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ECONOMIC INCENTIVES TO WIND SYSTEMS COMMERCIALIZATION

Final Report

By

Michael Lotker

Robert W. Shaw, Jr.

William F. Adolfson

Robert P. Bernardi

Peter H. Davidoff

Michael T. Eckhart

Douglas S. Gunwaldsen

Peter J. Mettam

Paul Narayanan

John O. Sillin

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Solar Energy

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FINAL REPORT

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Michael Lotker, Principal Investigator
Robert W. Shaw, Jr., Project Manager

William F. Adolfson
Robert P. Bernardi
Peter H. Davidoff
Michael T. Eckhart

Douglas S. Gunwaldsen
Peter J. Mettam
Paul Narayanan
John O. Sillin

BOOZ, ALLEN & HAMILTON, INC.
4330 East West Highway **Bethesda, Maryland 22014**

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ABSTRACT AND OVERVIEW

This assessment of "Economic Incentives to wind systems Commercialization" is an analysis of the quantitative and qualitative impacts of a variety of Government funded economic incentives on Wind Energy Conversion Systems (WECS). The purpose of this study is to achieve better understanding of the relationship between implementation of specific economic incentives for WECS, and the factors surrounding WECS commercial introduction.

The significant uncertainties associated with both WECS and WECS user economics in the various machine and market categories necessitated the development of extremely flexible incentives analysis methodologies which are capable of parametrically analyzing:

- . A broad range of different incentives
- . A variety of WECS cost and performance assumptions
- . Very different classes of WECS users.

In order to construct such tools, a number of simplifying assumptions were made. Viewed in aggregate, the assumptions combine to produce a "rational man" model for each market sector's decision process.

The rational man model presumes that each market will act strictly on the basis of discounted cash flow analysis. The procedure was to select decisionmaking variables (such as net present value, payback period, revenue requirements, etc.) and target values (e.g. 20-year payback) for each variable in each market. Then, through the use of nomographs and a step by step workbook, analyse the impact of incentives on each of the following market sectors:

- . WECS manufacturers
- . Utility market for WECS
- . Residential market for WECS
- . Agricultural & remote markets for WECS
- . Industrial market for WECS.

A simple computer model was also prepared to facilitate execution of the large numbers of repetitive calculations. Shortcomings in the rational man model are explicitly recognized in the analyses.

With these quantitative results in hand, the analysis went on to consider other areas important to incentives analysis including:

- . Cost to government (including administrative costs)
- . Potential for loss of government control of incentives
- . Phase in and phase out problems
- . Likely market response to selected incentives.

Specific conclusions for each market sector are presented in the study's executive summary and text. Not surprisingly, it was found that each sector will respond differently to each incentive. One general conclusion spanning the market sectors was that strictly economic incentives to potential WECS users will be largely ineffective until the technology is well proven and demonstrated.

I. INTRODUCTION

In this introduction, the overall objectives of the study effort, the approach to their achievement, and the limitations inherent in the analysis are examined. The discussion is divided into four sections:

- . Purpose of the Study
- . Analytical Approach
- . Study Limitations
- . Additional Areas Requiring Attention.

1. THE PURPOSE OF THIS STUDY WAS TO ASSESS THE IMPACT OF ECONOMIC INCENTIVES ON WECS.

The past few years have seen a dramatic renewal of interest in Wind Energy Conversion Systems (WECS). Like other solar systems, they are seen to have advantages of inexhaustible supply, benign impact on the environment and potentially attractive economics in areas of high average wind speed and/or high alternative energy costs. The current state of the WECS manufacturing industry and market, one characterized by small production volume and high cost devices, has prompted many observers to suggest that Government funded economic incentives could spur the development of the WECS industry and market to a vigorous and self sustaining level. In fact several states have enacted direct subsidies and sales and property tax exemptions for wind powered systems and the National Energy Act (before the Congress at this writing) would provide additional tax credits.

In this environment, the Department of Energy (DOE) has found itself responding more and more often to inquiries from Congress, other departments in the Executive Branch, industry, and the public concerning incentives. While government policymakers must weigh the relative cost effectiveness of stimulating wind power versus other energy (and non-energy) fields, industry and the public are concerned with the prospects for WECS incentives in connection with their businesses and personal energy planning. Many express concern at the relatively small share of government incentives currently directed at solar (including WECS)

energy developments relative to other energy forms. This "Assessment of Economic Incentives to Wind Systems Commercialization" has two major objectives:

- . To provide analytical techniques in a workbook format for use as a tool by Government or other analysts in assessing the impact of economic incentives on WECS.
- . To utilize the techniques developed to analyze various incentives and provide recommendations to DOE concerning the effectiveness of options.

2. THE APPROACH TO THIS PROBLEM DIVIDED THE WECS MARKETPLACE INTO FOUR MARKET SECTORS.

The five chapters following this introduction address the overall WECS Technology Delivery System and the four WECS markets in the following order:

- . The Wind Energy Industries Producing and Delivering WECS
- . The Utility Market for WECS
- . The Residential Market for WECS
- . The Agricultural and Remote Markets for WECS
- . The Industrial Market for WECS.

The overall study logic and general approach are illustrated in Exhibit I-1 and are described below.

(1) The First Task Was to Characterize the WECS Marketplace

The WECS marketplace, both as it exists today and as it may develop in the future, is comprised of a complex and interacting set of manufacturers, consumers, utilities, banks, insurers, regulators, distributors, fabricators, etc. This WECS Technology Delivery System (TDS) will mature and evolve subject to many factors, including incentives. Chapter II of this report discusses TDS development, emphasizing the WECS manufacturing sector's role and presents a plan for assessment and implementation of incentives.

EXHIBIT I-1 Incentives Analysis Approach

In characterizing the WECS marketplace, it was found to be convenient to divide the subsequent analysis into separate utility, residential, agricultural/remote, and industrial markets. Chapters III-VI discuss each of these users and the impact of economic incentives on their decisionmaking processes.

(2) It Was Found Necessary to Incorporate Simplifying Assumptions in a "Rational Man" Model.

As detailed below, WECS technical and economic development is an area characterized by wide ranges of uncertainty. Similarly, for many of the markets, but most notably in the residential sector, buyer behavior patterns associated with large capital expenditures designed to reduce future energy costs are equally uncertain. Within the limitations of this study it was concluded that a simplifying assumption was needed in order to create a methodology that would be sufficiently flexible to accommodate the wide uncertainties associated with WECS. Accordingly, a "rational man" model was developed for each sector.

The key assumption in such a model is that the WECS purchaser will base his decision on economically rational analysis. Developing such a model requires an insight into the user's economics (cost of energy, tax liabilities, access to capital, discount rate, etc.) to determine the decisionmaking variables he will consider important and the target values of such variables necessary for a decision to purchase. For example in the residential sector, cash flow indicators such as payback, downpayment recovery and loss period times were considered important and were analyzed in detail. In the utility sector, the "rational man" analysis focused on revenue requirements, a very close approximation of this market sector's actual behavior. Other sectors focused on net present value and internal rate of return analysis. In each market the key decision-making variables were identified, and through examination of the literature and discussions with a variety of individuals knowledgeable in each market, target values for each variable were selected.

(3) Flexible Tools Were Developed to Assess the Impact of Incentives on the Rational Man.

A variety of methodologies were developed to facilitate analysis of the impact of economic incentives on each WECS market. The techniques emphasized the use of flexible nomographs which permit the analyst to provide his own assumptions for key (and often highly uncertain) variables such as WECS capital costs, conventional energy cost and escalation rate, WECS capacity factor and useful life, owner's cost of capital, tax bracket and discount rate, etc. Descriptions of each of these methodologies are presented individually in Chapters III-VI and are collected into an overall workbook in Appendix A. In addition, a simple computer model, capable of performing the repetitive calculations rapidly and accurately was developed and used and is described in Appendix B.

While there is a wide variety of potential economic incentives (see Exhibit I-2) to consider, only a small set of these can have significant economic impact on the rational decisionmaker. The incentives selected for detailed analysis in the market sectors included:

- . Direct cash subsidies
- . Tax credits
- . Low interest loans and loan guarantees
- . Sales tax exemptions
- . Property tax exemptions
- . Accelerated depreciation.

(4) The Analysis Tools Were Used in Connection With Base Case Assumptions to Analyze the Impact of Incentives

In each market sector, a base case was developed using plausible assumptions regarding potential WECS user economics and WECS cost parameters. Using the methodology previously developed and varying the levels of government incentives available, allowed analysis of the impact of incentives, acting alone or in combination (e.g., tax credits combined with sales and property tax exemptions), on the users' decisionmaking process. In this way one is able to judge the magnitude of each incentive needed to overcome specific economic barriers and which incentives are unable to surmount such barriers. Again, the

EXHIBIT I-2
Economic Incentives for Wind Energy Conversion Systems

1. DIRECT FINANCIAL INCENTIVES

- . Direct cash subsidy to
 - Purchaser*
 - Manufacturer*
- . Cash rebates

2. TAX INCENTIVES

- . Income tax deductions
- . Income tax credits*
- . Sales tax exemption*
- . Property tax exemption*
- . Accelerated depreciation for tax purposes*
- . Capital gains applicability to all WECS sales
- . Wind Energy Investment Trust (WEIT)

3. FAVORABLE LOAN TERMS

- . Loan guarantees
- . Low interest loans*
 - Granted through federal agencies (SBS, HUD, FMHA, REA, DOE)
 - Interest subsidy on loans made through private lenders

4. RD&D SUPPORT

- . WECS product and component improvement
- . Wind surveys
- . Performance and safety standards
- . Education and training grants
- . Information dissemination

EXHIBIT I-2
(Continued)

5. GOVERNMENT PROCUREMENT*

- . Demonstration program
- . DOD installations

6. INSURANCE GUARANTEES

- . Government backed insurance pool
- . Government issues insurance

7. GOVERNMENT EQUITY INVESTMENT IN WECS MANUFACTURING FACILITIES

8. DISINCENTIVES TO CONVENTIONAL ENERGY FORMS

- . Eliminating existing incentives
- . Deregulation of price controls
- . Use and consumption taxes
- . Strengthened environmental legislation

9. REGULATORY ACTIONS

* Incentives studied in detail.

analysis technique is presented in sufficient detail to allow the reader to perform his own assessment, using his own base case assumptions, to determine incentive impacts.

(5) Institutional Issues Associated With WECS Incentives Were Also Investigated

In addition to the purely quantitative analysis of the impact of economic incentives on WECS purchasers, an assessment of the significant institutional issues was conducted. This included considerations of:

- . Administrative Costs, emphasizing qualitative (tax credits have an existing implementation agency, direct subsidies do not; subsidies and tax credit involve one time actions, a low interest loan program implies a continuing commitment, etc.) as well as quantitative (estimated costs where available) features. Of course, the direct cost of each incentive was also considered in the analysis.
- . Potential Loss of Government Control focused on the capability of some incentives to maintain active fiscal control of expenditures (through, for example, the annual appropriations cycle) and for others to have less control in this area (tax credits could be taken by many or few individuals and have only low potential for government control).
- . Phase in and out Problems relate to the legislative difficulty associated with implementing and terminating incentive options.
- . Policy questions include the degree to which one is willing to distort an energy marketplace to achieve policy goals, and the potential effects of that distortion.

(6) Recommendations Concerning WECS Incentives Were Presented

For each market sector, specific recommendations concerning the effectiveness of economic incentives are provided. Such recommendations take into account each of the quantitative and qualitative factors discussed above and, where possible, include a preliminary assessment, beyond the rational man assumptions, of likely market response to incentives. The timing of incentives was also examined with the general conclusion that most purely economic market incentives will be premature until the WECS manufacturing industry can demonstrate sufficient product reliability and ability to meet the demand that incentive could stimulate.

The general approach described by this six step logic was applied to each market sector.

3. IT WAS RECOGNIZED THAT THIS STUDY COULD NOT FULLY ADDRESS DETAILED MARKET RESPONSE TO WECS INCENTIVES.

The reader is cautioned to recognize the limitations of the rational man model-based assessment described above. Key points include the following:

(1) Ultimately, Incentives Analysis Should Address Probable Market Response to Specific Incentive Packages

This study was designed to go no further than to examine the impact of economic incentives on a hypothetical user's decision processes. Determining actual market response is a much more complex problem involving determination of the magnitude of market response to specific incentives levels. The rational man model assumes the user will purchase a WECS when his cost criterion is met; it does not predict the size of the total market or what fraction of that market will buy at various levels of WECS cost effectiveness. Clearly such information will be desirable but difficult to obtain.

(2) The WECS Market is Currently Characterized by Diversity and Uncertainty

Each WECS market contains enormous internal diversity associated with its members':

- . Income (or profitability) level
- . Access to mechanical skills
- . Risk adversity
- . Access to capital
- . Utility of capital - whether the decision-maker will use discretionary capital to
 - reduce operating costs (WECS)
 - invest in other areas (new land, plant, equipment, processes, marketing, etc.)
 - "invest" in non-income producing consumables (vacations, cars, etc.).

In addition, there are substantial areas of uncertainty associated with WECS itself. These include:

The economics of WECS, which will vary:

- technically with different machine types and manufacturers and will have uncertain potential for performance improvement
- economically with a wide range of estimates concerning capital costs, installation costs, and O&M costs
- locally with each specific site's average wind velocity having a most significant impact.

The economics of WECS users, which will vary with:

- energy costs, escalation rates and structure (e.g. declining block or demand electricity rate schedule). For purposes of this study we have

generally assumed flat rate structures, uniformly escalating with time.

- discount rate, a most sensitive variable in discounted cash flow analysis, incorporating economic (average opportunity cost of capital) and quasi-social (time value of money) factors. For purposes of this study, we have generally assumed a 10% discount rate for individual users and government with higher values for industry.

The likely role of government in development of WECS and other solar energy technologies.

These uncertainties, which motivated the development of the rational man model, must be kept in mind while using the model.

4. THIS STUDY, THEREFORE, MUST BE VIEWED AS AN IMPORTANT FIRST STEP IN THE WECS INCENTIVES ANALYSIS PROCESS

This study can provide an important insight into the structure and analysis of WECS user economics and the potential impacts that a wide variety of economic incentives, acting singly or in combination, can have. In addition, it reflects where incentives will be especially inappropriate or premature. However, the analysis only approximates the actual market decisionmaking process with an accuracy level that depends on how financially rational the market sectors are.

More detailed market surveys and assessments will be required to:

- . Determine the utility of each markets' "rational man" model and suggest refinements and changes to improve it
- . Better fix target values for decision parameters associated with various markets
- . Suggest other approaches (e.g., risk aversion, portfolio analysis, etc.) to market sector analysis

... Estimate the probable magnitude of market response (number of units sold) as a function of degree of cost effectiveness

... before the actual impact of economic or other incentives for WECS can be determined. Such an assessment will be extremely difficult given the uncertainties highlighted above.

* * * *

This Chapter has introduced the purpose, approach and limitations of this study. In the next, the current and future structure of the WECS marketplace is discussed with emphasis on the role of incentives in stimulating an effective WECS Technology Delivery System.

II. INCENTIVES TO THE WIND ENERGY INDUSTRIES

This chapter presents the development of a federal incentives plan for the wind energy industries. The analysis seeks to answer four key questions:

- . What are the components of a mature wind energy industrial infrastructure?
- . How is the infrastructure likely to evolve over time to maturity?
- . What are the major business problems, risks and uncertainties during the evolution?
- . Which federal incentives can be most effective in stimulating the infrastructure at each stage?

The following sections address each question individually.

1. A MATURE TECHNOLOGY DELIVERY SYSTEM WILL INVOLVE EQUIPMENT MANUFACTURERS, ENGINEERING FIRMS, INSTALLATION AND SERVICE CONTRACTORS, FINANCIAL INSTITUTIONS, UTILITIES, AND A VARIETY OF GOVERNMENTS AND ASSOCIATIONS

The Technology Delivery System (TDS) is the entire industrial, financial and governmental infrastructure which works smoothly to have a product and associated services--in this case WECS--available to its markets. In broad terms, a mature wind energy TDS is likely to consist of the following major components, as illustrated in Exhibit II-1:

- . Equipment and service industries:
 - R&D firms
 - Component manufacturers
 - System manufacturers
 - Distributors (marketing networks)
 - Engineering and consulting firms
 - Contractors (electrical and construction)

Affected institutions:

- Financial institutions
- Electric utility companies

Affected governments:

- Zoning and code officials
- Tax authorities
- Energy policy and program agencies

Interested associations:

- Industry (trade) associations
- Technical societies
- Standards organizations.

At the point of "maturity," each business, institution or government group will be dealing effectively and professionally with wind energy technology on a regular basis. The nature of a fully developed TDS is described in the following sections.

(1) Each Business and Institution has a Unique Role in the Successful Deployment of WECS Technology

Business opportunities and institutional involvement will increase as WECS markets develop and grow. In a mature stage, the well-functioning TDS includes unique roles for each organization:

- . Component manufacturers are likely to specialize in supplying rotors, blades, generators and alternators, mechanical and electrical equipment, and tower structures
- . System manufacturers will specialize by type and size of WECS, and by market
- . Distribution and sales networks will be unique to each market
- . Engineering and installation contractors will be the crucial points of contact between the WECS industry and markets

EXHIBIT II-1
Basic Components of the Generalized WECS
Technology Delivery System (TDS)

- . Financial institutions will have a key role in the remote, agricultural and residential/commercial markets, in which purchases are likely to be financial individually by the owners
- . Key government activities include adoption and enforcement of technical standards, local building and electrical codes, local zoning ordinances, tax policy and utility regulation.

(2) The Lack of a Fully Developed Technology Delivery System is a Major Constraint to Initially Developing Each Market

Elements of the TDS are involved at five functional points, as shown in Exhibit II-2:

- . Equipment development
- . Equipment manufacture and delivery
- . Point of sale
- . Point of installation
- . Equipment operation.

At each key point of involvement, a different combination of TDS businesses and institutions comes together:

- . Manufacturers and R&D firms will be involved in equipment development as major actors. To a lesser extent, electric utilities and standards organizations are likely to have influence on technology development, depending upon the scale and type of equipment.
- . Equipment manufacturing will most likely be conducted by a series of component and systems producers in three groups:
 - Wind turbine component manufacturers
 - . Blades
 - . Rotor mechanisms
 - . Special electrical equipment

- General equipment manufacturers
 - . Generators and alternators
 - . Gearboxes and drivetrains
 - . Tower structures
 - . Electrical equipment
- WECS system manufacturers
 - . Small scale systems (1kW to 8kW)
 - . Medium scale systems (25kW to 100kW)
 - . Large scale systems (500kW to 2MW).

Equipment delivery will likely be a combined effort of manufacturers, distributors, installers, and engineering firms, although each market will require a different distribution channel.

At the point of sale, a combination of national and local businesses become involved to satisfy often conflicting needs:

- Purchasers
- Financial institutions (lender)
- Installers
- Zoning officials
- Distributors and manufacturers
- Electric utility companies.

At the point of equipment delivery and installation, local-level businesses and institutions become involved to protect self-interests:

- Technical quality
- Financial security
- Electrical safety.

During equipment operation, service contractors (usually the installer) will provide maintenance and repair. In addition, manufacturers remain involved to satisfy warranty claims, financial institutions to protect against loan default, and electric utilities to assure safe and authorized performance.

EXHIBIT II-2
Time Periods When Each TDS Business
Is Heavily Involved

TDS COMPONENT	TIME PERIOD OF TDS INVOLVEMENT				
	EQUIPMENT DEVELOPMENT	EQUIPMENT DELIVERY	POINT OF SALE	POINT OF INSTALLATION	EQUIPMENT OPERATION
R&D FIRMS					
MANUFACTURERS					
DISTRIBUTORS					
ENGINEERS					
INSTALLERS					
FINANCIAL INST.					
ELECTRIC UTILITY					
ZONING BOARD					
CODES REG.					
SERVICE CONTRACTOR					
TAX ASSESSOR					

KEY:

■ KEY ACTORS
 ▨ OTHER ACTORS

The points of sale and installation are the crucial areas of TDS development. Without these points of contact between the industry and markets, the concept of technology deployment is not possible.

(3) The Mature TDS Will Have Elements Which Serve the Unique Needs of Each Market

Each market has unique technical problems and unresolved issues. Particularly, the technical problems inherent to adding a small scale technology to the utility grid system, and performance requirements will likely be unique to each scale of WECS and each application:

- . Small scale systems (1kW to 8kW) for remote, agricultural and residential/commercial applications
- . Medium scale systems (25kW to 100kW) for industrial, institutional and larger agricultural applications
- . Large scale systems (500kW to 2000 kW) for direct utility applications.

In addition, information needs, marketing approaches, distribution methods, financing, installation and after-sales service are unique to each type of purchaser:

- . Consumers (homeowners)
- . Real estate investors
- . Commercial firms
- . Industrial firms
- . Individual farmers
- . Agricultural corporations
- . Electric utilities:
 - Investor owned
 - Municipal
 - Rural cooperative
 - Federal.

Further, government activities are somewhat unique to each market:

- . Zoning
- . Codes and standards
- . Consumer protection
- . Taxation
 - Sales
 - Property
 - Income
- . Regulation
 - Environmental
 - Health and safety
 - Power plant siting
 - Utility activities and rates.

Recognizing the many differences in market needs, the following four subsections discuss the likely TDS for each major market.

1. The TDS for Residential/Commercial Markets is the Most Complex System of Distribution, Local Installation, Financing and Government Involvement

The residential/commercial market TDS is a classical example of complex technology deployment, as shown in Exhibit II-3:

- . Extensive product information systems are required to develop market demand
- . National brand name reputations are important to the consumer market
- . But business transactions are conducted through installation contractors at the local level
- . Financing is obtained for each WECS purchase, by the purchaser
- . Local zoning and code regulations prevail.

EXHIBIT II-3
Components of the Residential WECS
Technology Delivery System

These factors indicate the need to establish national or at least regional equipment networks which can operate effectively with local financial and institutional conditions.

2. The Industrial Market TDS Will Be Dominated By Manufacturers' Sales Agents And Local Contractors

The industrial market TDS is expected to match standard methods in industrial marketing, as shown in Exhibit II-4:

- . Direct sales through manufacturers' sales agents, supplemented by advertising of sales performance
- . Sales engineering services
- . Utilization of engineering consultants and contractors for several functions:
 - Equipment specification
 - Installation
 - After-sales service.

The industrial TDS is simplified by less involvement of zoning officials, consumer protection agencies and safety code officials. In addition, capital sources are not likely to be concerned with WECS purchases for two reasons:

- . Capital funds for industrial investments come from discretionary spending budgets rather than separate loans (see Chapter VI for discussion)
- . WECS investments are not in the mainstream of business decisionmaking, and are not likely to be a major portion of capital spending.

3. The Agricultural/Remote Market TDS has Characteristics of the Industrial TDS and Residential TDS

Deployment of WECS technology to agricultural and remote markets is also not likely to be burdened by extensive zoning and other government involvement.

