)
      write(iunit,943) drate
943   format(" User's Discount(Opportunity Cost) Rate = ",f5.3)
      write(iunit,941) taxbrac
941   format(" User's Tax Bracket = ",f5.3)
      write(iunit,942) taxliab
942   format(" First year tax liability (w/o swecs) = $", f10.2)
      write(iunit,932) frac
932   format(" Enter residential use fraction = ",f5.3)
      write(iunit,999)
      write(iunit,903) gridcost
903   format(" Utility Grid Cost for first year ($/kwh) = $",f5.3)
      write(iunit,904) eerate
904   format(" Utility grid cost Escalation Rate = ",8x,f5.3)
      write(iunit,935) ubbf
935   format(" Utility buy back factor =",19x, f5.3)
      write(iunit,999)
      write(iunit,2225)
2225  format("-----------future costs/benefits-----------------")
      write(iunit,999)
      write(iunit,908) omcost
908   format(" Operating and Maintenance Costs for first Year = $",f10.2)
      if(omflag.ne.1) write(iunit,949)
949   format(" Operating and Maintenance factor is constant.")
      if(omflag.eq.1) write(iunit,912) (inyr+i-1, future(i),i=1,jlife)
912   format("0Operations and Maintenance costs by year"/"  Year",4x,"Cost"/
    1        100(2x,i4,3x,"$",f10.2/))
      write(iunit,909) omrate
909   format(" Operating and Maintenance Escalation rate =",5x,f10.2)
      if(rpflag.eq.1) write(iunit,911) (inyr+i-1, rcosty(i),i=1,jlife)
911   format("0Replacement costs by year"/"  Year",4x,"Cost"/
    1        100(2x,i4,3x,"$",f10.2/))
      if(rpflag.eq.1) write(iunit,910) rerate
910   format(" Replacement Escalation rate = ",f5.3)
```

```
      write(iunit,999)
c
      write(iunit,902) reliab
 902  format(" Availability factor =",4x,f4.2)
      write(iunit,934) aduf
 934  format(" Total direct use factor =",f5.3)
      if(duf.eq.-1) write(iunit,950) (inyr+i-1, dufy(i),i=1,jlife)
 950  format("0Direct use factors by year"/"  Year",4x,"Factor"/
     1          100(2x,i4,4x,f5.2/))
      write(iunit,905) salvage
 905  format(" Salvage value of SWECS =        $",f10.2)
      write(iunit,921) euf
 921  format (" Economic utilization factor =",f5.3)
      write(iunit,954) ttaxbene
 954  format(" Total first year tax benefits (includes state)= $",f10.2)
      write(iunit,999)
c
      if(frac.eq.1.0) go to 2222
      if(depmet.eq.1) write(iunit,944)
 944  format(" Using Straight Line Depreciation ")
      if(depmet.eq.2) write(iunit,945) dbrate
 945  format(" Using Declining Balance Depreciation with rate =",f6.3)
      if(depmet.eq.3) write(iunit,946)
 946  format(" Using Sum of the Years Digits Depreciation ")
      write(iunit,948) dlife
 948  format(" Depreciation life (in years) = ",f5.2)
c
 2222 go to (100,200,300),emat
 100  continue
      write(iunit,210) sagkwh
 210  format(" Annual energy yield= "f10.0," kwh")
      go to 400
c
 200  continue
      write(iunit,922) (i,emon(i),i=1,12)
 922  format("0Energy production by month"/"  Month",4x,"Energy (kwh)"/
     1          12(3x,i2,8x,f10.2/))
      write(iunit,210) sagkwh
      go to 400
c
 300  continue
      write(iunit,203)
 203  format("1Power curve used in subsequent calculations"
     1 //5x,"Vel",5x,"Power"/)
      v=0.0
      dv=1.0
      do 4 i=1,40
      v=v+dv
      call power(p,v,ptab,vtab)
 4    if(p.gt.0.0)write(iunit,204)v,p
 204  format(f10.1,f10.2)
      if(jvar.ne.1)return
c
c
      write(iunit,213) sagkwh
 213  format(" Calculated annual energy yield= "f10.0," kwh")
      write(iunit,211) pbar
 211  format(" Annual average power output= "f10.2," kw/h")
      write(iunit,212)vmax,pmax,vmaxe
 212  format(/5x,"Most probable wind speed= "f5.1,
```