Distribution is expected to be achieved through installation contractors which handle several manufacturer's systems on an exclusive basis. Installers will also provide after-sales maintenance and repair, as shown in Exhibit II-5.

Financing is expected to be arranged for each purchase, and is likely to be as much a problem as for the residential market. Banks and other local lending institutions will provide capital funds.

4. The Utility TDS is Considerably Different Than Those of the Other Markets, and is Dominated by the Utilities, Architectural/Engineering Firms, and WECS Manufacturers

There are no middlemen or distributors in the utility TDS, since large-scale WECS manufacturers will sell direct to utilities through sales-engineering staff, as illustrated in Exhibit II-6. Also, the financial institutions will have little involvement, since capital funds will be raised in the normal course of the utility's capital market dealings.

Individual state public utilities commissions will represent the major governmental involvement. Other government activities will include siting, environmental and safety authorization.

System design and specification will be performed by utility company staff or architectural/engineering firms, depending on the staff capabilities of each utility company. A number of A&E firms are in the regular business of supplying technical services to the utility industry, and can be expected to provide these services on WECS technology.

EXHIBIT II-4
Components of the Industrial
WECS Technology Delivery System

EXHIBIT II-5
Technology Delivery System For
Agricultural/Remote Markets

EXHIBIT II-6
Technology Delivery System For The
Electric Utility Market

The extent to which construction firms, consulting firms, governments and institutions will be involved in the utility TDS depends upon the type, size and complexity of the WECS technology and the nature of each utility in each purchase case.

* * * *

This section has presented a general view on the form of a mature TDS for wind energy technology. The next section discusses how the TDS is likely to evolve over time, following which the key business problems are identified and incentive options are assessed.

2. THE TECHNOLOGY DELIVERY SYSTEMS WILL EVOLVE AS PROFIT OPPORTUNITIES IN EACH MARKET BECOME EVIDENT, AND AS INSTITUTIONAL PROBLEMS ARE CREATED AND OVERCOME

Formation of the business and institutional infrastructure will take place over time as people take advantage of profit opportunities and as others respond to market pressure to solve institutional problems. While it is difficult to forecast accurately how the TDS will evolve, this section presents indicators on the likely evolution of events and conditions.

(1) Market Growth Will be the Driving Factor in Building the TDS

Market segments are expected to develop in different timeframes as a function of three key factors:

- . Proof of technical performance of each type and scale of WECS
- . Demonstration of WECS as a product which meets the particular needs of each market
- . Resolution of institutional problems, such as financing, zoning restrictions and utility interaction.

Presently, industry leaders expect the remote applications market to develop first, utilizing small-scale technology. This market includes remote siting of agricultural, industrial and residential systems. The key TDS elements to be developed are installation/service contractors and lending institutions.

The development and growth of other markets are uncertain, and there is some degree of disagreement in the industry as to the probable course of events. The three major market categories are:

- . Industrial/institutional applications for medium-scale (25kW to 100kW) systems with utility backup power
- . Residential applications for small-scale (1kW to 8kW) systems with utility backup power
- . Direct utility applications for large-scale systems on the existing grid system.

Development and growth of each market provides the revenue and profit potential which is the attraction for business development in each TDS.

(2) Capital Investments Will be Made in Three Key Stages of Corporate Growth as the Technology is Refined and Potential Profitability Increases

There is a sequence of investment-related events which are likely to occur in the growth of the WECS industry, as illustrated in Exhibit II-7.

- . Seed capital is attracted when there is evidence of technological feasibility, market potential in general and profit potential for the individual firm
- . Sustaining capital is attracted when the technology is proven, specific markets have been identified, and initial sales are expected or have been achieved
- . Growth capital is attracted when sales are being generated, production is running (but constrained by capacity) and rapid growth is expected.

EXHIBIT II-7
Major Points of Corporate Investment

Stage of Major Capital Infusion	Prior Conditions Satisfied	Next Steps To Be Satisfied	Implications for Management
. Seed Capital	<ul style="list-style-type: none"> . Technology defined . Market potential Indicated . Business opportunity indicated 	<ul style="list-style-type: none"> . Develop and prove product feasibility . Identify markets 	<ul style="list-style-type: none"> . R&D for marketable product . Market research
. Sustaining Capital	<ul style="list-style-type: none"> . Technology is proven . Markets are identified 	<ul style="list-style-type: none"> . Create market demand . Enter production . Generate sales 	<ul style="list-style-type: none"> . Set up marketing network . Attack introductory markets
. Growth Capital	<ul style="list-style-type: none"> . Sales are being generated . Production is running 	<ul style="list-style-type: none"> . Implement full market strategy . Gear up production . Establish stable financial structure 	<ul style="list-style-type: none"> . Marketing programs . Manufacturing policies . Financial policies . Management policies

EXHIBIT II-8 Major Market Entry Strategies

SOURCE: (DERIVED FROM) PINSOFF, H.L., AND STEWART, J.M., "STRATEGIES FOR A TECHNOLOGY-BASED BUSINESS," HARVARD BUSINESS REVIEW, NOVEMBER-DECEMBER 1967.

Although somewhat different for each company in the TDS, the general sequence will appear in increasing capital investment as the potential for profit increases and the risk of failure decreases. Importantly, venture investors continually monitor market penetration forecasts and profit potential:

Market penetration forecasts: Each commitment of business resources is made according to how much it will speed up annual sales growth and safeguard success potential. Market penetration scenarios are written well before instead of just prior to commercial entry. The scenario becomes the controlling script for determining resource allocation during the business gestation period.

Appraisal of profit potential: Investors ask: "What are we buying for our investment?" at each step in a venture's development. Typically, there are three key measures used in appraising current or future performance:

- Return on investment
- Sales (dollars and units)
- Percentage share of market.

(3) Wind Energy Businesses Will Develop From Entrepreneurial New Ventures, Corporate New Ventures and Extensions of Existing Businesses

Industrial parts of the TDS will begin to emerge as business ventures through new enterprise or extensions of related businesses:

- Entrepreneurial new ventures will be new-product oriented or specialized in serving the needs of individual market niches
- Corporate entries can be expected throughout the industry's lifetime, and will result from unique market entry strategies of each company throughout the future course of the industry, as illustrated in Exhibit II-8:

- First-to-market strategy
- Follow-the-leader strategy
- Applications engineering strategy
- Last-to-market strategy.

Component manufacturing, installation, service and financing are likely to evolve out of existing local businesses.

(4) If Substantial WECS Markets Develop, the Equipment Industry is Likely to Evolve From Small Private and Corporate Ventures Into Divisions of Diversified Corporations

For nearly every new venture, one or more of the following five events will eventually happen:

- . Bankruptcy occurs
- . Liquidation is initiated and the company goes out of business
- . The company is sold to another investor
- . Stock is sold to the public and the company remains intact
- . The company is either merged with or acquired by another company.

While inevitable outcomes are clear, it is difficult if not impossible to predict the evolution of an industry accurately. Certainly, wind systems manufacturing will change over time. Corporate evolutions include changes in ownership, organization, financial structure, products and markets. During these changes, most WECS manufacturers will be one of the following four types of companies, as illustrated in Exhibit II-9:

- . New ventures: Entrepreneurial ventures can be individual efforts (e.g., Zephyr Wind Dynamo, Natural Power Inc., Dynergy Corp.) or outgrowths of existing companies (e.g., GENEREC, Alcoa, Head Ski/AMF). Venture companies and venture divisions are new product oriented. The key to survival is adequate seed capital and early sustaining sales revenue.

EXHIBIT II-9 Typical Stages of Business Growth

SOURCE: (DERIVED FROM) SCOTT, R.R., "THE INDUSTRIAL STATE: OLD MYTHS AND NEW REALITIES," HARVARD BUSINESS REVIEW, MARCH-APRIL 1973

. Small businesses: Viable businesses are based on adequate growth capital and sustained sales. Companies are usually market oriented rather than process oriented. These businesses fill one part of the production sequence from raw materials to markets. The key to competition is having a unique market niche. Examples of small businesses are Windworks, Inc. (wind), Solarex (photovoltaics) and Solaron (solar heating).

. Integrated business: Integration is the first extension of a small business. Companies integrate backwards into component and raw material production and forward into system assembly, distribution, marketing and installation. The key to success is increased efficiency and control of the business environment.

. Diversified business: Diversification is initiated to take advantage of corporate skills in other businesses and to establish stability.

Diversification is a complex process of balancing financial capabilities, product advantages, marketing skills and human talents. Some firms lose an identity in the diversification process. However, there are three basic types of diversified businesses which could, under varying circumstances, absorb the WECS industry, as shown previously in Exhibit II-9:

. Diversified business with a dominant product: These businesses result from large stable markets. Heavy capital commitments are incurred. Efficiency is gained through specialization and integration. The key to competition is market share, although anti-trust issues are a constraint on growth. Examples are GM, IBM, Texaco, Scott Paper, U. S. Steel and Xerox.

- . Diversified with related businesses: These companies grow by adding divisions through internal development or acquisition. Management and marketing are built by utilizing related skills and reputations from existing businesses. Keys to competition are product R&D and/or marketing. Flexibility is more important than efficiency. Examples are DuPont, Eastman Kodak, General Electric and General Foods.

- . Diversified with unrelated businesses: These companies exhibit the purest form of diversification. The purpose of diversifying is to achieve financial balancing and growth. Counter-cyclical businesses make good combinations. Examples are Litton, LTV, Olin, Rockwell International and Textron.

Dominant product businesses are not likely to emerge in the WECS industry since large (multi-billion dollar) markets are unlikely to develop. Further, WECS competes with a variety of technologies that provide a similar function, implying that WECS is not a "stand alone" type of product which is most attractive to dominant product firms.

Financially-diversified businesses may acquire or develop WECS businesses, but it is unlikely that WECS manufacturing will become "distinct" enough to fit the strategies of these firms, which diversify into unrelated businesses.

These are, however, a number of reasons that the attracted corporations will be "diversified with related businesses":

- . Capital resources, and managerial and technical talents are available
- . Product R&D and manufacturing capabilities are already in place
- . Related business reputations may be important to the market, particularly the utility market

- Capability to market WECS is already in place, can be more easily developed by experienced corporations, or can be developed by extending existing, related marketing systems.

Of course, actual results are difficult to forecast, but industrial precedent indicates that diversified corporations with "related business" strategies are likely to play an increasingly major role in the WECS industry.

(5) Government Policy Should Recognize That Successful Companies Will Develop Strategies That Establish Competitive Advantages in the Marketplace

Corporate strategies are forming presently in the WECS industry. Already, the strategic character of each company is becoming apparent and no two firms are operating under the same objectives, market outlook, or investment plan. While not a major factor in success today, direct competition can be expected to increase. The successful companies will be those which capture a clear competitive advantage in each marketplace.

For this reason, federal incentives policy should recognize that, during TDS evaluation, a variety of strategies will be played by business. In fact, for new ventures, studies have shown that successful firms will have been developed on more than a pure one-product strategy:

- Tandem products: Bringing an "easy winner" to market early buys time to develop slower but heavier earners. The early earner is usually a product whose added value is easily perceived by the market. Investment is minimized by drawing on proven technology, existing channels of distribution and validated market acceptance. An example of this strategy in the wind business is early sales of the "Jacobs" machines while developing new designs.

Related products: Another approach to develop cash flow is the time-honored "razor and blades" technique. One product is marketed as a relatively low-priced utilitarian commodity. It is designed to stimulate mass repeat sales for a second product, which is marketed as a high-margin, branded specialty item. The wind energy industry is unlikely to develop this specific opportunity, but "related" products may establish key footholds in the market (for example, marketing generators, inverters, and other equipment).

Combined product and services: Venture businesses have learned to diminish risk and accelerate product acceptance by marketing related services. The two most typical services that large companies supply with products are financial support (lending or leasing) and a combination of customer consultation and education. The ideal product/service system is marketed as a unit of sale. In the WECS industry, the product/service system could include wind surveys, equipment, installation, maintenance, and financing as a package sales unit (autos, swimming pools, computers and other high-ticket products are sold in this manner).

* * * *

This section has discussed the likely evolution of the wind energy TDS, based on historical precedents. The next section identifies major business problems which are likely to occur during this evolution of business.

3. THE MAJOR CONSTRAINTS TO ACCELERATING TDS DEVELOPMENT ARE LACK OF MARKET DEMAND, INSTITUTIONAL INTERFERENCE IN ACHIEVING SALES, AND LACK OF CAPITAL FOR RISK INVESTMENTS

This section identifies the key problems which must be overcome to accelerate the WECS TDS development.

(1) Lack of a Market for WECS Technology is the Primary Constraint to Business

The two most prevalent reasons for business failure are the absence of a market and overspending in the perfection of a product beyond market needs.

Lack of a market is either a mismatch between the technology and market needs, or the lack of market need at all. The key questions are: what are the needs of each market, and does WECS fulfill those needs? At this time, market potentials are estimated on the basis of utility bill reductions and fuel savings, but it is not clear that the markets need these benefits to the extent that investments will be made to achieve them.

Overspending in the perfection of a product beyond market needs is a critical factor since R&D investments represent sunk costs which may not be recovered unless the market perceives the added value to be worth the price.

(2) Institutional Interference in Achieving Sales is a Constraint to the Extent That Mass Markets Cannot be Stimulated

Institutional problems such as financing, local zoning and code compliance and interaction with utilities (technical requirements, rates and grid hookup) are roadblocks to consummating sales.

Private purchases for dispersed applications with utility backup power are constrained by the complexity of institutional involvement, and lack of uniform guidelines, at the points of sale and installation. For example, anticipation of demand or other similar electricity rate structures can significantly affect market growth.

Direct utility purchases for central station power are not constrained by local institutional problems. They are, however, constrained by public and regulatory oversight of management decisions on equipment purchases.

Private purchases for remote applications are not constrained by institutional problems. For this reason, sales are constrained only by the industry's ability to reach potential purchasers and fill market needs.

(3) Lack of Capital for Risk Investments is a Constraint Which is a Result of Other Business Problems

Lack of risk capital limits a new venture's ability to reach the markets with viable products. Small businesses are affected strongly by lack of capital funds since their success depends upon building an entire business structure and marketing mechanism from scratch. Larger, established businesses have related talents and resources which can be shared in the business development phase, and for this reason are not so acutely constrained by lack of capital funds.

Nonetheless, both small and large firms in the WECS industry today consider lack of risk capital to be a constraining factor since there is little information upon which to evaluate business prospects and build strong arguments for attracting capital funds from parent corporations or private investors:

- . Actual markets do not exist today (although potential markets have been identified)
- . A complete and functioning WECS industry does not exist from which competitive positions can be assessed and competitive advantage identified
- . Government energy policy, which will affect future markets, is evolving and changing, and is unpredictable.

Importantly, the three major categories of problems--market demand, institutional constraints, and capital availability--are highly interrelated. To overcome these problems, the federal government can take a number of incentives approaches, as discussed in the following, and final, section of the chapter.

4. FEDERAL INCENTIVES TO WECS BUSINESSES CAN BE PLANNED
AT THREE LEVELS OF GOVERNMENT INVOLVEMENT

Without a sustained and growing market for WECS technology, there is little reason to develop an industry. Conversely, a market may not develop unless the technology is proven and an industry exists to deliver high quality products which carry a value greater than the price. Because business risks are high when markets must be created, it may be necessary to incentivize business in the interim until a sustained market emerges.

This section assesses federal incentives options to WECS businesses, based on discussion in previous sections. A three-tier plan has been developed for the purpose of evaluating incentives, as shown in Exhibit II-10:

- . Incentives to create basic business opportunities
- . Incentives to encourage investors
- . Incentives to improve business viability.

(1) First-Level Incentives Create Basic Business
Opportunities Through RD&D Cost-Sharing and
Market Stimuli

Business opportunity exists when a market need can be filled with a known product. For this reason, the first level of government incentive is aimed at preparing the technology and stimulating basic market demand, as discussed in the two following subsections.

1. Market Incentives Help Create Demand but
do not Provide the Industry or Individual
Firms With Sales

Market incentives are the most general type of federal incentive since individual companies are not affected directly, and the industry is left to compete for the market on its own. These incentives can be utilized at three levels of action, as shown in Exhibit II-11:

- . Create the market need for WECS by altering energy conditions in each market

- Create market demand by communicating the value of WECS to fill market needs, and by improving the market perceptions of value versus price

- Improve the fraction of demand that becomes sales in each year by reducing marketing problems (e.g., institutional barriers to sales).

Importantly, however, federal incentives do not consummate sales for the industry. The selling activities and marketing strategies will be implemented by business, unless policy decisions place the government between the industry and markets as a selling agent.

2. Research, Development and Demonstration (RD&D) Incentives Accelerate the Proof of Technological Feasibility, but can Direct Product Development Beyond Market Needs

Cost-shared RD&D is an incentive to industry in two respects:

- Reduces the level of up-front investment required in starting a new business

- Reduces the risk of product failure from technical or economic shortfalls

Conversely, RD&D subsidies can be a disincentive for a number of reasons:

- Increases product prices, and reduces marketability if technological targets exceed market perceptions of value versus price

- Delays marketability if performance targets are not related to market needs

- Reduces the ability of individual firms to establish competitive advantage based on product superiority.

EXHIBIT II-10
Three Major Levels of Federal
Incentives to the WECS Industry

1.	First Level Incentives	<u>Create Basic Business Opportunities:</u> <ul style="list-style-type: none">. Develop the WECS products. Develop the WECS markets
2.	Second Level Incentives	<u>Encourage Investment:</u> <ul style="list-style-type: none">. Provide capital funds. Reduce investment risks. Improve potential returns
3.	Third Level Incentives	<u>Improve Business Viability:</u> <ul style="list-style-type: none">. Direct investments. Reduce costs. Subsidize price. Enhance sales. Subsidize profits

EXHIBIT II-11
Conceptual Illustration of Market
Incentives Impact

While basic business opportunity is dependent on market and product viability, the ultimate effect of RD&D incentives is related to the way programs and incentives are implemented. A recent study concluded that RD&D incentives should be designed to achieve two results:

- . Reward private success
- . Reduce the risk and cost of failure.

In addition to creating basic business opportunities through market stimulus and RD&D, federal incentives can be directed at a second level: encouraging investors.

(2) Incentives to Encourage Investors Represent a Second Level of Government Involvement and Can Be Designed to Affect Capital Transactions and Profit from Capital Investments

There are two major aspects of investment which can be affected by federal incentives, as shown in Exhibit II-12, which traces the mechanisms by which investors put money into business ventures and later receive returns:

- . Capital transactions, which include provision, and recovery, of debt capital and equity capital
- . Returns from selling assets and business operations, which include perquisites to owner/managers, income in the form of interest or salary, and dividends from profits.

Each element of investment is affected by three factors, which serve as the focal points of federal incentives:

- . Supply: whether the funds are available at all, and, if they are available, whether in the form of debt or equity funds
- . Security: whether there is high risk or low risk of recovering invested capital or receiving rewards from business operations

Tax effects: whether the flow of funds are reduced by taxes.

Federal incentives can affect each factor of investment, as discussed in the following seven subsections.

1. Federal Incentives Can Provide Debt Capital From Public Sources or Guarantee Its Recovery by Private Sources

Return of debt capital is unaffected by taxes, as shown previously in Exhibit II-12. However, due to risks on recovery, debt capital may not be available at all to new ventures in the wind energy industry. The government can provide debt capital from public funds or guarantee its return to private lenders.

Government cost of this incentive is not predictable, since business failure rates are tied to the viability of WECS markets. In general, new business failure rates run as high as 80 percent or more. However, experience gained through SBA programs indicates that losses can be considerably lower.

2. Incentives Can Provide Equity Capital in a Cost-Sharing Program

Equity recovery is also unaffected by taxes, as shown previously in Exhibit II-12. However, as is the case for debt capital, equity funds may not be available from private or corporate investors. This problem may, in part, be overcome by federal cost-sharing of equity investments.

In fact, existing federal programs in wind technology RD&D are forms of equity-sharing by providing funds for RD&D and market research, which would have required start-up capital by new venture owners.

EXHIBIT II-12
Case Examples to Show Federal
Incentives Options to Improve
Investors' Returns

Straightforward extension of existing programs would provide funds for other business uses, such as investment in production facilities and marketing mechanisms. Such an extension of current federal policy is, however, not favored by a large number of business executives for the reason that government would be directly involved in industry's function of building productive capital from which profits are earned.

3. Capital Gains from Successful Equity Investments Will Be Enhanced by Exclusion from Capital Gains Taxes

As shown previously in Exhibit II-12, capital gains taxes reduce equity profits by 25 percent for the investor in a 50 percent income tax bracket. By improving capital gains potential, WECS business investments appear more attractive to individuals and corporations.

Removal of capital gains tax from WECS business investments is attractive for several reasons:

- . Government cost is offset partially or entirely by income taxes which are incurred by successful firms.
- . The incentive rewards success, rather than insuring against failure.

There is, however, a problem of implementation in that few businesses are likely to be in the wind energy business purely (as discussed in Section 2). For this reason, it will be difficult to classify capital gains on the basis of success in developing, producing and selling wind energy products and services.

4. Special Perquisites to WECS Business Investors Can Provide Additional Returns From Business Operations

Exhibit II-12 shows the four mechanisms for receiving profit returns:

- . Perquisites
- . Salary
- . Interest
- . Dividends.

Payments in the form of perquisites is the only mechanism which is not taxed as income (perquisites are business expenses such as automobiles, housing expense, country club memberships and the like which act as compensation to managers and owners). By permitting unusual perquisites to WECS business owners, the return on investment is enhanced.

5. Tax Incentives and Guarantees on Interest and Salaries Improve Financial Security to Lenders and Managers

Federal income taxes reduce the returns from interest on debt, and salaries, to owner/managers, as shown previously in Exhibit II-12. Incentives can provide security by guaranteeing interest or salaries, and can enhance returns by reducing or removing taxes:

- . Interest guarantees are complementary with debt repayment guarantees.
- . Interest subsidies (partial or complete) can replace total debt guarantees by reducing a portion of risktaking.
- . Salary guarantees or subsidies can be effective in providing security to entrepreneurs, but are unlikely to affect investment decisionmaking, however.

6. Federal Incentives Can Also Be Aimed at Reducing or Eliminating Double Taxation of Dividends to Enhance On-Going Investor Returns

Dividends are the most heavily taxed form of investment return. The typical example shown in Exhibit II-12 demonstrates that only 26 cents is

returned on the average dollar of before-tax income. Dividends can be improved at two levels of federal taxation:

- . Taxes on corporate income
- . Taxes on investor income from dividends.

Dividend incentives carry the same benefits as capital gains incentives--they reward success--but also the same problems of implementation--difficulty in classifying the portion of income which is derived from WECS in businesses with other products and/or services.

7. In General, the "Second Level" Incentives to Investors Can Be Categorized As Providing Capital, Reducing Risk, Improving Interim Returns, and Improving Ultimate Returns

Each type of investor incentive is designed to accomplish a different result:

- . Government funds can provide debt and equity capital when private perceptions of risk do not permit investment or lending.
- . Government guarantees of private debt serve to reduce the risk of lending to start-up businesses.
- . Special tax treatment of business profits enhance interim returns.
- . Removing taxes on capital gains and dividends are the mechanisms to reward success, by improving ultimate returns to investors.

Importantly, all major types of investor incentives (except those which affect capital gains and dividends) are "defensive" in nature since their purposes are to provide capital when it would not otherwise be available and to reduce investor risks. On the other hand, incentives for improving capital gains and dividends are "offensive" in nature since their purpose is to reward success.

In addition to first-level incentives on basic business opportunities and second-level incentives to investors, the federal government has a third option: to give direct incentives to improve business profits and performance.

(3) Incentives to Improve Business Performance Represent a Third Level of Government Involvement, and Can Be Designed for Investment, Costs, and Profits

The ultimate level of government incentives--short of direct ownership and operation--involves enhancing business operations, as illustrated in Exhibit II-13. These incentives go beyond the levels of providing business opportunity and stimulating investment, to the point of subsidizing business operations directly:

- . Investment funds can be provided for specific purposes:
 - Research and development
 - Market research
 - Business investment.
- . Fixed and variable costs of production can be subsidized:
 - Accelerated amortization and depreciation
 - Direct subsidy per unit produced.
- . Sales can be subsidized:
 - Market incentives
 - Direct price subsidy
 - Guaranteed market size.
- . Profits can be subsidized:
 - Direct total profit subsidy
 - Special tax deductions and credits.

The benefit of direct business incentives is that WECS industry growth is more closely controlled by public policy--although a majority of business executives might consider this to be a greater cost than benefit. In fact, decisions to implement incentives

EXHIBIT II-13
Federal Incentives Options
For Direct Business Involvement

INCENTIVES:

- PROVIDE R&D FUNDS
- PROVIDE FUNDS FOR MARKET RESEARCH
- PROVIDE FUNDS FOR BUSINESS INVESTMENTS:
 - MARKETING
 - PRODUCTION

INCENTIVES:

- SUBSIDIZE INDIVIDUAL COSTS
- SUBSIDIZE FIXED COSTS
- SUBSIDIZE VARIABLE COSTS
- SUBSIDIZE PROFIT PER UNIT

INCENTIVES:

- SUBSIDIZE WECS PRICE AND/OR FINANCING
- INCENTIVIZE MARKET WITH NON-ECONOMIC MEASURES
- GUARANTEE TOTAL MARKET SIZE

INCENTIVES:

- SUBSIDIZE TOTAL PROFIT
- PROVIDE TAX CREDITS
- REDUCE OR REMOVE INCOME TAX
- REDUCE COST OF CAPITAL
- SUBSIDIZE DEFERRAL OF CAPITAL REPAYMENT (DEBT)

EXHIBIT II-14
Diagram of Key Decision Points
For WECS Incentives Plan

at the level of business operations implies basic policy-making on the federal position as it relates to business enterprise.*

(4) Selecting the Type, Timing and Amount of Federal Incentives Must be Based on Finding and Providing Solutions to Pragmatic Business Problems

In the previous section, three levels of incentives were developed as a logical way of approaching new venture problems. To assess how these incentives can be implemented, Exhibit II-14, on the following page, presents a "decision tree" of issues and actions. Basic logic of the decision tree is presented as follows:

- . Preliminary studies are necessary to initiate any level of activity
- . First-level incentives (creating basic business opportunities) are nearly mandatory if the government is to accelerate the creation of an industry and market environment which is at all viable for private enterprise. Once the product (WECS) has been proved feasible and market potential (based on an identifiable need) is established, business activity should develop. If at that time it does not, public policymakers can conclude one of the following:
 - The product is still not proven
 - Market potential is still not indicated
 - Investment requirements to tap the potential market are too great for private investors

* Ultimate extension of business operating incentives is direct and complete involvement of the government by owning and operating WECS businesses. Since this policy is beyond the level of incentivizing private enterprise, it is considered to be beyond the scope of this report.

- Uncertainties on the market and business risks are too great to attract the needed capital

Public policy might extend to second-level incentives (stimuli for investors) if the likely evolution of industry is too slow to meet federal objectives.

Second-level incentives are directed to establish the fundamental capital base for business activity. Once this capital formation has occurred and businesses enter production and marketing, a level of sales and profitability should be reached. If at that time it does not, public policymakers can conclude one of the following:

- Product and market conditions which were assumed to exist do not, in fact, exist.
- The timing, amount and use of investments were incorrect
- Major specific barriers exist between the industry and its markets

Depending on the judgments at that time, any one of several incentive approaches may be taken to overcome the problems:

- First-level product/market incentives can be increased and/or redirected
- Second-level investment incentives can be increased and/or redirected
- Specific programs to overcome sales barriers can be undertaken
- Third-level incentives to improve (subsidize) business operations can be initiated

- . Third-level incentives are directed towards stronger government involvement in the profitability of individual WECS businesses. Future business problems are difficult to anticipate specifically and, for this reason, it is not possible to select appropriate actions in advance. However, the basic concept of third-level incentives is that other incentives for creating business opportunity and encouraging investors have failed or are judged to be inadequate, and the only recourse is direct business subsidy.

It is important to recognize that the preceding discussion is based on the view of incentives that they can be characterized as having different levels of government involvement in the process of business ownership and management. A separate matter is, however, the distinction between the business problems of small companies as they compare to larger, established companies.

(5) The Choice of Federal Incentives Will Depend, in Part, on Policy Choices Regarding the Role of Small Business in the WECS Industry

Large, established companies have financial resources, managerial and technical talent, and production and marketing capabilities to move quickly into wind energy business ventures. Small companies, on the other hand, have the capability for innovation which is often not possible in larger corporate environments. For these reasons, executives in the wind energy industries express the view generally that both types of firms have important roles in the emerging industry.

However, it is also accepted generally that when WECS markets enter growth phases, the small companies will not be able to compete for mass markets due to lack of resources. Under such conditions, small companies can be expected to:

- . Bankrupt or liquidate
- . Merge or be acquired by larger firms
- . Remain intact and specialize in a unique product or market niche.

Further, during the period between business formation and market development (early sales) a significant fraction of small businesses can be expected to fail, for a variety of reasons:

- . Lack of sustaining capital
- . Technical (product) failures
- . Managerial problems (incorrect use of financial and other resources)
- . Faulty market strategies.
- . Other business problems.

Of course, larger companies are prone to the same problems, but adequate resources and management can often correct or mitigate the effects.

Specifically, new small businesses have a number of common problems which can be overcome, in part, by federal policy and incentives:

- . Difficulty in raising debt capital can be overcome by loan guarantees and low interest (subsidized) loans.
- . Difficulty in raising equity capital can be overcome to some degree by removing tax on capital gains.
- . Provision of sustaining cash flow can be achieved through any of the capital-attracting incentives and through federal aid in generating revenues (federal purchases, special small business RD&D programs, or other programs).
- . Provision of elements of "competitive advantage" can be achieved by special attention to protecting small business patent rights and by subsidizing patent application expenses.

While incentives that overcome these four key problems may also aid larger firms, it is considered in the industry that larger firms are affected more directly by preparation (RD&D) of the technology and stimulation of substantial markets for WECS.

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This chapter has described the mature Technology Delivery System, discussed its likely evolution over time, identified key problems which are most likely to occur during the evolution, and developed and assessed a plan of federal incentives to accelerate the industry's growth. It has been concluded that federal incentives should be planned to overcome pragmatic business problems as they relate to public policy objectives. The resulting incentives plan is based on three levels of government involvement in WECS private enterprise, with separate consideration of incentives for small business development.

The following chapter focuses on incentives for the utility market for WECS, and is the first of four chapters which develop incentives plans for major potential markets.

III. INCENTIVE ANALYSIS OF THE UTILITY WECS MARKET

This chapter presents the analysis of various economic incentives as they relate to the WECS utility market. In presenting this analysis the chapter has been organized into three sections:

- . The process by which utilities assess alternative investments
- . The approach and methodology used to evaluate the impact of economic incentives on the utility WECS market, and an analysis of the impact of economic incentives on utility WECS economics
- . A discussion of the current status of WECS development and those economic incentives judged most effective in promoting WECS.

This section does not evaluate the detailed economics of specific utility applications of WECS. DOE has focused a considerable effort and number of contracts in this area; this study has not attempted to duplicate this work. What this chapter is directed at is evaluating the potential impact on WECS cost-effectiveness of various economic incentives, and under what conditions they are likely to be useful.

1. THE PROCESS BY WHICH UTILITIES ASSESS ALTERNATIVE INVESTMENTS INCLUDES AN EVALUATION OF THE STATE OF THE TECHNOLOGY AS WELL AS ITS RELATIVE ECONOMICS

(1) Utilities Require That a Technology Satisfy Certain Operating Criteria Before Purchase is Con- sidered

Utilities, like any other business, must have a high degree of assurance that a system which they invest in will meet certain minimum operating standards and criteria. In fact, since utilities are heavily regulated by numerous economic, financial, and technical authorities at the state and federal levels,

these standards are almost always higher than for other types of business, i.e., utilities must always be prepared to prove that their investments are financially sound and in the long term best interests of their customers.

Standards must be met in order for the utility to earn the required return on its investment, and to satisfy the energy needs of its customers. These minimum standards include:

- . Technical reliability criteria as measured by plant availability, capacity factor, or some similar measure
- . Safety requirements such that normal operation of the facility will not result in either property damage or personal injuries
- . Durability, e.g., assurance that the device and its major equipment components will operate over its designed lifetime.

In order to satisfy these criteria the technology under investigation must be observed to have operated up to these minimum standards under realistic demonstration conditions. These observations, particularly when utilities are involved, should take place over a time period of several years, and include a diversity of demonstration sites.

To date, WECS have not as yet satisfied these criteria. Test data are only now being accumulated from the Mod 0 and the early Mod 0A facilities. The Mod 1 facility, at the MW scale most likely to be used by the larger utilities, is still in the construction stage and more advanced and potentially more cost-effective concepts are still in their design stages. Thus, WECS do not presently satisfy the initial investment criteria that almost all utilities will require for a new technology. The implications of the technological status of WECS to the use of various economic incentives will be discussed in subsequent sections of this chapter.

(2) Utilities Use A Revenue Requirements Analysis in Evaluating the Relative Economics of a System After Its Technical Acceptability Has Been Determined

Revenue Requirements are established by determining the cost associated with each expense or income category. In establishing revenue requirements or the cost of energy associated with investing in a new generation project, the following individual cost components are initially determined:

- . Operating and maintenance (O&M) costs
- . Non-income taxes, primarily property taxes
- . Depreciation
- . Interest charges, primarily on long-term debt
- . Net operating income, including income taxes and return on preferred and common equity.

Operating and maintenance costs, non-income taxes, and depreciation are essentially fixed expenses over which a utility has little control. Operating and maintenance expenses depend on the specific technology under evaluation. Non-income or property taxes depend on the locale in which the facility will be installed. Depreciation is dependent on the accounting technique utilized, i.e., straight line or some form of accelerated depreciation.

Interest charges depend on the percentage of the investment financed through use of long-term debt and the cost of this source of financing to the utility.

Net income, which includes return on preferred stock and common equity, is determined based on the amount of preferred stock and common equity financing used as a percent of of total investment and its associated cost to the utility.

Income taxes are based on initially determining the net income necessary to support an investment and then calculating the Federal and state income taxes which must be paid relative to this net income requirement.

Overall revenue requirements on a project basis are thus determined by:

- . Arriving at net income requirements
- . Calculating income taxes by dividing net income requirements by one less the effective Federal and state income tax rate
- . Combining net income and income taxes to determine net operating income requirements
- . Adding interest charges, depreciation, non-income taxes and operating and maintenance costs to net operating income to arrive at an overall revenue requirement for the proposed investment. These are tax deductible items, thus they are added in only after net operating income levels have already been established.

Revenue requirement determination is thus a bottom up approach where individual investment and income accounts are determined to establish a minimum overall revenue level needed to support a specified choice of additional generation capacity. Energy costs associated with a specific investment are calculated by dividing revenue requirements by the energy output of the proposed facility. A more complete discussion of revenue requirements calculation is presented later in this chapter.

The utility "rational decision model" is based primarily on a comparison of alternative projects' revenue requirements. In evaluating investment options in alternative technologies, utilities perform a revenue requirements analysis for each proposed option. Because utilities are a regulated industry their decision regarding investment in alternative technologies is based on the following factors:

- . Providing reliable service to customers
- . Satisfying stockholder return requirements and meeting debt (creditor) obligations
- . Providing energy to customers at as reasonable or as low a level as possible consistent with the two requirements stipulated above.

In attempting to provide energy at a reasonable cost, utilities will choose to invest in that technology which has the lowest overall revenue requirement level. Thus, all else being equal i.e.:

- . Each technology having a demonstrated operational capability
- . The alternatives having similar characteristics (i.e. load factor) and applications,

the utility "rational decision model" is primarily defined as choosing the system which has the lowest overall revenue requirements.

* * * *

This section has presented an overview of the revenue requirements approach used in utility decisionmaking; the subsequent section provides a detailed description of how the various components which comprise revenue requirements are calculated, and how they are affected--individually and in combination--by various economic incentives.

2. A METHODOLOGY FOR EXAMINING THE IMPACT OF GOVERNMENT INCENTIVES ON UTILITY WECS REVENUE REQUIREMENTS HAS BEEN DEVELOPED

(1) Fixed Costs and Revenue Requirements Are Affected by the Ownership Characteristics of the Utility.

Investor-owned utilities generate more than 75% of U.S. electricity and, because they are regulated on a state-by-state basis, represent a heterogeneous target for government WECS incentives. While each of these companies has a unique capital structure and the accounting standards adopted by each vary, virtually all of the roughly 250 utilities which generate power evaluate alternative generation proposals on the basis of revenue requirements or on some modification of this methodology (such as discounted cash flow analysis).

Publicly-financed utilities fall into three categories:

- . Federal Systems (e.g. TVA)
- . Public Non-Federal Systems (e.g. municipals)
- . Cooperative (Co-op) Systems.

Of the Federal Systems, TVA is the only one with the mandate to supply all electric power within an established service area. The others (the Bonneville, Southwestern, Southeastern, and Alaska Power Authorities and the Bureau of Reclamation) supply bulk power for distribution through non-Federal systems. These systems are 100% debt-financed and have no taxable income. They are exempt from property taxes but may make payments in lieu of taxes. Federal systems accounted for 12% of marketed electric power production in 1970.

Public non-federal systems generated roughly 9% of U.S. electricity in 1970. This category encompasses municipal and county systems and also certain state authorities such as the Power Authority of the State of New York (PASNY). Financing non-federal systems differs from the federal ones primarily in that interest from their bonds is exempt from federal tax; accordingly, these systems have access to lower cost financing.

Cooperative systems originally developed as a mechanism for providing distribution networks in rural areas where standard utility financing would make the costs of these systems prohibitive. The Rural Electrification Administration (REA) was created to provide a mechanism for funding distribution systems (and generation systems, where bulk power was not available) at low interest rates. Until 1973 all loans were made at a standard 2% interest rate. Since then, the 2% loans have been restricted to distribution systems with less than two customers per mile of line and in special cases (e.g., disasters, etc.) as determined by REA. In more densely populated systems, loans are provided at a 5% interest rate. Qualifying generation projects are financed at "competitive rates" (exempt from federal taxation--normally between 8-9.5% interest) through the aegis of the Loan Guarantee Authority. Co-ops generated less than 2% of the marketed electricity in 1970 but served 8% of the electric customers, relying on other systems for the bulk of their generation requirements.

Co-ops pay state and local property taxes, sales taxes, and may pay other taxes on gross revenues, etc., depending on local tax laws.

(2) Revenue Requirement Calculations Permit a Close Approximation to Be Made of the Impact of Various Government Incentives on Utility Generation Costs

Because the revenue requirements methodology permits an exact accounting to be made of the levelized revenues which generation projects must produce to cover

- . . . Return on capital
- . . . Depreciation
- . . . Income taxes, and
- . . . Operation and maintenance expenses,

application of this technique allows a close approximation of the impact of various incentives on the utility's cost of WECS operation.

Return on capital refers to the revenues a project must generate to repay creditors and stockholders for their capital investments in the utility. Obviously, the capital structures of individual utilities vary substantially as a result of past managerial decisions. This term, also referred to as the "Weighted Average Cost of Capital" (WACC), is calculated as follows:

$$k = k_c \frac{C}{V} + k_p \frac{P}{V} + k_d \frac{D}{V} \quad (\text{Eqn. 1})$$

where

- k: Weighted Average Cost of Capital (%)
- k_c : Return on common equity (after taxes; %)
- k_p : Return on preferred equity (after taxes; %)
- k_d : Interest on outstanding debt (%)

$\left. \begin{array}{l} \frac{C}{V} \\ \frac{P}{V} \\ \frac{D}{V} \end{array} \right\}$ Fractions of the company's capital structure made up of common equity, preferred equity, and debt, respectively.

The cost of capital values are established in the marketplace and are determined by investor's perceptions of the prospects and risks of each utility relative to other investment opportunities.

Depreciation refers to the revenues each project must produce to repay the capital invested in it over its service life. On a company's internal books, this term is generally calculated as the annuity, reinvested at the company's weighted average cost of capital, which will exactly equal the plant's installation cost at the end of its service life. Thus, revenue requirements for depreciation may be calculated as follows:

$$i = \frac{k}{(1 + k)^n - 1} (100\%) \quad (\text{Eqn. 2})$$

where

- i: Revenue requirement for book depreciation (%)
- k: WACC (expressed in decimal form)
- n: Service life in years.

In actual practice, utilities will not assign a precise value to the service life (n), but will describe "n" by a range of values corresponding to the probabilities that the plant will either outlive its expected lifetime or become obsolete before that time. Since no data exist with which to estimate probable lifetimes of modern utility-scale WECS systems, a discrete value (n = 20 years) will be used throughout this analysis.

Income taxes refer to the revenues that the project will need to produce to cover federal and state income tax liabilities incurred over its lifetime. Revenue requirements analysis provides an exact tool for measuring the impact of the various federal incentives which have been--and are being--offered to encourage corporate capital investment. Revenue requirements for income taxes are calculated as follows:

$$T = \frac{t}{100 - t} \left\{ (k + i - i_b) \left(1 - \frac{\frac{D}{V} k_d}{k} \right) + (i_b - i_t) - \frac{IC(k + i)}{100 + i} \right\} - \frac{IC(k + i)}{100 + i} \quad (\text{Eqn. 3})$$

where

- T: Revenue requirements for income taxes (%)
- t: Combined Federal/State income tax rate (%)
- k: Weighted average cost of capital (%)
- i: Revenue requirements for depreciation (%)
- i_b : Book depreciation annuity (1%)
- $\frac{D}{V}$: Debt fraction of company's capital structure
- k_d : Interest rate on debt (%)
- i_t : Tax depreciation annuity (%)
- IC: Investment tax credit (%)

Two points should be emphasized here. First, the calculation of T used throughout this analysis assumes "flow-through" accounting; that is, the reduction in taxes resulting from accelerated tax depreciation allowances (i_t) will flow through the company's accounts and will appear as increased earnings on the balance sheet during early years of the project's life. An alternative accounting convention, referred to as "normalized" accounting, tends to average out the tax advantages of allowing accelerated tax depreciation over the project's lifetime. This reduces the tax advantages of accelerated depreciation; revenue requirements for income taxes assuming normalized accounting may be calculated as shown:

$$T = \frac{t}{100 - t} \left\{ \left[(k + i - i_b) + \frac{t}{100} (i_b - i_t) \right] \left(1 - \frac{\frac{D}{V} k_d}{k} \right) - \frac{IC (k + i)}{100 + i} \right\} + \frac{t}{100} (i_b - i_t) - \frac{IC (k + i)}{100 + i} \quad (\text{Eqn. 4})$$

The other important caveat which should be noted here is that the analysis presupposes that the utility does, in fact, have taxable income. This is not the case for every investor-owned utility, and for those utilities without taxable income, providing income tax incentives such as the investment tax credit and liberalized depreciation may have little or no impact on investment decisions.

The final revenue requirement category, operation and maintenance, includes property taxes, insurance, periodic servicing and repairs, and administrative (overhead) costs. These costs may be expected to escalate over time. To determine revenue requirements, it is necessary to convert the escalating series of payments into an equivalent levelized annual series. This may be done as follows:

$$O\&M = \left(\frac{1}{1+k} \right) \left[\frac{1 - \frac{1+r}{1+k}^n}{1 - \frac{1+r}{1+k}} \right] \left[\frac{k(1+k)^n}{(1+k)^n - 1} \right] \frac{A}{Y} \times 100\% \quad (\text{Eqn. 5})$$

where

- O&M: Revenue requirements for operation and maintenance (%)
- k: WACC (expressed as a decimal)
- r: Annual escalation rate (expressed as a decimal)
- n: Service life in years
- A: First year O&M expenses
- Y: Installed capital cost of the plant

This section has presented the analytical basis for the utility sector WECS incentive analysis. The analytical techniques and definitions employed in this section were adopted from: Jeynes, Paul H., Profitability and Economic Choice (Iowa State University Press, copyright 1968), a standard text on this subject. The next section will produce base case revenue requirements estimates and will present a methodology for examining various incentive strategies.

(3) Building on the Revenue Requirement Methodology, a Graphical Technique Has Been Developed Which Permits Rapid Estimation of the Impact of Government Incentive Strategies

Representative base case revenue requirements estimates have been made for each of the utility markets described in the preceeding section. These estimates are tabulated in Exhibit III-1. This section will present a methodology by which the impact of government WECS incentives on revenue requirements can rapidly be estimated for each utility market.

To a first approximation, utilities evaluate competing generation alternatives purely on the basis of each alternative's revenue requirements, assuming that each alternative will provide identical benefits. By choosing the alternative with the lowest revenue requirements, utilities will minimize electric rates and--in the case of investor-owned systems--maximize profits to their owners. More realistically, utilities choose between generation alternatives on the basis of supplying system load at minimum system revenue requirements, at some specified level of reliability.

The value of WECS generation to each utility can be estimated to be equal to the revenue requirements for WECS such that system revenue requirements are equal to that for the least costly alternative system plan. This value may be expected to vary depending on the existing system's generation and distribution configuration, its load, and on a variety of other system-dependent variables. If calculated revenue requirements for WECS are higher than their value to a particular system, the utility would not be likely to select WECS in the absence of incentives. It must be noted that such an estimate is an extreme oversimplification of actual utility financial decisionmaking with respect to WECS. However, the detailed analysis that a utility would actually go through, including:

- . An assessment of local wind speeds (including correlations, if any, with loads)
- . A detailed evaluation of load and existing generation capacity

- . An evaluation of capital and operating costs associated with alternative future generation "mix" options

is beyond the scope of this study and is not necessary to illustrate the impact of economic incentives on the process.