```
      1  /5x,"Most probable power output= "f6.2,
      2  /5x,"Wind speed for maximum energy density= "f5.1)
c
 400     continue
         write(iunit,999)
         write(iunit,2226)
 2226    format("--------------economic analysis----------------")
         write(iunit,999)
         write(iunit,919) acse
 919     format(" Annualized cost of SWECS energy = $",f5.3)
         write(iunit,920) acge
 920     format(" Annualized cost of grid energy  = $",f5.3)
c
         write(iunit,960)
 960     format("1Cash flow "//"  Year",t10,"Benefits",t25,"Costs",
     1           t35"Yearly cash flow",t60,"Total cash flow"//)
         sum = 0.0
         do 601 i=1,jlife
c
         ycf = scbeney(i) - tcosty(i)
         sum = sum + ycf
         write(iunit,961) inyr+i-1, scbeney(i), tcosty(i), ycf, sum
 961     format(2x,i4,t9,f10.2,t22,f10.2,t38,f10.2,t62,f10.2)
 601     continue
         write(iunit,962)
 962     format(" Yearly present value"//"  Year",t10,"P.V. Benefits",t25,
     1           "P.V. Costs",t42,"Yearly P.V. change",t65,
     2           "Total NPV"//)
         sum = 0.0
         do 602 i=1,jlife
         ypv = SPVBY(I) - PVCY(I)
         sum = sum + ypv
         write(iunit,964) inyr+i-1, spvby(i), pvcy(i), ypv, sum
 964     format(2x,i4,t10,f10.2,t26,f10.2,t45,f10.2,t65,f10.2)
 602     continue
x        write(iunit,924) (inyr+i-1, tcosty(i),i=1,jlife)
x 924    format("0Total costs by year "/"  Year",4x,"Cost"/
x     1          100(2x,i4,3x,"$",f10.2/))
x        write(iunit,951) (inyr+i-1, dep(i),i=1,jlife)
x 951    format("0Deprecation values by year"/"  Year",4x,"Dep. Value"/
x     1          100(2x,i4,3x,"$",f10.2/))
x        write(iunit,925) (inyr+i-1, scbeney(i),zmint(i),i=1,jlife)
x 925    format("0Total SWECS benefits by year "/"  Year",4x,"Benefits"/
x     1          100(2x,i4,3x,"$",2f10.2/))
x        write(iunit,956) (inyr+i-1, lcosty(i),i=1,jlife)
x 956    format("0Loan costs by year"/"  Year",4x,"cost"/
x     1          100(2x,i4,3x,"$",f10.2/))
x        write(iunit,957) (inyr+i-1, pvcy(i),i=1,jlife)
x 957    format("0Present value costs by year"/"  Year",4x,"cost"/
x     1          100(2x,i4,3x,"$",f10.2/))
         return
         end
```

```
C         PROGRAM TO CALCULATE ENERGY YIELD OF A SWECS
C         GIVEN THE SWECS POWER CURVE AND THE PARAMETERS
C         FOR EITHER A NASA OR A WEIBULL WIND DISTRIBUTION
C
C         THE PROGRAM FITS A CUBIC POLYNOMIAL TO SIX P,V
C         POINTS TO REPRESENT THE POWER CURVE.  V(1) IS
C         TAKEN AS CUT-IN SPEED, V(6) IS TAKEN AS CUT-OUT.
C
C         WRITTEN BY C HANSEN FOR THE BUREC CYBER SYSTEM
C         AND MODIFIED FOR ECLIPSE 25 OCT 79.
C
          DIMENSION VTAB(8),PTAB(8)
          DIMENSION LTITLE(20)
          NTAB=8
          OPEN 7, "PCURVE"
          OPEN 12, "ECALCOUT"
          TYPE "ENTER TITLE INFORMATION"
          READ(11,110)LTITLE
  110     FORMAT(20A2)
          WRITE(12,111) LTITLE
  111     FORMAT(10X,"ENERGY YIELD CALCULATIONS"/10X,20A2)
          DO 1 I=1,NTAB
  1       READ(7,100) VTAB(I),PTAB(I)
  100     FORMAT(2F10.3)
          WRITE(10,200)
  200     FORMAT("STARTING POWER CURVE TABLE"//,4X,"I",
     1    3X,"V(I)",3X,"P(I)"/)
          DO 2 I=1,NTAB
  2       WRITE(10,201)I,VTAB(I),PTAB(I)
  201     FORMAT(I5,F6.1,F9.2)
          WRITE(10,202)
  202     FORMAT("DO YOU WISH TO CHANGE THIS TABLE?",/
     1    "(0=NO,1=YES)")
          ACCEPT ICHANG
          IF(ICHANG.NE.1)GO TO 3
          CALL TABL(PTAB,VTAB)
  3       CONTINUE
          WRITE(10,203)
          WRITE(12,203)
  203     FORMAT(/"POWER CURVE USED IN SUBSEQUENT CALCULATIONS"
     1    /5X,"VEL",5X,"POWER"/)
          V=0.0
          DV=1.0
          DO 4 I=1,40
          V=V+DV
          CALL POWER(P,V,PTAB,VTAB)
          IF(P.GT.0.0)WRITE(10,204)V,P
  4       IF(P.GT.0.0)WRITE(12,204)V,P
  204     FORMAT(F10.1,F10.2)
  13      WRITE(10,205)
  205     FORMAT("ENTER 1 FOR WEIBULL, 2 FOR NASA DIST.")
          ACCEPT NDIST
          IF(NDIST.EQ.2)GO TO 5
          WRITE(10,206)
  206     FORMAT("ENTER AVERAGE VEL AND K VALUE")
          ACCEPT VBAR,RK
          C=VBAR*(1.081+0.068*ALOG(RK))
          CONST=1.
          GO TO 6
  5       WRITE(10,207)
```