Exhibit III-2 presents base case revenue requirements (in mills/kWh) for the four utility markets, assuming an average WECS capacity factor of 30% (the actual value will vary with wind speed characteristics) over a range of installed capital costs).

Assuming that installed costs are determined to be too high for WECS to be selected under base case financing assumptions, a variety of incentive options exist which would be applied to reduce WECS revenue requirements. The following economic incentives were analyzed in this study:

- . Direct cash subsidy
- . Low interest loans
- . Exemption/refund of property taxes
- . Investment tax credit (investor-owned utilities only)
- . Accelerated depreciation (investor-owned utilities only)

The analysis developed is targeted on achieving some required percentage reduction in capital-related revenue requirements within each utility market. This approach was taken because:

- . Actual installed costs of utility WECS systems are unknown at present.
- . WECS O&M charges other than for property taxes are speculative, and since government action is unlikely to affect them, these charges were excluded from the incentives analysis.
- . The value of WECS generation to individual utilities will, as discussed above, vary with each utility and is not known at present.

EXHIBIT III-1
Base Case Revenue Requirements for the
Electric Utility WECS Market⁽¹⁾

	Investor Owned	Federal	Public Non-Federal	Cooperative
Return on Capital (% capitalization; cost)				
Debt	50%; 8%	100%; 8%	100%; 6%	100%; 8.75%
Preferred Equity	12%; 8.5%	--	--	--
Common Equity	38%; 12%	--	--	--
WACC (k)	9.58%	8%	6%	8.75%
Depreciation (i) (20-Year Project Life)	1.83%	2.19%	2.72%	2.01%
Income Taxes (T) (See Note (2) Below)	1.88%	--	--	--
Annual Expenses (See Note (3) Below)				
Property Taxes	2.86%	--	--	2.89%
Payments in Lieu of Taxes	--	2.92%	3.01%	--
Operation and Maintenance	2.86%	2.92%	3.01%	2.89%
Total Revenue Requirements	19.01%	16.03%	14.74%	16.54%

Notes: (1) Based on Methodology in Preceding Section

(2) Book Depreciation Rate = 5%

(3) Property Taxes, Payments in Lieu of Taxes, and Operation/Maintenance Expenses are levelized revenue requirements based on a 2% first-year charge, escalating 5% annually over the 20-year system life.

EXHIBIT III-2
Base Case Revenue Requirements for WECS

Exhibits III-3 through III-6 present nomographs which permit varieties of incentive strategies to be developed to achieve predetermined reductions in capital-related revenue requirements for the four utility markets. Briefly, the steps in the analysis are as follows:

- . Determine base case WECS revenue requirements (r_b) from Exhibit III-2 (mills/kWh);
- . Determine (or estimate) the maximum revenue requirements at which WECS will be competitive (r_r ; mills/kWh);
- . Calculate the reduction in revenue requirements which must be achieved to make WECS competitive as shown (r_n ; mills/kWh):

$$r_n = r_b - r_r;$$

- . Calculate the capital-related revenue requirements (r_y) from the formula

$$r_y = \frac{Y R_Y}{867(CF)}$$

where

r_y : Capital-related revenue requirements (mills/kWh)

Y: Installed capital cost (\$/kW)

R_Y : Capital-related revenue requirements rate (% of capital cost per year)

- Investor-owned utilities,
 $R_Y = 16.15\%$
- Federal systems, $R_Y = 13.11\%$
- Public non-federal systems,
 $R_Y = 11.72\%$
- Cooperative systems, $R_Y = 13.65\%$

CF: WECS capacity factor (decimal; base case value = 0.3)

Calculate the total reduction in capital-related revenue requirements (T_{cc}) which the incentives must achieve to equate r_b with r_r as shown:

$$T_{cc} = \frac{r_n}{r_y} (100\%)$$

where

T_{cc} : Total reduction in capital-related revenue requirements (%)

On the appropriate incentives nomograph (Exhibits III-3 through III-6), locate T_{cc}

Beginning at the "other end" of each nomograph and proceeding in a clockwise direction, map out incentive strategies which achieve the required reduction. The rules which must be followed in mapping out strategies are as follows:

- Travel around the nomograph must be either horizontal or vertical
- One option must be selected in each incentive quadrant, either the base case or some level of incentive, and at that point a 90° (clockwise) change of direction must take place
- Each path so selected must end at the required T_{cc} .

Intermediate incentives (i.e. a 33% direct purchase subsidy) are acceptable; discrete options are mapped out solely for reference purposes.

Exhibit III-7 demonstrates the use of these nomographs. For an investor-owned utility, the impact of an incentive strategy including

EXHIBIT III-4 Incentives Analysis Nomograph for Cooperative Utilities

EXHIBIT III-5 Incentives Analysis Nomogram for Publicly Financed Federal Utilities

EXHIBIT III-6
Incentives Analysis Nomogram for
Publicly Financed Nonfederal Utilities

EXHIBIT III-7
Use of Incentives
Analysis Nomograph

- 20-year sum-of-years'-digits tax depreciation
- 20% investment tax credit
- 8% loan
- 10% direct cash subsidy
- Property tax exclusion

is illustrated.

It may readily be seen from the Exhibit that the combined impact of this strategy is a 54% reduction in base-case capital-related revenue requirements.

(4) The Impacts and Costs of Each Economic Incentive Vary Due to the Different Processes by Which They Operate

An analysis was performed on the relative cost to the government of effecting a 1% reduction in investor-owned utility capital-related revenue requirements through

- . Providing direct cash subsidies
- . Increasing the investment tax credit
- . Providing low-interest loans
- . Allowing accelerated depreciation and
- . Eliminating property taxes

on WECS systems. This section examines the manner in which each incentive enters the utilities' revenue requirement calculations, and calculates governmental costs for each option.

. Direct cash subsidies

Direct subsidies were assumed to take place through governmental provision of some percentage of installed capital cost of the WECS unit(s) installed by each participating utility. Each unit was assumed to enter the rate base at the utility's actual capital investment. Accordingly, revenue requirements for

- Depreciation
- Return of capital and
- Income taxes

were assumed to be reduced by the fraction of capital invested by the government. Property taxes, which are typically levied by state or local government, were assessed on the full capital investment. On this basis, a 10% direct cash subsidy was evaluated as follows (refer to Exhibit III-1 for base case assumptions):

- Depreciation: $.9(1.83\%) = 1.65\%$
- Return on capital: $.9(9.58\%) = 8.62\%$
- Income taxes: $.9(1.88\%) = 1.69\%$
- Property taxes: 2.86%
- Total capital-related revenue requirements: 14.82%

The revenue requirement reduction, then, amounts to 1.33%, or 8.2% of the base case revenue requirements (16.15%). Base case revenue requirements for operation and maintenance expense were estimated to be an additional 2.86% so the net effect of a 10% direct cash subsidy would reduce total generation costs by 7.0%. The cost to the government for this case would be its investment in the subsidy, or 10% of the installed capital cost. Thus, for each percent reduction in revenue requirements, 1.43% of the installed capital cost would have to be provided through direct cash subsidies. Thus the government would have to supply 14.3% of the WECS capital costs to reduce overall revenue requirements by 10% (The excess needed to offset O&M, property taxes, etc.). The application of a direct cash subsidy will also have a directly proportional impact on reducing other incentives (with the exception of property tax elimination) impacts on revenue requirements.

Note that this calculation assumes that the government subsidy is not subject to income taxes. An alternative would be to treat the subsidy as miscellaneous income and enter the entire plant into the rate base.

Investment tax credit

The investment tax credit enters the utilities' books as a reduction in the first year's tax liabilities. Since current tax law already permits a 10% credit, an effective WECS credit would require an increase above this base rate.

The capital exempted from tax liabilities is then presumed to be reinvested in income-producing assets (which are, in turn, subject to later tax liabilities), but the net effect of increasing the tax credit beyond 20% would be that this future reinvestment would produce income sufficient to more than cover the original plant's revenue requirements for income taxes. Accordingly, the investment tax credit provides a potent incentive for those utilities which have taxable income.

For the base case, by using Equation 3 the impact of a 20% investment tax credit is calculated as follows:

$$\begin{aligned}\text{Income taxes (\%)} &= \frac{.52}{1-.52} \left\{ (9.58 + 1.83 - 5.00) \left(1 - \frac{8(.5)}{9.58} \right) + \right. \\ &\quad \left. (5.00 - 5.00) - \frac{20 (9.58 + 1.83)}{109.58} \right\} - \frac{20 (9.58 + 1.83)}{109.58} \\ &= -.29\%\end{aligned}$$

Therefore:

- Depreciation = 1.83%
- Return on capital = 9.58%
- Income taxes = -0.29%
- Property taxes = 2.86%
- Capital-related revenue requirements = 13.98%

and total revenue requirements (including O&M) equal 16.84%.

Governmental costs from the investment tax credit were calculated to be lost tax revenues at the end of the first year, discounted one year to arrive at a net present cost. For the examples above, the costs are calculated as follows:

$$10\% \frac{1}{1.10} = 9.09\%$$

Exhibit III-8 compares the cost effectiveness of increasing levels of investment tax credit.

Low-interest loans

Low-interest loans were assumed to enter the utilities' books solely as a lowering of the cost of capital for the WECS unit. Units were assumed to enter the rate base as though they were conventionally financed otherwise. Implicit in this treatment is the assumption that the utility is taking a risk in investing in WECS; otherwise, WECS generation would be viewed by the utility as purchased power.

A 6% loan is evaluated as follows:

- Depreciation = 1.83%
- Return of loan = 6%
- Income taxes = 1.88%
- Property taxes = 2.86%
- Capital-related revenue requirements = 12.57%
- Total revenue requirements = 15.43%

Thus, a 6% low-interest loan would reduce base case revenue requirements by 18.8%.

Costs to the government may be calculated from the formula:

$$C(\%) = \left\{ 1 - r \left(\frac{(1+i)^{n-1}}{1(1+i)^n} + \frac{1}{(1+i)^n} \right) \right\} 100\% \quad (\text{Eqn. 6})$$

EXHIBIT III-8
Government Incentive Cost and effectiveness:
Utility Investment Tax Credit

Investment Tax Credit	Utility Revenue Requirements		Government Cost**	Government Cost** per 1% RR Reduction
	%	% Reduction		
10%*	19.01	0	9.09	--
20%	16.84	11.4	18.18	1.59%
30%	14.67	22.8	27.27	1.20%
40%	12.50	34.2	36.36	1.06%
50%	10.33	45.6	45.45	1.00%
60%	8.16	57.1	54.55	.96%
70%	5.99	68.5	63.64	.93%
80%	3.82	79.9	72.73	.91%
90%	1.65	92.3	81.82	.89%
100%	-0.52	102.7	90.91	.89%

* Base Case

** "Cost is expressed as a percentage of WECS installed capital cost (note that cost to government is deferred one year beyond WECS in-service date, discounting the cost accordingly).

where

C: Loan cost to the government as a percentage of the loan principle (installed capital cost)

r: Loan interest rate (decimal form)

i: Government discount rate = 0.1

n: Loan term (20 years)

For $r = .06$, $C = 34.1\%$; therefore, the cost to the government of reducing utility WECS revenue requirements 1% through a 6% loan would amount to 1.8% of the installed system cost.

Accelerated depreciation

Accelerated (or "liberalized") depreciation permits utilities to defer their income tax liabilities by depreciating the bulk of their investment in WECS during the early years of its life. This reduces income taxes and increases cash flow during the early years of a project's life, allowing productive use of the capital until the liabilities ultimately become due. For the government, on the other hand, liberalized depreciation means a deferral in receipt of its tax revenues.

Calculating benefits and costs to both parties involves calculating the present value of taxes payable and due, respectively. For the utilities these streams are converted to an equivalent levelized annuity for revenue requirement calculations; for the government revenues are computed as net present values.

A number of accelerated depreciation schedules are in current use; the most common of these are the sum-of-years' digits and double-declining balance schemes. Sum-of-years was selected for this analysis because annual payments could be unambiguously calculated. Double declining amortization would not yield substantially different results.

Increasing levels of liberalization were provided by shortening the depreciation term while the system life was held constant. In the extreme case, utilities were permitted to expense WECS units in their first year of operation for tax purposes while maintaining them on their books for the full 20 years service life for rate purposes.

Exhibit III-9 demonstrates how accelerated tax depreciation enters the calculation of revenue requirements for income taxes via the utilization of Equation 3. As in the case of the investment tax credit, it may readily be seen that accelerating depreciation beyond a certain point results in an elimination of these tax requirements.

Accelerated depreciation differs from the investment tax credit in that it represents a deferral, rather than an elimination of governmental tax revenues. The cost to the government of providing this incentive is thus the difference in the net present value of tax revenue streams under base case and accelerated depreciation rules, as shown in Exhibit III-10.

Accelerated depreciation can be an effective incentive mechanism given two conditions:

- That the depreciable life on the WECS facility can be reduced significantly as compared to its actual operating life
- That the utility has taxable income against which the accelerated depreciation can be credited. This situation is similar to the condition which exists with the investment tax credit incentive.

Given these above conditions, government costs can be as low as roughly 0.5% of installed capital costs for each 1% reduction in total utility requirements.

EXHIBIT III-9
Calculations for the Impact of Accelerated Depreciation
on Revenue Requirements for Income Taxes

Basic formula (assumes "flow-through" accounting):

$$T\% = \frac{t}{100 - t} \left[(k + i - i_b) \left(1 - \frac{\frac{D_i}{V} k_d}{k} \right) - (i_t - i_b) - \frac{IC(k + i)}{100 + k} \right] - \frac{IC(k + i)}{100 + k}$$

t = Combined Federal/state income tax rate (52 percent)

k = Weighted average cost of capital (9.58 percent)

i = Depreciation annuity (1.83 percent)

IC = Investment tax credit rate (10 percent)

i_b = Book depreciation rate (100/N or 100/20 = 5.00 percent)

i_t = Tax depreciation rate, defined by:

$$i_t = (k + i) \sum_{x=1}^N D_x \frac{1}{(I)^x}, \quad I = 1 + \frac{k + i}{100}, \quad D_x = Y: \text{ (fraction depreciated in year } x \text{)}$$

Depreciation Schedule	i _t	T (%)
20-Year Straight Line	5.00	1.88
20-Year S.O.Y.D.*	6.30	0.35
15-Year S.O.Y.D.	7.15	-1.81
10-Year S.O.Y.D.	8.10	-3.44
5-Year S.O.Y.D.	9.28	-5.46
Fully Expense in Year 1	10.41	-7.40

*Sum-of-Years'-Digits

EXHIBIT III-10
Calculation of Governmental Cost of Providing
Accelerated Tax Depreciation Incentives

$$PV_{gc} = Y \frac{(t)}{100} \sum_{x=1}^N (D_{x,a} - D_{x,b}) \frac{1}{(1 + i_g)^x}$$

(Eqn. 7)

PV_{gc} = Present value of governmental acceptance of deferred tax revenues

Y = Installed capital cost of WECS

t = Combined Federal/state income tax rate (52 percent)

$D_{x,a}$ = Dollar value of accelerated depreciation during year x

$D_{x,b}$ = Dollar value of base case depreciation during year x ($\frac{Y}{20}$ dollars)

i_b = Governmental discount rate (0.1)

If $Y = \$100$, then

Tax Depreciation Schedule	PV_{gc}
20-year straight line	0
20-year S.O.Y.D.*	\$ 6.31
15-year S.O.Y.D.	\$ 9.91
10-year S.O.Y.D.	\$14.32
5-year S.O.Y.D.	\$19.78
Fully expense in Year 1	\$24.26

* Sum-of-years'-digits

Property tax elimination

Property taxes are normally levied by state or local government; therefore, elimination of these taxes would cost the Federal government nothing (unless, of course, one postulates a federal reimbursement program). The cost to state and local governments, assuming they also use a 10% discount rate, may be computed as the net present value to them of the loss of tax revenues. Therefore:

$$C(pt) = \frac{1}{(1+i)} \left[\frac{1 - \frac{1+r}{1+i}^n}{1 - \frac{1+r}{1+i}} \right] R \quad (\text{Eqn. 8})$$

where

C(pt): Cost to government of property tax exemption

i: State/local discount rate (assumed = .1)

r: Annual escalation rate for property taxes (= .05)

n: WECS system life (= 20 years)

R: Year 1 property assessment (=2%)

Therefore C(pt) = 24.2% for the base case. Elimination of this tax reduces base case revenue requirements by 15.0%. Thus, state and local governments would give up tax revenues equivalent to 1.61% of the WECS capital cost for each percentage reduction in utility WECS revenue requirements.

To demonstrate the calculation of incentive impacts, Exhibit III-11 presents the calculation of revenue requirement reductions from the incentive strategy evaluated graphically in Exhibit III-7. It may be seen that the graphical and analytical methodologies agree closely (54 vs. 54.7 percent reduction, respectively), even for this very complicated strategy.

This section has discussed the application of WECS incentives to the investor-owned utility sector, and has presented an analysis for calculating governmental costs for each incentive. These costs were then normalized on the basis of effecting a 1% reduction in total WECS revenue requirements. The cost to government (as a percentage of WECS installed capital costs) for each incentive is summarized as follows:

- . Direct cash subsidy: 1.43%
- . Investment tax credit: 0.9 - 1.5%
- . Low-interest loans: 1.7 - 2.8%
- . Accelerated depreciation: 0.5%

(5) The Investment Tax Credit and Accelerated Depreciation Appear to Be the Most Effective WECS Economic Incentives Relative to the Investor-Owned Utility Sector

In developing conclusions regarding which economic incentives are the most appropriate in the WECS investor-owned utility market various factors need to be taken into consideration, including items which do not directly relate to relative economic impacts. These factors include:

- . The institutional acceptability of the incentive
- . The difficulties associated with implementing and administering each economic incentive.

When these two factors are combined with the relative impacts on WECS cost-effectiveness, it becomes apparent that the investment tax credit and accelerated depreciation are the most appropriate economic incentives to the WECS investor-owned utility market since:

- . These two incentives apparently cost the government less relative to expected impact on WECS cost-effectiveness than do the other economic incentives
- . The investment tax credit allowances and accelerated depreciation schedules are incentives which are currently being used by the utility industry.

- . The investment tax credit and accelerated depreciation incentives can be administered through the IRS, thus no new bureaucratic agency or department need be created.

- . The investment tax credit and accelerated depreciation do not represent direct expenditures or subsidies in the part of government to the utility industry, as do the other incentives. Rather, these incentives are generally excepted mechanisms recognized for their capability to increase internally generated funds, raise corporate levels of profitability, and stimulate increased investment.

The single biggest disadvantage associated with these two incentives, as stated previously, is that in order for them to be effective, the electric utility considering the WECS investment must be paying Federal income taxes.

The other three incentives applicable to the WECS utility market--direct cash subsidies, low-interest loans, and property tax elimination--do not have to satisfy this condition, although if a utility is paying little or no income taxes, it is unlikely to be profitable enough to afford to invest in a technology which is in a developmental stage similar to that associated with WECS. These incentives have the apparent disadvantages of:

- . Having a greater cost to the government relative to expected economic benefits
- . Taking the form of direct payments or being direct subsidies to utilities
- . Requiring the formation of a new group or bureaucracy to evaluate and administer the incentives.

(6) The Effectiveness of Loan, Purchase and Property Tax Exclusion Subsidies On Publicly Financed Utilities Is Calculated in Much the Same Way Investor-Owned Utilities Case

The three publicly-financed utility markets differ from each other only in the selection of their base cases. Since income tax incentives are irrelevant for these utilities, the analytical complexity of examining the incentive options is greatly reduced.

The analytical foundation, built on revenue requirements analysis, is also identical to the analysis for investor-owned utilities. Accordingly, the impact of the incentives will be presented in summary form only.

- . Exhibit III-12 presents the results of the loan incentive analysis for publicly-financed utilities,
- . Exhibit III-13 presents the direct cash subsidy analysis, and
- . Exhibit III-14 evaluates the impact of payments-in-lieu-of-taxes exclusions.

From this analysis, it is apparent that the incentives options for the publicly-financed utilities do not have as significant an impact as they do in the investor-owned utility sector. This occurs because their operations are already heavily subsidized and few additional options remain which could be uniquely applied to WECS.

* * * *

This section has evaluated the specific impacts of WECS in the utility market given the availability of a technically proven WECS, the following section evaluates the applicability of these incentives given current state of WECS development. The section also outlines options to demonstrate the technical feasibility of WECS.

EXHIBIT III-11
Revenue Requirement Calculation of the Incentive
Strategy Presented in Exhibit III-7
(Investor-Owned Utilities)

- The Strategy Selected in Exhibit III-7 Includes the Following Incentives
 - Accelerated Depreciation: 20 year sum-of-years'-digits
 - Investment Tax Credit: 20% of capital cost
 - Low-interest Loan: 8% annual interest
 - Direct Cash Subsidy: 10% of capital cost
 - Property taxes excluded
- The Calculation of Capital-Related Revenue Requirements Is As Shown

	Base Case	Requirements Assuming Strategy Implemented
Income Taxes .9 (Equation 3)	1.88%	$(.9) \left\{ \frac{52}{48} \left[(9.58 + 1.83 - 5.00) \left(1 - \frac{.5(8)}{9.58} \right) + (5.00 - 6.30) - \frac{20 (9.58 + 1.83)}{100 + 9.58} \right] - \frac{20 (9.58 + 1.83)}{100 + 9.58} \right\} = -1.53\%$
Depreciation .9 (Equation 2)	1.83%	$(.9)(1.83) = 1.65\%$
Weighted Average Cost of Capital .9 (low interest loan rate)	9.58%	$.9 (8.00) = 7.20\%$
Property Taxes	2.86%	0%
Capital-Related Revenue Requirements (%)	16.15%	7.32%

The net effect of this strategy reduces capital related revenue requirements from 16.15% to 7.32%, a net reduction of 54.7%. Graphically, the net effect of the strategy was estimated in Exhibit III-7 to be a 54% reduction, thus the two show close agreement for this complicated strategy.

EXHIBIT III-12
Impact of Loan Incentives on Publicly-Financed Utilities

	FEDERAL SYSTEMS	PUBLIC, NON-FEDERAL SYSTEMS	COOPERATIVE SYSTEMS
Base Case			
Debt Interest Rate	8%	6%	8.75%
Total Revenue Requirements	16.03%	14.74%	16.54%
Low Interest Loan Rate	7%	5%	7.75%
Adjusted Revenue Requirements	15.03%	13.74%	15.54%
Percentage Reduction in Revenue Requirements	6.2%	6.8%	6.0%
Cost to Government (% of NECS Capital Cost)	25.5%	42.6%	34.0%
Subsidy Application Cost % of Capital Cost 1% Revenue Reduction	4.1%	6.3%	5.7%

EXHIBIT III-13
Impact of Direct Cash Incentives on Publicly-Financed Utilities

	FEDERAL SYSTEMS	NON-FEDERAL SYSTEMS	COOPERATIVE SYSTEMS
Base Case			
Capital-Related Revenue Requirements	10.19%	8.72%	10.76%
Total Revenue Requirements	16.03%	14.74%	16.54%
Supply 25% Direct Cash Subsidy: Reduction of Revenue Requirements	7.64%	6.54%	8.07%
Capital-Related Revenue Requirements	13.48%	12.56%	13.85%
Percentage Reduction in Total Revenue Requirements	15.9%	14.8%	16.3%
Cost to Government (% of WECS Capital Cost)	25%	25%	25%
Subsidy Application Cost % of Capital Cost 1% Revenue Reduction	1.6%	1.7%	1.5%

EXHIBIT III-14
Impact of Payments-in-Lieu of Taxes Exemption
on Publicly-Financed Utilities

	FEDERAL SYSTEMS	NON-FEDERAL PUBLIC SYSTEMS	COOPERATIVE SYSTEMS
Base Case			
Payments-in-Lieu of Taxes Rate	2.92%	3.01%	2.89%
Total Revenue Requirements	16.03%	14.74%	16.54%
Adjusted Revenue Requirements with Exemption	13.11%	11.73%	13.65%
% Reduction in Revenue Requirements	18.2%	20.4%	17.5%
Cost to Government (% of WECS Capital Cost)	24.2%	24.2%	24.2%
Subsidy Application Cost % of Capital Cost 2% Revenue Reduction	1.33%	1.19%	1.38%

3. DIRECT INVESTMENT SUBSIDIES APPEAR TO BE THE ECONOMIC INCENTIVES WHICH WILL MOST DRAMATICALLY IMPACT THE INSTALLATION OF WECS ON UTILITY SYSTEMS IN THE NEAR FUTURE—BUT THEY MUST BE PRECEDED BY DEMONSTRATIONS

(1) At This Date WECS Have Not Been Technically Proven as Capable of Operating Effectively on Utility Systems

The Mod 0 100 kW facility at Sandusky, Ohio and OA unit (200 kW) at Clayton, New Mexico have operated for only a short period of time since being completed and the Mod 1 unit, under construction at Boone, North Carolina is not yet operating. WECS systems will attain an MW operating scale on a per unit basis only when Mod 1 facilities become operational. Most significantly, these units have costs many times that needed for utility operation. Thus, WECS' subsystems, and related components and equipment, have not been tested or proven operationally, and their design and equipment have not been standardized.

(2) Utilities Will Not Invest in WECS Since It Will Be Viewed as an Unproven Technology

Utilities, being extremely conservative in their generation planning, will only install those facilities for which there is a reasonably certain assurance of a profitable return. Because WECS have still to prove their durability and operational effectiveness there is little or no assurance that utilities will realize such a return. This uncertainty will effectively eliminate any economic benefits which will theoretically accrue as a result of the installation of a WECS versus some alternative system.

Until there is greater certainty regarding WECS operating characteristics and economics, incentives directed toward improved cost-effectiveness are unlikely to receive serious consideration by utilities due to the inability to accurately measure their relative impacts. Thus, incentives which marginally improve WECS economics, i.e., low interest loans and property tax incentives are unlikely to have any impact on the installation of WECS by utilities in the near future.

(3) Significantly Reduced Financial and Operating Risk May Encourage the Installation of WECS by Utilities

The technical risks associated with WECS can be overcome by the intensive testing of WECS on utility systems. To encourage utility participation in the testing, and the possible commercialization process, the financial risks to utilities will have to be reduced or eliminated. At present, the only mechanism available to achieve this objective is for the Government to provide funds for most, or all, of the installation cost of the WECS, i.e., a direct investment subsidy.

The Government could conceivably earn some return, or minimize its losses, on this investment by arranging for the purchase of energy produced by the utility whose system the WECS is located on. An agreement could also take the form of a purchase of the WECS by the utility after its operational effectiveness and economic viability have been proven.

(4) The Federal Government Could Procure, Install and Operate WECS on Its Own Facilities as an Alternative to a Utility Oriented Demonstration Program

The Federal Government has a number of alternative sites at which WECS might be sited, including military bases/installations and buildings and other Government facilities. These facilities are located in geographical areas of all types throughout the country, thus assuring a large diversity of potential wind sites. The Government could develop a procurement program, with DOE as the lead agency, which would seek to define:

- . Performance specifications
- . Reliability and maintenance specifications
- . Personnel training
- . Quality control systems
- . Data collection and analysis techniques.

The objective of this program would be to design, construct, test and prove the operating capabilities of WECS, under various conditions, in a competitive bidding and cost-effective manner. By establishing the economic and operating capabilities of WECS, the necessary technical and economic information base required by utilities in making alternative technology investment decisions would be formed. Once operating capabilities and relative economics of WECS have been assessed, both the Government and utility industry will be better informed regarding the type and magnitude of economic incentives required.

Potential problem areas with such a program to be addressed include:

- . Defining the responsibilities of each agency involved in the procurement process, and who has final decisionmaking authority
- . Assuring that the program is directed at producing an efficient, marketable WECS, and does not become subject to unwarranted political intervention
- . Assuring that the information and data developed during the program is effectively communicated to potential WECS users
- . Encouraging contractor innovation relative to WECS design, development, installation and operation, while at the same time setting basic criteria or standards by which to measure WECS performance
- . Establishing clearly defined objectives to track the progress of the Government demonstration program, and mark the completion point of the project, thus when the program should be terminated and the WECS industry stand on its own merits.

A more detailed discussion of Federal procurement as WECS incentive is presented in Appendix C.

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This completes the assessment of economic incentives as they apply to the utility WECS market. Appendix A contains a workbook approach to incentive analysis, including a presentation of how to evaluate various economic incentive combinations as they apply to the WECS utility market.

IV. RESIDENTIAL MARKET INCENTIVE ANALYSIS

This chapter addresses the need for and relative merits of various incentive approaches for stimulating the residential Wind Energy Conversion Systems (WECS) market. Home-owners/buyers and rental property owners/investors are possible users of WECS and may install a system as part of new construction or retrofit. (The mobile home market was not considered).

From the wide range of possible incentive options described in Chapter I, the most appropriate economic incentives for the residential market were selected. The incentives analysis for this market is restricted to direct cash subsidies, tax credits, accelerated depreciation, sales and property tax exemption/reductions, and low interest loans. The analysis:

- . Develops and assumes a "rational man" decision model for the consumer
- . Compares the economic impact of incentives on the basis of a present value analysis
- . Evaluates the economic incentives with respect to their impact, cost to the Government, consumer acceptance, and limitations
- . Recommends the most effective incentives for use of WECS in the residential market.

1. TO FACILITATE THIS ANALYSIS, A "RATIONAL MAN" DECISION MODEL WAS ASSUMED FOR THE CONSUMER

Each decisionmaker in the WECS residential market has a unique perspective with respect to the WECS investment. For example, a homeowner cannot depreciate the WECS installation for tax purposes, while the rental property owner can depreciate the cost of a WECS or deduct the cost of alternative fuel charges. Moreover, the actual investment decision may be made for non-economic reasons such as social, environmental or the desire to be independent of the utility. Determining true buyer behavior is a complex exercise in

market analysis well beyond the scope of this report. Therefore, to facilitate the analysis, a "rational man" decision model is assumed for the consumer. The following sections:

- . Define the "rational man" decision model
- . Identify the key decisionmaking variables
- . Discusses target values for each of the decision-making criteria.

(1) The "Rational Man" Decision Model Defines Consumer Investment Based on Life-Cycle Costing

Most energy conserving improvements require a significant initial investment to reduce future operating costs. This higher investment is acceptable to rental property owners for whom life-cycle costing is a matter of course in project planning. It has historically been unacceptable to homeowners, who are generally limited in their first costs availability. However, evidence indicates that homeowners are increasingly willing to pay for moderate increases in first costs to save future operating costs.(1)

This analysis, as have others(2), assumes that the consumer is willing to compare WECS with alternative conventional energy on the basis of total cost over the life of the WECS. The "rational" consumer then chooses the system with the lowest cost over its life.

(2) Net Present Value, Internal Rate of Return and Other Cash Flow Indicators Were Used to Appraise the Consumer's Investment Decision

The acquisition of a WECS involves an initial investment to purchase and install the system with the promise of reducing future operating costs. As Narayanan(3) has shown, standard investment appraisal techniques can be applied in the decision process in acquiring a solar energy system.

Three economic indicators are commonly used to analyze the capital investment decision:

- . Net Present Value (NPV): The sum of all cash flows discounted to present value using the consumer's discount rate.
- . Internal Rate of Return (IRR): The discount rate that equates the present value of the expected cash outlays with the present value of the expected inflows.
- . Payback: The time required for the cumulative cash position to repay the remaining loan balance.

There are, of course, other important parameters which help model the residential decision process, and work in the solar energy field has suggested two additional cash flow indicators which are useful in assessing the economics of WECS:

- . Loss Period: The time required for annual energy savings to exceed annual costs
- . Breakeven Period: The time required for the consumer to recover the cash value of the downpayment.

Payback, loss period, and breakeven period are illustrated in Exhibit IV-1, which depicts the cash flows of the investment:

- . The dark line, entitled "remaining principal on mortgage" represents the outstanding debt on the WECS loan
- . The annual cash flow line represents net cash flows projected on an annual basis
- . The cumulative cash position line represents the accumulated cash flows over time
- . Point A indicates the date when annual net cash flows become positive for the first time. The time from installation to point A is known as the loss period
- . Point B indicates the breakeven point
- . Point C corresponds to the payback period.

While these cash flow indicators are more specific measures of the actual consumer decision process, they too are at best simplifications necessary for the analysis.

(3) These Standard Indicators Employed With a Set of Decision Rules Establish the Consumer Decision Criteria

The consumer's actual decision criteria are highly uncertain. The cost of the WECS and the consumer's desire to buy it can depend on the individual's financial position, the local price and availability of energy, the individual's propensity or adversity to risk, and a host of other factors. These influence his desire to make a profitable investment over the long-term and his need for immediate positive cash inflows. In lieu of a detailed market analysis, experience with consumer decision criteria in the solar energy field(4) was assumed to be applicable to the WECS buyer:

- . An investment is acceptable on the basis of NPV if the NPV is positive
- . A loss period of one year or less is the typical limit of acceptability for an "energy conserving" investment. This assumes that residential consumer will not make investments unless they can realize immediate annual savings.
- . Breakeven period should be five years or less, based on the assumption that cash outlays and early losses must be returned in a period equal to, or less than, the average housing turnover rate, which is now approximately five years
- . Payback period should be ten years or less, based on the response of over 90 percent of a market sample.(5) This is more stringent than merely requiring that the system pay for itself within its useful life
- . IRR typically should be equal to or greater than 15 percent to achieve an adequate return on investment for a rental property owner using WECS to offset his operating energy costs.

EXHIBIT IV-1
Wind Energy System Investment—Cash Flow Diagram

EXHIBIT IV-2
Homeowners' Ranking of the Importance of Factors Relating to
Possible Purchase of Solar Energy System

	% Ranking First or Second
1. Reduction of utility bills	56
2. Initial price of the system	55
3. Reduced dependence on utility companies	15
4. Repair and upkeep cost of the system	13
5. Amount of heat and hot water provided	11
6. Civic duty to help conserve energy	9
7. Number of years system will last	9
8. Desire for a cleaner environment	8
9. Increase in the resale value of the house	7
10. Manufacturer's reputation	5
11. Availability of financing for the system	4
12. Increase in mortgage payments*	3
13. Solar collector appearance on outside of house	3
14. Increase in downpayment for house (new only)	2
15. Other	1

* Asked of new home sample

Source: Reference 6.

These criteria are believed to be representative of the minimum requirements of consumers to purchase a WECS. However, it must be noted that these still are the result of simplifying assumptions made to conduct the analyses.

Actual purchase decision criteria will, of course, be unique to each individual. While economic considerations are the principal factors in the consumers' decision process, a substantial minority may make their choice for non-economic reasons, as illustrated in Exhibit IV-2 taken from a recent solar market analysis.(6)

2. AN ANALYTICAL TECHNIQUE BASED ON PRESENT VALUE ANALYSIS PROVIDES A CONSISTENT PROCEDURE TO EVALUATE AND COMPARE THE IMPACT OF ECONOMIC INCENTIVES ON THE RESIDENTIAL WECS MARKET

An analysis based on the present value technique was used to determine the level of incentive or combination of incentives needed to make WECS economically competitive with an alternative energy source. The results of modeling the economics of WECS were generalized into a graphical representation which considered six economic incentives:

- . Direct cash subsidy . .
- . Property tax exemption/reduction
- . Sales tax exemption/reduction
- . Tax credits
- . Low interest loans
- . Accelerated depreciation (multifamily rental property only)

These incentives can be applied to the WECS investment singly or in combination to reduce WECS first costs or to amortize the capital costs to lower WECS monthly payments.

This section describes:

- . The development of the base case
- . The analytical technique used to analyze the WECS economic performance
- . The methodology used to determine the impact of incentives.

(1) A Base Case, Developed by Assuming Typical Values for the Parameters of the Investment Decisions, Facilitates the Comparative Incentive Analysis

There are many factors that affect the economics of the WECS investment. In assembling the base case WECS economics for subsequent incentives analysis, values for parameters were selected as shown in Exhibit IV-3.

The size of WECS was taken to be a 3kW unit with a 0.3 capacity factor. Assuming all WECS generated electricity may be effectively used by the consumer, the WECS provides 7,884 kWh of electricity whose economic value will be used to offset WECS costs. For new construction in New England having all electric heating, 7,884 kWh would be about 25 to 40 percent of the annual electrical requirements.(7)

A discount rate of ten percent was used for the homeowner. A rental property owner is assumed to use a minimum of 15 percent as a discount rate, which represents a reasonably attainable return on investment. Proper choice of discount rate is an extremely controversial subject and the methodology developed in this study allows the analyst to select his own value. Inflation is assumed to be five percent over the period of analysis. Alternative electricity costs are assumed to escalate at a rate of two percent over the inflation rate. Typical values for the cost of capital were obtained from the banking industry.

A WECS installed capital cost of \$2000/kW for the 3kW system was chosen for the base case. The method of analysis is not dependent on the choice this value.

(2) A Model Was Developed as a Tool for Analyzing the Economic Performance of WECS in Terms of the Decisionmaking Variables

A computer model (fully described in Appendix B) was developed to account for each of the parameters of the investment decision in evaluating the economics of WECS. The basic analysis involves computing all annual cash flows associated with energy costs, financing, taxes, maintenance and insurance and forecasting them for a 30-year period. The model is a sophisticated tool that analyzes the economics similarly to the graphical technique also presented in the appendix. However, the computer model has more capability in the following areas:

- . Besides simple payback, loss period and NPV, it can calculate full payback, the breakeven period, and internal rate of return
- . The tax deductibility of interest is accounted for
- . An energy escalation rate different from the inflation rate can be handled.

Representative input and output are presented in Exhibit IV-4 and IV-5. The key decisionmaking variables that appear in the output—NPV, IRR, payback, breakeven (YRDP), and loss period (YRPCF)—are computed during standard economic relationships shown in Appendix A.

(3) To Simplify Economic Analysis, a Graphical Technique is Used to Determine the Impact of Various Government Incentives on WECS Costs

Given a set of input parameters and incentive options, the computer analysis or "manual" workbook calculates the resulting values of the decisionmaking variables. However, it is helpful to analyze the impact of economic incentives on a more general basis. An analytical technique based on present value (PV) analysis provides a consistent procedure for a general assessment. It is summarily discussed in the following section and in detail in Appendix A.

1. The Magnitude of the Incentive Is That Value Necessary to Reduce the PV of WECS Costs Over Its Useful Life to the Equivalent PV of the Alternative Energy Costs

The PV's of WECS and an alternative energy source are compared using normal mortgage or home improvement financing. The PV of electricity cost per kWh that would have been incurred over the 30-year WECS lifetime may be calculated using Exhibit IV-6. Multiplying by the annual electrical load and assuming all WECS electricity generated is useful gives a total PV for electricity expenses. This is then compared to the PV of WECS costs, calculated from Exhibit IV-7 and the system size. The "rational" man model indicates that if a WECS is less costly than its alternative, incentives are not needed to induce "rational" consumers to use WECS. However, in reality it was noted that consumers make decisions on criteria other than economic, which implies that WECS may have to be made substantially more economically attractive or may require different types of incentives. In this type of analysis, one might require that WECS achieve a 25 percent PV cost advantage over the alternative. If WECS is more costly, then economic incentives may be employed to make it cost competitive with the alternative energy source. In this case, the discounted level of incentive is the difference between the PV's of a WECS and its alternatives.

A ratio is formed by dividing the level of incentive by the PV of WECS; it reflects the amount that the PV of WECS has to be reduced to be cost competitive.

Given the base case initial conditions, for a homeowner with a 30-year loan, Exhibit IV-8 summarizes this procedure. The PV's of electricity and WECS are \$5913 and \$8100, respectively. Hence, a 27 percent reduction in PV of WECS is required to meet the target system cost.

A similar procedure for the other three cases results in needed reductions for WECS PV of:

37% for a homeowner with a 5-year loan
at 15%

EXHIBIT IV-3
Base Case Assumptions for Residential Market

<u>Parameter</u>	<u>Value</u>
ENGINEERING PERFORMANCE	
. System size	3 Kw
. Capacity factor	0.3
. Annual electrical load	7,884 Kwh
. System	30 yrs.
ECONOMICS	
. Initial cost of WECS	\$6,000
. Cost of conventional energy	4¢/Kwh
. Energy escalation rate	7%
. Initial WECS O&M and insurance expenses	2%
. Annual property tax	2%
. Sales tax rate	5%
. Inflation rate	5%
. Depreciation (rental property only)	Straightline
. Discount rate	
- Homeowner	10%
- Rental property owner	15%
. Marginal income tax rate	
- Homeowner	25%
- Rental property owner	50%
. Period of analysis	30 yrs.
FINANCING	
. New Housing	
- Downpayment	20%
- Term	30 yrs.
- Interest rate	9%
. Retrofit	
- Downpayment	20%
- Term	5 yrs.
- Interest rate	15%

EXHIBIT IV-4

Sample Output to WECS Economic Model

INPUT		
1	SYSTEM SALES PRICE, \$	6000.00
2	SYSTEM ANNUAL USEFUL ENERGY DELIVERY, KWH	7884.00
3	SYSTEM USEFUL SERVICE LIFE, YRS	30.00
4	UNIT COST OF UTILITY ENERGY, CENTS/KWH	4.00
5	ENERGY COST ESCALATION RATE, %/YR	7.00
6	RATIO : LOAN TO SYSTEM SALES PRICE	80.00
7	ANNUAL INTEREST RATE, COMPUTED MONTHLY, %	9.00
8	LOAN TERM, YRS	30.00
9	OWNER MARGINAL INCOME TAX RATE, %	25.00
10	DISCOUNT RATE FOR NPV CALCULATIONS	10.00
11	DEPRECIATION METHOD 0 NONE 1 STLINE 2 DDB	.00
12	PERIOD OF ANALYSIS	30.00
13	CHARGES< O&M, VALUE	2.00
14	CHARGES< O&M, TYPE	40.00
15	CHARGES< O&M, ESCALATION RATE, %/YR	5.00
16	CHARGES< PROPERTY TAX, VALUE	2.00
17	CHARGES< PROPERTY TAX, TYPE	41.00
18	CHARGES< PROPERTY TAX, ESCALATION RATE, %/	5.00
19	CHARGES< SALES TAX, VALUE	5.00
20	CHARGES< SALES TAX, TYPE	21.00
21	CHARGES< SALES TAX, ESCALATION RATE, %/YR	.00
22	CHARGES< OTHER (1), VALUE	.00
23	CHARGES< OTHER (1), TYPE	.00
24	CHARGES< OTHER (1), ESCALATION RATE, %/YR	.00
25	CHARGES< OTHER (2), VALUE	.00
26	CHARGES< OTHER (2), TYPE	.00
27	CHARGES< OTHER (2), ESCALATION RATE, %/YR	.00
28	CREDITS< DIRECT CASH SUBSIDY, VALUE	.00
29	CREDITS< DIRECT CASH SUBSIDY, TYPE	70.00
30	CREDITS< DIRECT CASH SUBSIDY DURATION	.00
31	CREDITS< TAX CREDIT, VALUE	.00
32	CREDITS< TAX CREDIT, TYPE	90.00
33	CREDITS< TAX CREDIT, DURATION, YRS	1.00
34	CREDITS< OTHER (1), VALUE	.00
35	CREDITS< OTHER (1) TYPE	.00
36	CREDITS< OTHER (1) DURATION, YRS	.00
37	CREDITS< OTHER (2) , VALUE	.00
38	CREDITS< OTHER (2) , TYPE	.00
39	CREDITS< OTHER (2) , DURATION, YRS	.00

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EXHIBIT IV-5
Sample Output for WECS Economic Model

Major iterated variable is tax credit (%)

Minor iterated variable is system price (\$)

MAJOR	MINOR	PRICE	NPV	S/PB	F/PB	YRDP	YRPCF	IRR
0.	1500.	1500.	3909.	6.	7.	2.	1.	59.22
0.	3000.	3000.	1892.	11.	15.	8.	1.	20.67
0.	4500.	4500.	-125.	16.	22.	18.	8.	9.50
0.	6000.	6000.	-2142.	21.	28.	27.	15.	2.64
10.	1500.	1500.	4046.	5.	6.	2.	1.	74.84
10.	3000.	3000.	2165.	10.	14.	6.	1.	25.54
10.	4500.	4500.	284.	15.	22.	16.	1.	11.36
10.	6000.	6000.	-1596.	20.	28.	26.	1.	3.57

Note the following abbreviations apply:

- . Net Present Value (NPV)
- . Simple Payback (S/PB)
- . Full Payback (FPB)
- . Years to Recovery Downpayment (YRDP), or Breakeven Period
- . Years to Positive Cash Flow (YRPCF), or Loss Period

EXHIBIT IV-6
Present Value
of Electricity Costs
Over 30 Years

EXHIBIT IV-7
Present Value
of WECS Costs
for Base Case Parameters

EXHIBIT IV-8
Example Calculations to Estimate the Reduction
in WECS Capital Costs

Step 1: Calculate the Present Value of Conventional Energy Source

- Cost of Electricity: 4¢/kwh
- Annual electrical output: 7884 kwh
- Calculate PV of Electricity Using Exhibit IV-6

PV of Electricity	x	Electrical Load	=	Total PV of Electricity
per kwh				
<u>\$0.75/kwh</u>	x	<u>7884 kwh</u>	=	<u>\$5913</u>

Step 2: Calculate the Present Value of WECS Costs

- Homeowners, 30-year loan: 25%
- Initial WECS Cost: \$2000/kw
- Calculate PV of WECS Capital Costs Using Exhibit IV-7

PV of WECS Cost	x	System Size	=	PV of WECS
per kwh				
<u>\$2700/kwh</u>	x	<u>3 kw</u>	=	<u>\$8100</u>

Step 3: Estimate the Level of Incentive

PV of WECS	-	PV of Electricity =	Level of Incentive
(Step 2)			
<u>\$8100</u>	-	<u>\$5913</u>	<u>\$2187</u>

Step 4: Estimate the Required Production in WECS Capital Costs

Level of Incentive		PV of WECS Costs		Reduction in WECS Costs
(Step 3)		(Step 2)		
<u>\$2187</u>	÷	<u>\$8100</u>	=	<u>27% of PV</u>

- . 15% for a rental property owner with a 30-year loan at 9%
- . 44% for a rental property owner with a 5-year loan at 15%.