```
207     FORMAT("ENTER AVERAGE VELOCITY")
        ACCEPT VBAR
        C=VBAR
        RK=2.25
        CONST=0.7738
6       CONTINUE
        ENERGY=0.0
        EMAX=0.
        HMAX=0.
        V=VTAB(1)
        DV=0.05
        DO 7 N=1,1000
        CALL POWER(P,V,PTAB,VTAB)
        HOURS=8760.*(EXP(-CONST*(V/C)**RK)-EXP(-CONST*(
     1  (V+DV)/C)**RK))
        DELEN=P*HOURS
        IF(DELEN.LT.EMAX)GO TO 8
        EMAX=DELEN
        VMAXE=V
8       IF(HOURS.LT.HMAX) GO TO 9
        HMAX=HOURS
        VMAX=V
        PMAX=P
9       CONTINUE
        ENERGY=ENERGY+DELEN
        V=V+DV
        IF(V.GT.VTAB(NTAB))GO TO 10
7       CONTINUE
10      CONTINUE
        IF(NDIST.EQ.2) GO TO 11
        WRITE(10,208) VBAR,RK,C
        WRITE(12,208) VBAR,RK,C
208     FORMAT(//"WEIBULL DISTRIBUTION PARAMETERS"/
     1  5X,"VBAR= "F5.2,"       K= "F4.2,"    C= "F4.1)
        GO TO 12
11      WRITE(12,209) VBAR
        WRITE(10,209) VBAR
209     FORMAT(//"NASA VELOCITY DISTRIBUTION"/
     1  5X,"MEAN VELOCITY= "F5.2)
12      CONTINUE
        WRITE(10,210) ENERGY
        WRITE(12,210) ENERGY
210     FORMAT(//"ANNUAL ENERGY YIELD= "F10.0," KWH")
        PBAR=ENERGY/8760.
        WRITE(12,211) PBAR
211     FORMAT("ANNUAL AVERAGE POWER OUTPUT= "F10.2," KW")
        WRITE(12,212)VMAX,PMAX,VMAXE
212     FORMAT(/5X,"MOST PROBABLE WIND SPEED= "F5.1,
     1  /5X,"MOST PROBABLE POWER OUTPUT= "F6.2,
     2  /5X,"WIND SPEED FOR MAXIMUM ENERGY DENSITY= "F5.1)
        WRITE(10,214)
214     FORMAT("DO YOU WISH TO REPEAT FOR A NEW WIND DIST.?")
        ACCEPT IREPEAT
        IF(IREPEAT.EQ.1)GO TO 13
        CLOSE 12
        CLOSE 7
        END
```

```
      INTEGER FUNCTION YN(LEN)
      READ(11,1001)IFLAG
1001  FORMAT(A1)
      YN = 0
      IF(IFLAG.EQ."Y ".OR.IFLAG.EQ."y ") YN = 1
      RETURN
      END
```

```
      SUBROUTINE POWER(P,V,PTAB,VTAB)
      DIMENSION PTAB(8),VTAB(8)
      NTAB=8
      NSTOP=NTAB-2
      IF(V.LE.VTAB(1))GO TO 2
      DO 1 I=1,NSTOP
1     IF(V.GT.VTAB(I))INT=I
      X1=VTAB(INT)
      X2=VTAB(INT+1)
      X3=VTAB(INT+2)
      Y1=PTAB(INT)
      Y2=PTAB(INT+1)
      Y3=PTAB(INT+2)
      P=(V-X2)*(V-X3)*Y1/(X1-X2)/(X1-X3)
      P=P+(V-X1)*(V-X3)*Y2/(X2-X1)/(X2-X3)
      P=P+(V-X1)*(V-X2)*Y3/(X3-X1)/(X3-X2)
      IF(V.GT.VTAB(NSTOP+2))P=0.0
      GO TO 3
2     P=0.0
3     CONTINUE
      RETURN
      END
```