2. The Particular Economic Incentive or Combinations of Incentives Required to Reach the Target Price May Be Determined Using a Nomograph

Various incentive policies are available to make WECS economically competitive with alternative energy sources. Four nomographs (Exhibits IV-9 through IV-12) representing the four base cases were developed to allow one to combine the effect of various incentives and combinations of incentives of the PV of WECS costs. Use of this type of nomograph was described in the previous chapter.

To illustrate their use, a homeowner with long-term financing is again assumed. While various combinations may effect the 27 percent reduction in PV of WECS, an example calculation, shown in Exhibit IV-13 shows that the combined effect of property tax exemption and a 6 percent loan (line ABCD on Exhibit IV-9) is one possibility.

3. ECONOMIC INCENTIVES NEED TO BE ASSESSED ON THE BASIS OF THEIR IMPACT, COST TO THE GOVERNMENT, ADMINISTRATION ISSUES, AND CONSUMER ACCEPTANCE

Residential WECS are being increasingly considered along with other solar options as eligible for economic assistance in state, local and Federal programs. States including WECS in various forms of tax incentives are Arizona, California, Georgia, Texas, Michigan, New York, and Kansas. Others have legislation pending. The current National Energy Plan (NEP) would provide an incentive for residential WECS units. However, there are few studies which evaluate the need for and relative merits of various incentive options. This analysis assesses the overall impact of government incentives applied singly or in combination with state incentives on the basis of their economic

impact and suitability for the residential market. The incentives, which are designed to reduce either first costs or annual carrying costs, are examined with respect to four characteristics:

- . Impact on economic performance of WECS
- . Cost to the Government
- . Implementation, administration, and phase-out problems
- . Consumer acceptance.

Based on this analysis, the relative benefits and costs of economic incentives are compared in the following sections.

(1) A Direct Cash Subsidy or Tax Credit Can Have a Powerful Impact on WECS Economics, but a Low Interest Loan Only a Marginal Effect.

The impact of economic incentives is examined from the perspective of their ability to reduce the present value of WECS costs equal to the present value of electricity costs. From the previous "workbook" analysis, it was determined that to make WECS cost competitive, the present value of WECS costs had to be reduced by:

- . 27% for a homeowner with a 30-year loan at 9% interest rate
- . 37% for a homeowner with a 5-year loan at 15% interest rate
- . 15% for a rental property owner with a 30-year loan at 9% interest rate
- . 44% for a rental property owner with a 5-year loan at 15% interest rate

Based on the incentive nomographs, Exhibit IV-14 presents data on several specific levels of incentives which are required to effect these reductions. There are six major observations that can be made from these data:

EXHIBIT IV-9 Homeowner's Long-Term Loan Investment Nomograph With Case Example

EXHIBIT IV-10 Homeowner's Short-Term Loan Investment Nomograph

EXHIBIT IV-11 Rental Property Owner's Long-Term Loan Investment Nomogram

EXHIBIT IV-12 Rental Property Owner's Investment Nomogram

EXHIBIT IV-13

Example Calculations to Select An Incentive Option

Step 1: Select the Appropriate Nomograph

- . For this case, use Exhibit IV-9

Step 2: Enter the Nomograph at the Right Hand Abscissa

- . Assume no Direct Subsidy (Point A)

Step 3: Move Counterclockwise Around the Nomograph

- . From Point A, move vertically up to 6 percent interest rate line (Point B)
- . From Point B, move horizontally to a 0 percent property tax rate (Point C)
- . From Point C, move vertically down to 5 percent sales tax rate (Point D)
- . From Point D, move horizontally to the axis titled "Reduction in WECS Costs"

Step 4: Exit the Nomograph

- . The combined effect of a 6 percent interest rate (a reduction of 3 percent from a base case of 9 percent) property tax exemption (a reduction of 2 percent from a base case of 2 percent) is a 27 percent reduction in WECS costs

EXHIBIT IV-14
Level of Incentive Required to Reach
Target Present Value (%)

Type of Incentive	Homeowner		Rental Property Owner	
	30-Year Loan @ 9% Reduce WECS PV by 27%	5-Year Loan @ 15% Reduce WECS PV by 37%	30-Year Loan @ 9% Reduce WECS PV by 15%	5-Year Loan @ 15% Reduce WECS PV by 44%
Direct Cash Subsidy (%)	36	58	10	46
. With property tax exemption	12	35	1	36
. With sales tax exemption	32	54	8	43
. With property and sales tax exemptions	10	31	0	34
. With accelerated depreciation	N/A	N/A	6	41
Tax Credit (%)	40	63	12	52
. With property tax exemption	13	39	1	42
. With sales tax exemption	36	60	9	50
. With property and sales tax exemptions	10	34	0	39
. With accelerated depreciation	N/A	-	7	47
Low Interest Loan (%)	N	N	2	N
. With property tax exemption	6	N	8	N
. With sales tax exemption	0	N	4	N
. With property and sales tax exemptions	7	N	9	N
. With accelerated depreciation	N/A	N/A	5	N

N = not able to achieve the desired reduction

NA = not applicable

- . The same reduction in WECS PV can be effected with less direct cash subsidy than a tax credit, because of the 9 to 17 (12 assumed in the analysis) month delay in receiving the tax benefit through the IRS system.
- . A direct cash subsidy and a tax credit can effect greater total reductions than can low interest loans since the potential impact of a loan program is limited by the interest rate subsidy alone.
- . From a strictly economic viewpoint, less incentive is needed when a WECS is financed as part of the mortgage loan than a home improvement loan.
- . Property tax exemptions provide yearly savings and over 30 years can make a significant impact on WECS economics. As part of a combined incentive package, a property tax exemption enables the level of the complementary incentive, such as cash subsidy, tax credit, or low interest loan, to be substantially reduced.
- . Since sales tax exemptions are one-time stimulants which reduce first costs by a small amount (generally less than 5% of the capital cost), they have a much smaller impact than property tax exemptions.
- . Accelerated depreciation will make WECS somewhat more attractive to the rental property owner. The percentage reduction is not large.

The impact of various incentives on the other decision variables—payback, breakeven period, loss period, and IRR—is presented in Exhibits IV-15 through IV-20. The effect of low interest loans on the decision variables, with or without sales or property tax exemptions, can be determined directly from the exhibits. The impact of a tax credit or cash subsidy can be determined by reducing the WECS cost by an appropriate amount. There is not a significant difference between the cash subsidy and the tax credit in their effect on these cash flow variables. From these exhibits, it is observed that:

- . A direct subsidy or tax credit which reduces the homeowner's WECS cost from \$2000/kW to about \$750/kW, or about a 60% reduction, is required to attain all three target values—payback, breakeven, and loss period.
- . A low interest loan even with a sales or property tax exemption, is insufficient to satisfy the decision criteria for a homeowner.
- . A low interest loan with a 30-year term can attain the minimum IRR target for rental property owners; however, over a 5-year term it is inadequate.
- . A direct cash subsidy or tax credit, on the order of 15% and 45% is needed to reach the IRR target for 30-year and 5-year loan term, respectively.

The conclusions are drawn using the base case cost assumption of \$2000/kW. The reader can select his own projected WECS costs along the abscissa of each Exhibit. Thus, using Exhibit IV-17 one can determine that interest-free loans can meet all targets if the WECS selling cost \$1200/kW or less.

(2) Based on Their Relative Administration Costs, Tax Credits Appear to Be Least Costly and Low Interest Loan Program Most Costly to the Government

Estimates of the comparative cost to the Government among the various incentive options are principally determined by two components:

- . Cost of the subsidy
- . Administrative costs.

In the case of subsidy costs, incentive costs are directly proportional to the sales volume and level of incentive. From the Government's perspective, the required level of incentive in total discounted dollars is the same whether it is a cash subsidy, tax credit, or loan. A \$1000 incentive/unit costs the Government \$1000/unit in discounted dollars irrespective of the incentive option selected (This assumes the Government's

EXHIBIT IV-15
The Effect of Low Interest Loans
on Internal Rate of Return for
Rental Property Owner

EXHIBIT IV-16
The Effect of Low Interest Loans Combined With
Property Tax Exemption on Internal Rate of
Return for a Rental Property Owner

EXHIBIT IV-17
The Effect of Low Interest Loans Combined With Property
Tax Exemption on Payback, Breakeven, and Loss Periods
for a Homeowner With Thirty-Year Financing

EXHIBIT IV-18
The Effect of Low Interest Loans on Payback, Breakeven,
and Loss Periods for a Homeowner
With Thirty-Year Financing

EXHIBIT IV-19
The Effect of Low Interest Loans on Payback,
Breakeven, and Loss Periods for a
Homeowner With Five-Year Financing

EXHIBIT IV-20

The Effect of Low Interest Loans Combined With Property Tax Exemption on Payback, Breakeven, and Loss Periods for a Homeowner With Five-Year Financing

discount rate is equal to the consumer—assuming different rates will result in different costs).

Estimates for administrative costs vary considerably. As part of their solar market analysis, RUP1, Inc.(8) derived administrative costs in terms of these components:

- . Fixed start-up costs
- . Processing costs
- . Annual servicing/management costs.

These data are presented in Exhibit IV-21 and were based on conversations with officials of HUD, FmHA, the Treasury Department, and the Federally insured student loan program. They are intended to include salaries as well as office space and other overhead expenses. It is emphasized that these represent only a rough administrative cost breakdown which could vary by several orders of magnitude. Attempts by Booz, Allen to verify these numbers with both state and federal officials were unsuccessful.

Based on conversations with state and local officials, administrative costs associated with sales tax and property tax incentive programs were assumed to be the same order of magnitude as Federal tax incentive programs.

Accepting these estimates as indicators of the relative costs likely to be incurred for the various options, it is observed that tax incentive options are the least costly and low interest loan programs the most costly incentive options.

(3) A Direct Cost Subsidy and Tax Credit Are More Attractive Than a Loan Program on the Basis of Ease of Implementation.

The practicality of using a specific incentive option depends on these principal implementation issues:

- . Legislative attractiveness
- . Ease of phase-out
- . Federal risk.

Direct cash subsidies, tax incentives and Federal loans are discussed with respect to these issues.

1. Direct Cash Subsidies Afford a Great Degree of Administrative Control

A direct cash subsidy program involves several variations of a one-time payment to the buying of a WECS. It would most commonly be given as a fixed amount, computed as percentage of the capital cost, with or without a maximum ceiling, or calculated as some form of graduated subsidy. Other options may consider system size or wind regime.

As part of a Federal program requiring substantial administrative control, direct cash subsidies have several advantages:

- . Straight-forward development of legislation to implement the program because of the simplicity of the subsidy mechanism
- . Easy to up-date and/or phase-out since Federal appropriations are subject to annual review
- . Federal risk is limited to the total subsidy allocation.

A potential problem with the fixed percentage subsidy is that it will result in higher priced systems dominating the market.

2. The Use of the Tax System to Provide Incentives Has Been a Favored Option, but Possible Objections Exist.

Tax incentives are a familiar concept, reflecting several advantages over direct cash subsidies:

- . Speed of implementation and ease of administration through the existing Federal tax system

EXHIBIT IV-21
Administrative Costs of Incentive Options
(1977 Dollars)

SOURCE: "FEDERAL INCENTIVES FOR SOLAR HOMES: AN ASSESSMENT OF PROGRAM OPTIONS," APPENDIX, p. VI-8.

- . Freedom from authorization ceilings and annual appropriation cycles
- . Numerous precedents in using tax provisions to encourage investment in projects deemed to be in the public interest.

There are four disadvantages which must be addressed and resolved before implementing a tax incentive program:

- . It will be difficult to control how much the incentive is used
- . The subsidy will be limited by the amount of tax liability unless any tax credit is made refundable or credited against prior or subsequent tax liabilities.
- . It is potentially difficult to phase-out a program since additional legislation must be passed or termination provisions must be included in the original legislation thereby reducing the flexibility.
- . It is potentially inconsistent with tax reform efforts to promote tax equity and ease of administration. The appropriateness of using the tax system to promote social behavior is debated widely.

Sales tax and property tax exemptions require further comment. While they have few risks and can be easily terminated, there remain two potential problems:

- . Sales and property taxes vary among state and local governments resulting in an inequity in benefits received through the tax system.
- . The administrative effort required in verification and certification processes could be significant.

The complexities of coordinating a Federal and state incentive program, which involves a non-uniform benefit and loss of state revenue, may tend to discourage such legislation. On the other hand, independent state action, especially in exempting WECS from sales and property taxes, seems likely to occur and should have a significant impact on WECS life cycle costs.

3. A Federal Loan Program May Have Complexities That Make It Undesirable

Federal programs to provide low-cost financing are also a familiar concept with precedents in FHA, VA and FMHA programs. If funds are allocated annually to pay the interest differential between the market rate and a low interest loan, then the program will have sufficient control of funds and can be phased out easily. There is moderate risk to the Government, because it is difficult to predict the total usage of funds from year to year. However, a loan program without annual review may be difficult to phase out and may become institutionalized.

In addition, several findings of a recent market study in the solar industry seriously question the appropriateness of a Federal loan program: (9)

- While it is generally assumed that existing Federal loan networks could provide a vehicle to deliver financial assistance, they in fact reach only a small segment of the new housing market and play a marginal role in the home improvement market.

- Since the housing finance system is segmented depending on whether the financing is for new construction or retrofit, whether loans are Federally or privately insured or uninsured, and whether the property is urban or rural; any Federal incentive program must have a mechanism to reach any lending institution currently serving these sectors.

- . A successful Federal loan program would have to overcome the stigma of association with programs directed at low-income families and the enormous administrative requirements these program have involved.

- . A Federal loan program would involve the Government in setting standards of borrower credit worthiness, processing and servicing of loans, and dealing with delinquent or defaulted loans.

(4) Consumer Acceptance of WECS and WECS Incentives Depends on Both Economic and Non-Economic Issues

In previous sections, WECS incentives were examined on their economic impact, cost to the Government, and ease of implementation and phase out. This section presents an assessment of how the consumer views the various incentive options.

1. Reducing First Costs Is the Key Consideration for Homeowners/Buyers

In designing an incentive program for homeowners/buyers, there are two options to consider:

- . A choice between first-cost reducing options and loan programs
- . A choice between direct cash subsidy or tax credit, if such an incentive is preferred over a loan program.

Experience in the solar industry indicates that direct cash subsidies are preferred over tax credits, and low interest loan programs are least attractive.(10) A number of reasons have been suggested for the expressed consumer preference for a cash subsidy:

- . The certainty in receiving the full amount of the benefit, since it is not affected by tax liability

- . The direct receipt of payment at or near the purchase date, offsetting the need to finance the full system cost
- . The possibility of applying the subsidy as partial payment or downpayment on the loan.

For the same reasons of timing of receipt and possible use as partial payment, a rebate received at the time of purchase is more acceptable to the buyer than one applied for at the time of purchase (with a subsequent delay). This may be achieved by directing the rebate toward the manufacturer or distributor, with appropriate insurance that it be passed through to the consumer.

Both direct cash subsidies and tax credits are preferred over low interest loans because of the emphasis on first cost. This finding is supported by a recent Congressional Research Service report, which noted that the current solar loan program has met with little success.(11) Other explanations for this response include:

- . Relatively few existing homeowners take out bank loans to pay for home improvements to their property.(12)
- . New homeowners are reluctant to apply for a loan if it involves separate application and processing.(12)
- . New homeowners tend to accept added costs if they improve the comforts of the home, i.e., larger areas, more appliances, etc. In the past they have not been anxious to invest significant front-end cost to reduce operating expenses.
- . Homeowners/buyers are adverse to assuming risk for financial loss from system failure or the inability to recoup costs on resale. This implies that a demonstration or standardization program should be implemented before an economic incentive program.

. A new homeowner may have to pay a higher portion of the WECS costs in the downpayments. The availability of mortgage credit for WECS will be scrutinized more closely than for some other conventional equipment.

For homeowners most concerned with first cost, state and property tax exemptions are largely symbolic in nature. They can provide only a small incentive; benefits derived from these exemptions include:(13)

. Elimination of a local disincentive as perceived by the consumer

. Demonstrating local government support of WECS.

Such incentives are generally in state and local control, and their proposed adoption can only be advocated by the Federal government as a complementary effort to a Federal incentive program.

2. The Existence of Appropriate Economic Incentives May Be Insufficient to Overcome Obstacles to a WECS Investment in the Rental Property Sector

Rental property is bought generally for investment purposes, whose returns are achieved through cash flows from operation, tax losses accrued (passed on) to investor(s), and capital gains on sale. Capital gains potential is enhanced through high debt/equity ratio financing. Through financial structures in which depreciation expense (non-cash) exceeds principal payments (cash) taxes losses are generated. This being the case, rental properties generally operate without tax liabilities. For this reason, WECS tax credits could not be taken by investors, unless the credit was legislated as a refundable credit (in effect, as a direct cash subsidy).

Accelerated depreciation and various loan programs are two approaches that address the rental property owners' concerns:

- . Accelerated depreciation allows a larger loss to be claimed in the early years of the investment
- . A Government loan program can be a powerful inducement for developers by providing availability of financing, where none is available or by providing substantially higher loan amounts as a proportion of cost than those obtainable from conventional sources.

Despite the existence of Federal incentives for WECS in the rental property sector, there are serious obstacles to an investment of this type. These include:

- . An emphasis on investment in relatively risk-free projects
- . A preference for shifting the responsibility for payment of operating costs to the renter
- . The competition for limited equity funds between WECS and the acquisition of other real estate projects or other measures for reducing operating costs
- . An emphasis on short-term cost recovery
- . Paying for property improvements from cash flows, which makes retrofitting of WECS on existing rental property unlikely.

4. UNTIL THE PERFORMANCE OF WECS IS DEMONSTRATED, ECONOMIC INCENTIVES WILL BE PREMATURE IN THE RESIDENTIAL SECTOR

It is generally believed that making WECS economically competitive will be accompanied by a concurrent solving of other obstacles, such as:

- . WECS performance
- . WECS reliability

- . Environmental issues (e.g. aesthetics, noise, EM and TV signal interference, land use)
- . Storage
- . Utility interface problems
- . Social and institutional problems (e.g. zoning, FCC regulation, safety-codes, etc.).

However, the residential market regards system performance and reliability as key parameters, which must be satisfactorily demonstrated. Thus, in the early development a Federal demonstration and standardization program is indicated. Using small scale WECS in Government buildings, schools and university buildings, and new commercial construction could serve as an appropriate demonstration program. Government procurement as an incentive to WECS is discussed at some length in Appendix C.

After the performance and reliability of WECS have been successfully demonstrated, the most probable early market acceptance will come from new commercial and custom home construction. Rental property owners and the more affluent homeowners generally understand life-cycle costing and are more prone to purchase a WECS unit. A limited loan program would provide for:

- . Availability of financing
- . Higher loan to cost ratios, and, combined with direct subsidy (presuming WECS costs are still high), could stimulate early purchases.

Accelerated depreciation would be appropriate for the rental property owner.

However, what is effective in the custom home market may not be equally so in connection with tract housing. Having seen that WECS is appropriate for residential use, the majority of homeowners might respond best to a direct cash subsidy for the reasons discussed earlier.

These results have been made on the basis of a quantitative analysis of incentives and a limited number of telephone and personal interviews. Specific data, of course, are valid only under the conditions used. Particular attention should be paid to the simplifying assumptions and WECS performance uncertainties in the analysis.

The assumption of the economic "rational man" model enabled the analysis to proceed using present value techniques. Non-economic factors, such as environmental considerations, TV interference, reliability, civic duty, etc. may particularly influence the homeowner/buyer, but were not considered in this analysis.

The impact of incentives on payback, breakeven, loss period, and IRR were based on variations on a specific base case. The specific results are valid only under the conditions stated. Relative results may be appropriately extrapolated and, using the workbook (Appendix A), other specific input data can be analyzed.

Potential market responses were tested on a limited sample. In many cases, general market behavior was based on experience in the solar industry.

* * * *

This chapter has addressed the relative merits of alternative incentive options to induce accelerated use of WECS in the residential market. In summary, economic incentives could be effective after the performance and reliability of WECS have been demonstrated and standards set.

In the next chapter, an assessment of the impact of incentives on the Agricultural and Remote markets is presented, using many of the same techniques described above.

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V. WECS INCENTIVES ANALYSIS FOR THE AGRICULTURAL & REMOTE SECTORS

This chapter contains an assessment of the agricultural and remote markets for Wind Energy Conversion Systems (WECS) and an evaluation of the effect of economic incentives to stimulate these markets to invest in WECS. The evaluation of the agricultural market is presented in five parts:

- Introduction, describing the general characteristics of the agricultural market for WECS and the potential applications of WECS.
- Investment Decision Criteria, describing the key economic and financial decision criteria employed by the agricultural sector for investment purposes.
- Economics of WECS, comparing the life-cycle cost of WECS and alternative energy systems using discounted cash flow analysis.
- Incentives Analysis, identifying the effect of economic incentives to stimulate the agricultural market to invest in WECS. A discussion of non-economic factors influencing agricultural investments is also included.
- Summary and Conclusions, citing the most and least promising incentives, and identifying problems and uncertainties with implementing a Federal incentives program.

In the context of this study, the remote market for WECS consists of a broad and diverse cross section of potential users, including remote homeowners, remote residential communities, remote farmers, government projects and facilities, and remote electric utilities. Depending on the specific application considered, the remote market closely resembles the residential, agricultural and utility markets for WECS. The unique aspect of the remote market is its high energy costs. Because of the similarities between the remote market and the other WECS market sectors, it is not

necessary to present a separate economic analysis for the remote market. As such, only a brief discussion of the remote market has been included. The reader may utilize the analyses presented in the other market sectors along with a suitably high fuel cost to evaluate the effect of incentives on remote utilities, residences, farms (and farm applications) and industries.

1. INTRODUCTION TO THE AGRICULTURAL MARKET FOR WECS

This introduction describes the general characteristics of the agricultural market for WECS and the potential applications of WECS in this market.

(1) The Agricultural Sector Represents a Relatively Small Portion of the Overall National Energy Consumption, but Perhaps the Most Promising Potential Near Term Applications of WECS

Since the mid 19th century, the agricultural market has used small wind power systems to pump water for irrigation in remote areas and even to generate electricity. However, most of the wind powered systems were replaced by centralized electric power systems after the Rural Electrification Administration provided cooperative utilities for most U.S. farms and remote areas in the 1930's. With the emergence of current energy supply problems, there has been a renewed interest by the Federal Government in the use of WECS in agriculture.

The major portion of non-transportation energy requirements in the agriculture sector today is provided by electricity, propane, and fuel oil. Applications include farm production systems such as irrigation and crop drying as well as residential space and water heat. Exhibit V-1 shows the distribution of the average farm energy use of electricity, propane and fuel oil in 1977. For residential space heat and water heat applications all three fuel forms are used. The distribution among the three fuel forms varies by region. For agricultural applications such as irrigation and crop drying, the predominant fuel form is electricity, although some farms use fuel oil and propane for on-site electrical generation.

In the agricultural market, the major competing fuel forms with WECS are electricity, fuel oil and propane. The major difference among these fuels is the lower relative cost of fuel oil and propane. As shown in Exhibit V-1, the cost of fuel oil and propane for agricultural applications is approximately \$.01/kWh equivalent, while the cost of electricity is much higher at \$.04/kWh. It will be difficult for WECS to compete with low cost fuel oil and propane at current prices, however, the prices of these fuels are expected to increase rapidly over the next few years.

At current prices for electricity (average for agricultural market = \$.04/kWh), WECS can be shown to be cost competitive, especially if economic incentives are given to potential WECS investors. As such, this analysis will focus primarily on electricity as the alternative competing fuel with WECS. It should be mentioned, however, that the analysis could easily be extended to include fuel oil and propane as competing fuels. An analysis of the economics of WECS relative to these fuels will become relevant as the price for fuel oil and propane escalates, or for those applications with especially low use efficiency (e.g. use in small internal combustion engines for irrigation).

(2) There Are Many Specific Applications of WECS in the Agricultural Sector

The market for WECS in the agricultural sector is broad and diverse ranging from irrigation and crop drying applications to residential space and water heat applications. The market for WECS will be most favorable, however, for farm applications which exhibit the following performance characteristics:

- . Large energy consumption patterns
- . Interruptible for varying periods of time
- . Capable of storing energy in inexpensive forms
- . Utilized predominantly in areas of high average wind velocities.

Application of these performance criteria against a sample list of farm operations is summarized in Exhibit V-2.

Irrigation and feed processing appear to have characteristics best suited for WECS usage. Building, heating, and farm product processing and storage, such as milk cooling and grain drying also appear to be well suited for WECS. Domestic water pumping, miscellaneous electric usage and several other applications appear to be less applicable candidates, primarily due to the non-interruptibility of the demand, and the more expensive energy storage required for continuous service.

(3) Modest and Large Commercial Farms and/or Family Operated Farms Represent the Largest Potential Market for WECS. Smaller Rural and Suburban Farms Are Less Likely to Invest in WECS

Farms are business enterprises comprised of corporation owned and family owned and operated units. In 1977, there were approximately 2,800,000 farms in the U.S. With respect to their sizes, the population of American farms is fairly heterogeneous, ranging from farms having less than 10 acres to farms having several thousand acres. To simplify this market, the farm community is stratified according to size into three categories:

- . Modest and large commercial having above 300 acres
- . Small and marginal family farms having between 50 to 300 acres
- . Rural and suburban farms having less than 50 acres.

Exhibit V-3 shows the principal characteristics of the farms in each of these categories.

In general, large and modest commercial farms (and some smaller family operated farms) represent the largest market for WECS since these farms have energy consumption patterns and applications most suitable for WECS. Even more important is the fact that these farms generally have the financial capability to consider an investment in WECS. This general category represents approximately 60 percent of the total farm population.

EXHIBIT V-1
Average Farm Energy Use in 1977

ENERGY SOURCE	ELECTRICITY	PROPANE	FUEL OIL
Quantity	30,000 kWh	580 gal	610 gal
Btu x 10 ⁶ Equivalent	103	56	86
Average Cost. (\$/kWh)	.04/kWh	.013/kWh	.01/kWh
Total Yearly Cost	\$1,200	\$200	\$260

Source: Reference 1

EXHIBIT V-2
Summary of Characteristics Relevant
To Wind Energy Use in Agriculture

	MAJOR USE OF ENERGY	ANNUAL OPERATING USAGE	LOW COST STORAGE OR INTER- RUPTIBLE	USED IN HIGH WIND AREAS
IRRIGATION				
RESIDENTIAL HEAT				
POULTRY BROODING				
LIVESTOCK ENVIRONMENT				
WATER HEATING				
CROP DRYING				
FEED HANDLING				
MILK COOLING				
REFRIGERATED STORAGE				
FROST PROTECTION				
WATER PUMPING				
MISCELLANEOUS ELECTRIC POWER AND LIGHTS				
VENTILATION				
MILKING EQUIPMENT				
WASTE DISPOSAL				
LIVESTOCK HANDLING				
GRAIN HANDLING				

LEGEND

VALUE	SYMBOL	PROPORTION OF TOTAL AGRICULTURAL ENERGY USE	ANNUAL OPERATING USAGE WEEKS/YEAR	INTERRUPTIBILITY OF ENERGY STORABILITY	AVERAGE WIND IN PREDOMINANT USE AREA W/m ²
GOOD		≥5%	≥26	WORK INTERRUPTIBLE AND WORK STORABLE	>150
AVERAGE		<5% ≥0.5%	<26 ≥5	LOW COST INTERMEDIATE ENERGY STORAGE	<150 >50
POOR		<0.5%	<5%	HIGH COST INTERMEDIATE ENERGY STORAGE	<50

Source: reference 2

Rural and suburban farms, on the other hand, have far less discretionary capital and, in most cases, are less likely to invest in WECS.

2. THE SUCCESS OF PARTICULAR FEDERAL INCENTIVES TO STIMULATE THE AGRICULTURAL MARKET TO INVEST IN WECS DEPENDS, TO A LARGE EXTENT, ON THE INVESTMENT DECISION MAKING CRITERIA EMPLOYED BY FARMERS

This section provides a discussion of economic and financial considerations which are particularly critical to farmers contemplating an investment in WECS. Specific economic and financial indicators (such as cash flow criteria) are selected, as they were in the previous chapter, to evaluate agricultural investments in WECS.

(1) An Understanding of the Criteria Used by Farmers to Evaluate Investments is Fundamental to the Selection of Appropriate Analytical Techniques to Evaluate the Economics of WECS

Typically, farmers consider investments to improve and expand production capabilities and crop yields. The two major investments made by farmers are the acquisition of land and the purchase of new production machinery and equipment. In the past 20 years, farms have shifted from small individual units to more sophisticated, highly mechanized operations. This has occurred, in part, because of rapid technological innovations which have been introduced into the farm market.

Under normal circumstances, farm capital is committed for land acquisitions and new equipment purchases which directly increase farm productivity. Investments in cost-cutting activities, such as WECS, are often of second order importance to farmers. For example:

Farmers may well decide that they are not in the business of generating electricity and choose to rely entirely on electric utilities to supply energy rather than integrate WECS into their holdings.

Even though the economics of WECS demonstrates that farmers can maximize returns in the long-run, they may hesitate to make

such an investment because of the considerable uncertainty and risk assumed to realize long-run profits. Farmers are often more concerned with the short-run outlook of their business.

- . The farmer is more interested in acquiring land to increase production and/or expand into new markets than in competing effectively with existing markets.

Each farm in the U.S. operates under its own unique planning and financial strategy, and for this reason it is difficult to generalize about decisions. The critical issue is, however, that while few farmers will invest in WECS unless there is economic justification, there will be farmers that would not invest into WECS even if it appeared economical. An assessment of actual market penetration of WECS as a function of economic viability is well beyond the scope of this report.

(2) The Farmers' Investment Criteria Takes Into Consideration Financial Returns, Risks and Uncertainties, and Several Nonfinancial Factors

In the agricultural sector, the commitment of capital in the expectation of financial returns in the short and the long-term is characterized by considerable risk and uncertainty. Sources of risk include variability in crop yield due to uncertain weather conditions and seasonal product price variations. Because farming is a high risk business, farmers may hesitate to make investments in projects such as WECS where the financial returns are realized over a long time period. Economic, political and technology changes make the forecasting of future farm financial conditions difficult, if not impossible in some cases.

For most investments, there are four economic/financial considerations which are particularly critical to farmers:

- . Financial returns on investment
- . Capital availability

EXHIBIT V-3
Farm Categories and Their Characteristics

CATEGORY	FARM SIZE (Acres)	OWNERSHIP PATTERN	COMMITTMENT TO FARMING	FARM AS A SOURCE OF INCOME	% DISTRIBUTION OF TOTAL FARMS
Large Commercial Farms	500+	Corporation or Family Owned and Operated	Full Time	All Income Derived from Farming	7%
Modest Commercial Farms	200-500	Family Owned and Operated	Full Time	All Income Derived from Farming	17%
Small Family Farms	100-200	Family Owned and Operated	Full Time	All Income Derived from Farming	17%
Marginal Farms	50-100	Family Owned and Operated	Full Time or Part Time	Farm Provides a Substandard Income	16%
Rural and Suburban Farms	Less than 50 Acres	Family Owned and Operated	Part Time	Not Dependent on the Farm for a Living	43%

Source: Reference 3

- . Opportunity costs associated with alternative investments
- . Prevailing market conditions and expectations.

(3) In an Attempt to Consider These Factors, a "Rational Man" Approach for Farm Investments is Assumed. The "Rational" Farmer Typically Employs a Variety of Cash Flow Techniques for Investment Planning

The "rational man" approach (described in detail in previous chapters) is intended to provide a framework to evaluate the effect of incentives on agricultural investments in WECS. This approach assumes that the "rational" farmer will make investment decisions solely on the basis of economic and financial criteria. This approach, however, is an oversimplification of the actual decisionmaking in the farm market. However, the intent of the evaluation is not to develop a detailed investment behavior model for farmers, but rather to evaluate the effect of economic incentives on agricultural investments in WECS. As such, the "rational man" is assumed appropriate for this study.

In this context, cash flow techniques provide a consistent framework to evaluate and compare the impact of economic incentives on the agricultural WECS market. Several cash flow techniques are in widespread use today:

- . Payback period, which measures the time for cumulative receipts from the investment to cover the expenditures necessary to implement the project.
- . Net present value (NPV), which is the positive or negative difference of the present value of outlays and receipts for the project, each discounted at the farmers' investment "hurdle rate."
- . Return on investment, which is a measure of the annual percentage return, calculated by dividing average annual income by the total investment.
- . Loss period, which is the time required for annual energy savings to exceed annual costs (the year the annual cash flow becomes positive for first time).

- . Internal rate of return (IRR), which is the discount rate that equates the present value of cash receipts for cash savings) from a capital investment with the present value of cash outlays made to support the investment.

(4) The Type of Cash Flow Technique Employed by Farmers to Evaluate Investments Depends, to a Large Extent, on the Relative Size and Financial Structure of the Individual Farm

Larger, more sophisticated farms often employ net present value or internal rate of return techniques for investment purposes. Although a number of risk assessment methodologies have been developed in academia, application of these techniques to farm investment decision has been limited. Risk analysis is not treated in this study.

Loss period and payback period are typically employed by smaller farmers who lack expertise in long range forecasting or have liquidity problems, since the major concern is capital recovery and annual cash flows.

(5) To Finance Investments, Farmers Rely Heavily on Farm Credit.

Loans to farmers are available from several sources which are peculiar to the agricultural sector. These include:

- . Federal Land Banks
- . Banks for Cooperations
- . Production Credit Association
- . Farmers Home Administration
- . Conventional loan institutions.

All lending institutions review proposed farm investments. Bankers employ similar cash flow techniques to evaluate the farmer's investment (i.e., WECS). The type of cash flow technique employed by banks to review farm investments depends on the financial conditions of the applicant.

(6) Interviews with Lending Institutions, Land Grant Universities and the Department of Agriculture Have Been Conducted to Establish Target Values and Hurdle Rates for the Cash Flow Techniques Employed by Farmers

Target values and hurdle rates have been established for three cash flow techniques typically employed by farmers for investments:

- . Net present value
- . Loss period
- . Payback period.

Target values are used as benchmark values to evaluate the effect of economic incentives on agricultural investments in WECS. These target values, along with other data inputs, may be used to establish a base case to evaluate the economics of WECS. The target values for the three cash flow techniques are as follows:

- . Net present value, the difference between the present value of WECS costs over its useful life and the present value of electricity costs must be greater than or equal to zero. For purposes of the base case analysis, the farmer discount rate or target internal rate of return is assumed to be 10%.
- . Loss period, the time required for the annual energy savings to exceed annual costs is assumed to be one year.
- . Payback period, the time for cumulative savings from a WECS investment to cover the WECS cost is assumed to be the length of the loan term, or 15 years.

3. AN ECONOMIC ANALYSIS OF WECS PROVIDES THE BASIS FOR EVALUATION AND COMPARISON OF THE EFFECT OF FEDERAL INCENTIVES ON AGRICULTURAL INVESTMENT IN WECS

A full life-cycle cost analysis of WECS is described in this section. This economic analysis forms the basis to evaluate and compare the effect of government incentives on agricultural investments for WECS. A base case scenario of the economics of WECS has been developed to illustrate the

methodology. The results of evaluating the economics of WECS are generalized into a graphical presentation.

(1) An Economic Analysis of WECS Based on Discounted Cash Flow Techniques Provides a Consistent Procedure to Evaluate and Compare the Effect of Federal Incentives to Improve the Economics of WECS and Stimulate Farmers to Invest in WECS

An investment in WECS for farmers involves a basic economic trade-off: purchase of WECS through a combination of downpayment and financing, against recovery of these costs through future energy savings. Three cash flow techniques are used to evaluate the economics of WECS: net present value, loss period and payback period. The results of the calculations show whether an investment in WECS will be cost effective to farmers. Calculations of net present value, loss period and payback period are made for a base case, which provides a baseline for further analysis. Based on the economic analysis using the base case, target values are used to assess the likelihood that farmers will invest in WECS. Where the analysis shows that the economics of WECS is unfavorable to the farmer, a sensitivity study is performed on the base case to determine the level of economic incentive necessary to make WECS economically competitive with alternative sources of energy and to stimulate farmers to invest in WECS.

Five Federal incentives are evaluated:

- . Direct cash subsidy
- . Tax credits
- . Low interest loans
- . Property tax exemption
- . Sales tax exemption.

(2) A Computer Model and a Manual Workbook Were Developed as a Tool for Evaluating the Economic of WECS

As introduced in the previous chapter and presented in Appendix A, a computer model and a manual workbook were developed to analyze the life-cycle cost of WECS. The computer model computes all annual cash flows associated with WECS system cost, financing, taxes, maintenance and repair costs and insurance

costs, and all annual cash savings associated with reduced electricity usage. The model then presents the economics of WECS in terms of the key investment decision-making criteria for farmers: net present value, loss period and payback period. The manual workbook essentially performs the same calculations but also provides the user with a step-by-step description of each process as well as a graphical presentation and guide of each step.

(3) A Base Case Scenario Was Developed to Calculate the Economics of WECS

There are many input variables necessary to calculate the economics of WECS in terms of net present value, loss period and payback period. A base case was developed for the agricultural market to reflect best estimates of these input variables for farm investments. Exhibit V-4 illustrates the input assumptions used in the analysis of WECS economics. A discussion of the highlight assumptions is as follows:

WECS System Characteristics

The energy needs of the farm were assumed to be supplied by a 10 kW WECS system. At an assumed 30% capacity factor, a 10 kW WECS system will deliver 26,280 kWh of electrical energy. The actual value of the capacity factor will be a function of machine characteristics and local wind velocities. It is further assumed that all electricity generated (26,280 kWh delivered) is useful. The WECS system is assumed to have a useful life of 30 years.

Economics

The initial cost of WECS and the alternative cost of electricity are two critical parameters in WECS economics. For the base case, it is assumed that the installed cost of WECS is \$2000/kw. For a 10 kW WECS system, the total installed cost is \$20,000. Because the economics of WECS is sensitive to initial system cost, and such costs are extremely uncertain, the cost of WECS was allowed to vary from \$1000/kw to \$3500/kw in the analysis.

Similarly the cost of electricity will strongly affect WECS economics. It was assumed the major competing fuel for WECS is electricity at a cost of \$0.04/kWh. Alternative energy sources such as fuel oil and propane were not included in the analysis since these fuels are relatively less expensive. However, as the price of these fuels escalates, then it will become relevant to compare these alternative fuels with the economics of WECS. It was also assumed that the price of electricity would escalate at a rate of 2% above general the inflation rate.

Finance

A farmer purchasing a \$20,000 WECS system is assumed to place a downpayment of 15%. The remaining balance will be financed at an interest rate of 9% for 15 years. These represent average interest rates and loan terms for farm equipment and machinery obtained from interviews with various agricultural cooperative banks.

Other

The discount rate is comprised of three components: an inflation factor, a time preference for money and a risk factor. For the base case, the general inflation factor was assumed to be 5%. A discount rate of 10% is also assumed for the base case.

- (4) Using the Base Case, the Economics of WECS is Highly Unfavorable to Farmers When Compared to the Alternative Option of Electricity Purchase. Economic Incentives Must be Provided to Reduce the Life-Cycle WECS Costs

Calculations of net present value, loss period and payback period were made using the base case. A sensitivity analysis was performed on each cash flow technique by changing the base case assumption concerning:

- . Installed cost of WECS
- . Cost of electricity
- . Loan term.

EXHIBIT V-4
Base Assumptions for WECS Economic Analysis

PARAMETER	BASE CASE VALUES
WECS System Characteristics	
. Size of System	10 kW
. Capacity Factor	.3
. Annual Electrical Load	\$26,280 kWh
. System Life	30 years
Economics	
. Initial Cost of WECS	\$ 2,000/kW
. Cost of Electricity	\$.04/kWh
. Energy Escalation Rate for Electricity	7%
. Annual O&M Costs of WECS	2%
. Annual Property Tax on WECS	2%
. Sales Tax on WECS	5%
. Inflation Rate	5%
Finance	
. Down Payment	15%
. Loan Term	15 years
. Interest Payment	9%
Other	
. Period of Analysis	30 years
. Discount Rate	10%
. Marginal Income Tax Rate	20%
. Depreciation Schedule	Double Declining Balance

Exhibit V-5 shows the results of the base case calculations and compares these values with target values and hurdle rates assumed for farm investments. Also shown are the sensitivity analysis calculations for installed cost of WECS, cost of electricity and loan term. The following observations may be made:

- . Under the base case scenario, the economics of WECS is highly unfavorable to farmers. All investment decision variables fall well above the target values and hurdle rates for farm investments.
- . The economics of WECS is particularly sensitive to the installed cost of WECS. For larger sized farms which employ net present value criteria to evaluate investments, the cost of WECS would have to be reduced to \$1400/kW before the economics of WECS becomes favorable. For smaller sized farms, which employ loss period to evaluate investments, (these farms typically have cash flow problems and are most concerned with recovery of capital), the cost of WECS would have to be reduced to \$900/kW before the economics of WECS becomes favorable.
- . The economics of WECS is also sensitive to the cost of alternative energy. At \$.055/kWh, the economics of WECS becomes favorable for those farmers employing NPV for investment decisions. At \$.10/kWh, the economics of WECS becomes favorable for farmers employing loss period for investment decisions.
- . A sensitivity analysis on the loan term for farms financing indicates that an increase in the loan term from the base case value of 15 years to 30 years does not substantially affect investment decisions for WECS.

(5) The Effect of Federal Incentives to Improve the Economics of WECS and to Stimulate Farmers to Invest in WECS is Evaluated

The object of a Federal incentives program is to reduce the costs of WECS to levels competitive with alternative energy systems. For the "rational man",

the cost of WECS must be reduced through individual and/or combinations of incentives to levels where the key investment criteria for farmers (i.e., net present value, loss period and payback period) match the target values and hurdle rates for farm investments. If these target values are met, the "rational" farmer should consider an investment in WECS. In reality, however, investment decisions for farmers are much more complex. To the extent that farmers invest according to a "rational" man, this approach does provide some insights into the effects of economic incentives on investments for WECS.

A number of Federal incentives have been analyzed which can reduce the cost of WECS to farmers:

- . Direct cash subsidy
- . Tax credits
- . Low interest loans
- . Property tax exemption
- . Sales tax exemption.

The level of economic incentive necessary to stimulate farm investments in WECS depends on the specific investment decision criteria employed by the "rational" farmer. Three criteria are investigated:

- . Net present value
- . Loss period
- . Payback period.

1. To Simplify the Incentives Analysis, Generalized Nomographs Are Used to Identify & Compare Incentives to Stimulate the Agricultural Market

The magnitude of the incentive required to make WECS economically competitive with the cost of electricity is that level necessary to reduce the base case calculated values of net present value, loss period and payback period, to match their respective target values for farm investments. As in previous chapters, nomographs are used to identify and compare the relative effects of incentives. The nomographs have been constructed to allow the user to evaluate incentives for any base case scenario. The base case developed above is used to illustrate the use of nomographs

to evaluate incentives. A more detailed description of the use of nomographs for incentives analyses is provided in Appendix A.

2. For the "Rational Farmer" Using Present Value as the Criteria to Evaluate Farm Investments, a Nomograph has Been Constructed Which Allows the User to Evaluate the Effects of Incentives

For the case of present value, the magnitude of the incentive necessary to make WECS cost competitive with purchased electricity, is the value necessary to reduce the present value of WECS costs over its useful life to the equivalent present value of the costs of purchased electricity.

Exhibit V-6 presents a generalized graph which can be used to evaluate the percentage reduction in PV of WECS costs necessary to make WECS cost competitive with purchased electricity. This graph combines the calculation of the PV of WECS costs over its useful life and the PV of electricity costs for the same time period. This graph is similar to graphs IV-6 and IV-7 of the Residential sector.

For the base case, the PV of electricity costs (at \$.04/kWh) is \$19,754. The PV of WECS costs is \$27,109. To calculate the percentage reduction in PV of WECS capital costs necessary to equate the PV of WECS costs to the PV of electricity costs the following calculation is performed:

$$\frac{\text{PV of WECS cost} - \text{PV of electricity costs}}{\text{PV of WECS costs}} = \% \text{ reduction in PV of WECS capital costs}$$

For the base case, the percentage of reduction in PV of WECS capital costs is 27 percent.

The nomograph shown in Exhibit V-7 graphically illustrates a methodology to identify and compare the effectiveness of Federal incentives to achieve a reduction in present value of WECS capital costs. The nomograph displays three quadrants which combine the various incentive options in a dimensionless format allowing combinations of incentives to be developed to achieve the target reduction in WECS costs. For the base case scenario, the target reduction in the PV of WECS costs is

27%. The effect of five economic incentives can be calculated from the nomograph, which is similar to the method presented in the residential sector. The results are summarized below:

- . A 30% direct subsidy reduces the PV of WECS costs by 27%
- . A 33% tax credit reduces the PV of WECS costs by 27%
- . A 2% low interest loan reduces the PV of WECS costs by 27%
- . A property tax elimination reduces the PV of WECS cost by only 19% and is not sufficient to reduce the PV of WECS costs by the required 27%. Another incentive would need to be applied in conjunction with a property tax elimination to achieve the target value of 27%
- . A sales tax exemption reduces the PV of WECS costs by only 5% and is not sufficient to reduce the PV of WECS costs by the required 27%. Another incentive would need to be applied in conjunction with a sales tax elimination to achieve the target value of 27%.

The nomograph has been constructed to allow the user to evaluate levels of incentives for any base case and for any combination of incentives.

3. For the "Rational" Farmer Using Loss Period and Payback Period as the Criteria to Evaluate Farm Investments, Graphs Have Been Constructed Which Allows One to Evaluate the Effects of Incentives

For the loss period and payback period decision criteria, the magnitude of the incentive necessary to make WECS cost competitive with purchased electricity, is the value necessary to reduce the loss period and payback period to their respective target values for farm investments.

EXHIBIT V-5
Impact of Incentives on Decisionmaking Criteria

	NET PRESENT VALUE (\$)	LOSS PERIOD (years)	PAYBACK PERIOD (years)
BASE CASE	- 7,400	16	21
Sensitivity to Installed WECS Cost			
. 1500/kW	- 600	14	16
. 1000/kW	6,200	3	11
. 500/kW	13,000	1	6
Sensitivity to Electricity Cost			
. .05/kWh	- 2,400	15	17
. .06/kWh	2,500	10	14
. .07/kWh	7,500	6	12
. .08/kWh	12,400	3	11
Sensitivity to Loan Term			
. 20 years	- 6,000	16	21
. 25 years	- 5,600	16	21
. 30 years	- 5,200	16	21
Target Values	≥ 0	1	15

EXHIBIT V-6
Present Value of Electricity and WECS Costs

EXHIBIT V-7 Agricultural Investment Nomogram

Exhibits V-8 and V-9 are generalized graphs which can be used to evaluate the effect of economic incentives to reduce the loss period and payback period respectively to the target values for farm investments. For the base case, the loss period for WECS investment is 16 years and the payback period for WECS investment is 24 years.

There are several economic incentives which can reduce the loss period from 16 years for the base case to the target value of 1 year. The effect of four economic incentives can be calculated from Exhibit V-8, which is similar to the graphs presented in the residential sector. The results are summarized below for the base case:

- . A direct cash subsidy or a tax credit of 55% reduces the loss period to the target value of 1 year
- . A 0% loan reduces the loss period from 16 years to 13 years, and is not sufficient to achieve the target reduction of 1 year
- . A sales tax exemption has no noticeable effect on loss period reduction.

Similarly, there are several economic incentives which can reduce the payback period from 24 years to the target value of 15 years (length of the loan). The effect of four economic incentives can be calculated from Exhibit V-9, which is similar to the graphs presented in the residential sector. The results are summarized below for the base case:

- . A 0% loan reduces the payback period from 24 years to 20 years. A 0% loan is not sufficient to achieve the target reduction of 15 years
- . A direct cash subsidy and a tax credit of 41% reduces the payback period to the target value of 15 years

A sales tax exemption reduces the pay-back period from 24 years to 22 years. A sales tax exemption is not sufficient to achieve the target reduction of 15 years.

These graphs have been constructed to allow the user to evaluate levels of incentive for any base case scenario and for any combination of incentives.

4. FEDERAL INCENTIVES NEED TO BE EVALUATED ON THE BASIS OF EFFECTIVENESS TO IMPROVE THE ECONOMICS OF WECS, COST OF ADMINISTERING INCENTIVES PROGRAMS, FARMER ACCEPTANCE AND INSTITUTIONAL LIMITATIONS

Agricultural WECS are being considered along with other solar options for economic assistance in state, local and Federal programs. The Food & Agriculture Act of 1977 has provisions to encourage the cooperative credit institutions to supply loans for the acquisition of any non-fossil energy application on the farm. Provisions are also given to encourage conservation. However, there are few if any direct economic incentives programs for WECS.

This section addresses the overall needs for and relative merits of various economic incentives options for agricultural WECS. Five options are evaluated for the agricultural market:

- . Direct cash subsidy
- . Tax credit
- .. Low interest loans
- . Property tax elimination
- . Sales tax elimination.

Each of the incentives options is examined with respect to:

- . Levels of incentive necessary to improve the economics of WECS relative to the economics of alternative energy
- .. Costs, implementation, administration and phase out of incentives programs

EXHIBIT V-8
Effect of Low Interest Loans
or Loss Period

EXHIBIT V-9
Effect of Low Interest Loans
on Payback Period

- Farmer acceptance and vehicles of information exchange.

(1) Direct Cash Subsidies and Tax Credits Can Have a Powerful Impact on WECS Economics, but Low Interest Loans, Property Tax and Sales Tax Exemptions Have Moderate to Small Effects

The levels of economic incentive necessary to make WECS cost competitive with alternative fuels in the agriculture market, depends, to a large extent, on the specific investment decision criteria employed by the "rational" farmer. The use of different criteria is related to the size of the farm and annual cash flow conditions of each farmer. In the previous section, the effect of five economic incentives to make WECS cost competitive was evaluated for three investment decision criteria:

- Net present value
- Loss period
- Payback period.

Larger, more sophisticated farms tend to use net present value criteria to evaluate investments, while smaller farmers who typically have annual cash flow problems are more concerned with loss period and payback criteria. A summary of the relevant calculations is shown in Exhibit V-10. These calculations are drawn from the nomographs and graphs presented in the previous section. The calculations were made using the base case assumptions on Exhibit V-4. The reader, however, can select his own assumptions to evaluate the effects of economic incentives on WECS. A more detailed description of the use of nomographs and the effects of economic incentives on payback and loss periods may be found in the residential sector.

As demonstrated on Exhibit V-10, direct cash subsidies or tax credits are effective incentives options, by themselves, to make the base case WECS cost comparative with electricity costs. The level of direct subsidy ranged from 30-55% and the level of tax credit ranged from 33-55%. Again the level of subsidy varies according to the evaluation criteria for the WECS investment. The levels of incentive needed were highest to successfully achieve the loss period hurdle

rates. This is primarily due to the fact that farmers using this loss period generally have financial (liquidity and annual cash flow) problems. Their major concern with respect to investments is short-term capital recovery and they will require added subsidies or credits to make a WECS investment.

Low interest loans have moderate effects on WECS economics. For only one criterion, that of net present value, was a low interest loan able to reduce base case WECS costs to competitive levels. For payback and loss period, low interest loans did not reduce WECS costs to meet target values for farm investments.

Property tax and sales tax exemptions provide relatively small improvements in WECS economics. These incentive options alone cannot achieve the required reduction in WECS costs to meet the target values for farm investments. Combinations of incentives would need to be considered. These incentive options could, however, become effective when the difference between the cost of WECS and alternative energy costs narrows.

(2) The Federal Government Has a Broad Range of Economic Incentive Strategies Available for Agricultural WECS. The Strategy Selected Should be Based on the Cost to the Government and Ease of Implementation

1. Estimation of Comparative Costs to the Government for the Various Incentives Involves Determination of Direct Subsidy and Administrative Costs

The costs of the subsidy are directly proportional to the sales volume of WECS and the level of incentive to make WECS cost effective. From the Government's perspective, the cost of a required level of incentive in total discounted dollars is the same whether the option is a cash subsidy, tax credit, tax exemption or low interest loan. To illustrate the point, a 27% reduction in present value of WECS costs is necessary to make WECS economically competitive for farmers. This reduction could be achieved through:

EXHIBIT V-10
Level of Incentive Required to Reach Target Values

INCENTIVE	NET PRESENT VALUE	LOSS PERIOD	PAYBACK PERIOD
Direct Subsidy (% reduction)	30	55	41
Tax Credit (% credit)	33	55	41
Low Interest Loan (loan interest rate)	2	N	N
Property Tax Exemption	N	N	N
Sales Tax Exemption	N	N	N

N: Not able to achieve the desired reduction and must be used in combination with additional incentives.

EXHIBIT V-11
Administrative Cost to the Government

TYPE OF INCENTIVE	ADMINISTRATIVE COSTS*		
	Start-up	Processing	Servicing
Direct Cash Subsidy	\$500,000	\$100/unit	-
Tax Credit	\$300,000	\$ 10/unit	-
Low Interest Loans	\$600,000	\$ 50/unit	\$30/unit/yr.
Property Tax Reduction	\$300,000	\$ 10/unit	-
Sales Tax Exemption	\$300,000	\$ 10/unit	-

* Figures for direct cash subsidy, tax credit, and government subsidy to lenders were derived by RUP I, Inc., "Federal Incentives for Solar Homes: An Assessment of Program Options, Appendix , page VI-8. These data were based on conversations with officials of HUD, FmHA, the Treasury Department, and the Federally-insured student loan program, and are intended to include salaries as well as office space and other overhead expenses. It is emphasized that these represent rough administrative cost breakdowns, which could vary by several orders of magnitude. Attempts by Booz, Allen & Hamilton to verify these estimates were unsuccessful.

Based on conversation with state and local officials, administrative costs associated with sales tax and property tax include program were assumed to be the same order of magnitude a Federal tax incentive programs.

- . A 30% direct subsidy
- . A 33% tax credit
- . A 2% low interest loan.

Each of these incentive options would cost the government 27% of the PV cost of WECS. (This assumes that the Government's discount rate is equal to the farmers'. Assuming different discount rates for the Government, however, will result in different costs for each incentive, but conclusions drawn from such analyses will only be as sound as the choice of discount rate--a controversial and often ambiguous process at best).

Estimates for administrative costs for each incentives, option, however, may vary considerably. As part of a solar market analysis, RUPI, Inc. (4) calculated the administrative costs of incentives programs in terms of three components:

- . Fixed, start-up costs
- . Processing costs
- . Annual servicing costs.

Administrative cost estimates obtained from this report are summarized in Exhibit V-11. As discussed in the previous chapter, the data were based on conversations with officials of HUD, FmHA, and the Treasury Department and attempts by Booz, Allen to verify these numbers with both state and Federal officials were unsuccessful.

The administrative startup costs vary from \$300,000-500,000 with associated processing costs ranging from \$10/unit-\$100/unit. A loan incentive program would also have a \$30/unit/yr. service cost. Accepting these estimates, as indicators of the relative costs likely to be incurred for the various options, it is observed that tax incentive options are least costly and low interest loan programs the most costly incentive option. The point to be stressed is that for large volumes of WECS purchased under an incentive program (i.e., 10,000 units), the administrative cost/unit becomes relatively insignificant when compared with the direct subsidy cost to the Government.

2. Direct Cash Subsidies and Tax Credits Are More Attractive Than Loan Programs on the Basis of Ease of Implementation to the Government

The practicality of using a specific incentives option depends, to a large extent, on three principal implementation issues:

- . Legislative attractiveness
- . Ease of phase-out
- . Risk to the Government.

Direct cash subsidies, tax incentives and Federal loans are discussed with respect to these issues.

Direct cash subsidies afford a great deal of administrative control. A cash subsidy program would involve several variations of a one-time cash payment to the agricultural investor of WECS. It would most commonly be given as:

- . A fixed amount with or without a maximum ceiling
- . Graduated subsidy.

Direct cash subsidies have several advantages with respect to Federal implementation:

- . Straightforward development of legislation to implement program because of the simplicity of the subsidy mechanism
- . Able to up-date and phase-out because Federal appropriations are subject to annual reviews
- . Federal risk is limited to the total subsidy allocation
- . Able to control and adjust ceilings on total subsidy allocation.

The major drawback to a direct subsidy, however, is that it may result in an artificially imposed high priced WECS system dominating the market for an extended period of time. The effect of market

forces to reduce WECS costs is less when the WECS system price is allowed to remain artificially high.

The use of the tax system is also a favorable mechanism to implement incentives, reflecting several advantages over cash subsidies:

- . Easy to implement and administer through the existing Federal tax system
- . Freedom from authorization ceilings and annual appropriation cycles
- . Numerous and often successful precedents in using tax provisions to encourage investments
- . Independent state action, especially in exempting WECS from sales and property seems likely to occur and should have a positive impact on WECS life-cycle costs.

There may be several disadvantages to tax incentives especially for sales and property tax exemptions which require further comment.

- . Sales and property taxes vary among state and local governments. This may result in regional differences in benefits from these tax exemptions
- . The administrative effort required in verification and certification processes could be significant
- . Complexities of coordinating state, local and Federal coordination of programs
- . It is potentially difficult to phase-out tax programs.

Federal programs to provide low cost financing are a familiar concept with precedents in FHA, VA and FmHA programs. In the agricultural market, the Farmers Home Administration has provided low interest loans to farmers for years. Even though a mechanism already exists to provide low interest loans to farmers (i.e., Farmers Home Administration), a Federal loan program specifically for WECS may have complexities which make it undesirable from an administrative standpoint:

- . A loan incentives program has higher administrative costs than either a tax credit or direct subsidy
- . . . Loan programs would be more difficult to phase out since they must continue for the length of the loan term, a period of up to 30 years
- . There is a high risk for low interest loans relative to subsidies and tax credits because of the potential for delinquent and defaulted payments.

(3) Farmer Acceptance of WECS is Central to the Success of an Incentives Program, and Depends on Both Economics and Non-Economic Issues

In the previous sections, WECS incentives in the agricultural market were examined to identify their economic impact, cost to the government, and ease of implementation and phase-out. This section presents an assessment of how the farmer views the various incentive options.

1. Reducing the Initial Cost of WECS is the Key Consideration to the Farmer

In designing an incentives program for the agricultural market, there are two options to consider:

- . A choice between first cost reducing options (direct subsidy and tax credit) and low interest loan programs
- . A choice between a direct cash subsidy and a tax credit if such an incentive is preferred by farmers over a loan program.

Typically, farmers consider investments to improve and increase production capabilities. The two major investments made by farmers are the acquisition of land and the purchase of new production machines and equipment. Under normal circumstances, farm capital is committed years in advance for these investments. Investments in cost-cutting activities, such as an investment in WECS, are often of second order importance to farmers, even though the economics of WECS demonstrates that they can maximize returns in the long-term.

As such, investments in WECS by farmers will be made by use of discretionary income in most cases. Under these conditions, the farmer closely resembles the residential investor. His major concern is with raising the necessary capital for the investment and rapid recovery of the capital. If the initial costs of WECS are extremely high, most farmers will have difficulty in raising enough capital to finance the investment, especially those farmers who have annual cash flow difficulties.

An incentive which reduces the first cost of the WECS will be more acceptable to farm investors than an equivalent low interest loan incentive. Both direct cash subsidies and tax credits are preferred by farmers because of their emphasis in reducing first cost.

Experience in the solar industry, as applied to the residential market, indicates that direct cash subsidies are preferred to tax credits and low interest loans.(5) Some of the suggested reasons are applicable to the agricultural market:

- . The certainty in receiving the full amount of the incentives benefit, since it is not affected by tax liability
- . The direct receipt of payment at or near the purchase date, offsetting the need to finance the full system cost
- . The possibility of applying the subsidy as partial payment or downpayment in the loan.

For the same reasons, a rebate received at the time of purchase is more acceptable to the farm investor than a rebate applied for at the time of purchase with a subsequent delay. This may be achieved by directing the rebate toward the manufacturer or distributor, with appropriate assurance that he pass it through to the consumer.

For farmers most concerned with first cost, sales and property tax exemptions are largely symbolic. Typically, these incentives can provide only a small impact on cost reductions.

2. Farmers Are Extremely Concerned With Risk and Uncertainty

In the agricultural sector, the commitment of capital in the expectation of financial returns in the short and the long run is characterized by considerable risk and uncertainty. Sources of risk include variability in crop yield due to uncertain weather conditions and seasonal product price variations. Because farming is a high risk business, farmers may hesitate to make an investment in WECS, where the financial returns are likely to be realized over a long time period.

Agricultural lenders are also concerned about risk and uncertainty. Respondents to a finance survey were asked whether the risk associated with farm lending in 1975 had changed as compared with previous years.(6) Sixty percent believed that the risk of making farm loans had increased. If agricultural lenders view an investment in WECS as risky because of a perceived high degree of uncertainty in system reliability and performance, then they will likely:

- . Reduce the amount of funds extended
- . Increase interest rates
- . Increase security requirements
- . Decrease the term of the loan
- . Increase the supervision of the loan.

The long-run trend towards the commercialization of U.S. farms may have amplified the impact of risk and variability in farming incomes. A larger portion of farm investments are purchased from off-the-farm sources, and specialization has decreased the diversity of farm enterprises. Farms are larger and typically use more debt capital. In some cases, for example, the farmer can finance up to 100% of the appraised market value of the farm. Thus the already difficult problems of farm financial management are aggravated by variable income cash flow. Farmers may be unwilling to use discretionary income to invest in WECS under these conditions.

Farmers are risk averse, implying that a demonstration program for WECS will be adviseable before an economic incentives program is implemented. The agricultural market regards system performance and reliability of WECS as important as the economic factors.

5. DEPENDING ON THE SPECIFIC REMOTE APPLICATION CONSIDERED, THE REMOTE MARKET FOR WECS CLOSELY PARALLELS THE OTHER MARKETS FOR WECS. THE UNIQUE ASPECT OF THE REMOTE MARKET IS THE HIGH COST OF ENERGY

In the context of this study, the remote market consists of a broad and diverse cross section of users including:

- . Remote homeowners and farmers
- . Remote residential communities
- . Government projects and facilities
- . Remote electric power generation.

In fact, depending on the specific remote application considered, the remote market for WECS closely resembles the residential, agricultural, industrial and utility markets for WECS. The unique aspect of the remote market is the high cost for alternative fuels and, as such, this market exhibits a high potential for the application of WECS.

Because of the similarities between the remote sector and the other WECS market sectors, it is not necessary to present a separate economic analysis for the remote market. A comprehensive evaluation of the economics of WECS for the remote market can rely heavily on economic analyses of the other WECS market sectors, depending on the specific remote application being considered. The effect of incentives could be similar except that the cost of alternative energy would be much higher.

Typically, the remote market relies heavily on oil and gas to supply energy needs. In remote areas, such as Alaska, the cost of oil and gas fuels can be extremely high. At high prices, WECS will be cost competitive without Federal incentives. In fact, using the base case assumptions for farm investments, the price of electricity which would make WECS cost competitive without Federal incentives is about \$.06/kWh. If the cost of electricity is even higher, then the "rational" man model implies that Federal incentives are unnecessary since the "rational" investor will purchase WECS anyway.

For cases where the cost of alternative fuels is less than \$.06/kWh then economic incentives would be necessary to stimulate investments. Again the decision-making criteria, target values, and investment assumptions would depend on the specific remote application being considered. The user of this report is reminded to refer to the appropriate WECS market to evaluate the effects of incentives on the remote market along with a suitably high fuel cost.

There is little evidence of significant purchases of WECS by the remote market, even though the economics of WECS demonstrates that these systems can be cost-competitive with alternative energy systems in many cases. Two possible explanations are:

- . Lack of demonstrated performance or reliability of WECS
- . Lack of information exchange among government officials, WECS manufacturers and distributors, and potential remote WECS investors.

Accepting these reasons, it is recommended that a demonstration program for WECS be established with the express purpose of informing the remote market about the use of WECS. The current test program at Rocky Flats, Colorado, is an

important first step, but testing needs to be conducted under more realistic user environments. Using small scale WECS on remote government facilities, schools and university buildings, and remote residential homes could serve as a demonstration program. Government procurement as an incentive to WECS is discussed at some length in Appendix C.

6. UNTIL THE PERFORMANCE AND RELIABILITY OF WECS IS DEMONSTRATED, ECONOMIC INCENTIVES IN THE AGRICULTURAL SECTOR MAY BE PREMATURE

In contrast to a number of other technological areas which traditionally involve major Federal R&D efforts (i.e., defense and aerospace), the major direct influence of the Government over the ultimate utilization of WECS in the agriculture and remote markets is by technology demonstration and then followed by implementation of appropriate economic incentives. Without appropriate demonstration and associated incentives, the progression of WECS to the point where they achieve significant levels of market penetration is likely to follow the evolutionary market processes, which have typified previous technological innovations. The time scale for eventual significant market penetration could take decades.

Although windpower was used in the agricultural market some 50 years ago, the resurgence of use of WECS for agricultural and remote applications is in its infancy. Natural gas, propane, oil and electricity collectively account for more than 95% of the energy used in these markets. Economic performance and reliability considerations together represent the major constraints on the more widespread utilization of WECS in the agricultural and remote markets.

As of 1978, the WECS industry and infrastructure are still largely in pre-economic phases. The present volume of production and installation of WECS in the agricultural and remote markets is dominated by market conditions not based on economic competition with alternative energy sources. This has resulted in an insignificant market for WECS. WECS are being produced and installed by some manufacturers in the agricultural and remote markets on an experimental basis to gain experience, and to acquire costs and performance data on which to base future planning. However, what is necessary at the present time are demonstration projects using small scale WECS in the agricultural and remote markets. The effect of this would be to catalyze the processes of technology transfer concerning performance and

reliability to ensure that potential agricultural and remote investors become effectively and responsibly informed of the characteristics and implications of WECS. Only after these systems have been demonstrated to be technically reliable can effective incentive programs be implemented.

Clearly, the most effective and powerful incentives for WECS in the agricultural and remote markets are direct cash subsidies and tax credits, particularly at the early stages of WECS development. Farmers and remote WECS users need a strong economic stimulus to invest in WECS. As the volume of WECS increases and it becomes evident that these systems are reliable and cost-competitive, low interest loan programs as well as state and local tax exemptions could serve as effective incentives. A limited loan program would provide for increased availability of financing, and combined with a direct subsidy or tax credit (presuming WECS costs are still high), could stimulate early investments.

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This chapter has evaluated the relative merits of alternative incentive options to stimulate the use of WECS in the agricultural and remote markets. The conclusion can be made that economic incentives could be effective in making WECS cost competitive with alternative energy sources, but such incentives should only be implemented after the performance and reliability of WECS have been demonstrated through a Federal demonstration program.

In the next chapter, the impact of economic incentives on the industrial market for WECS is examined.

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VI. INCENTIVES TO THE INDUSTRIAL WECS MARKET

This chapter presents an assessment of the industrial market for wind energy conversion systems (WECS) and an identification of incentives which would be most effective in stimulating the industrial market. The discussion is presented in four parts:

- . Identification of investment decisionmaking methods and criteria
- . Assessment of the industrial market for WECS
- . Financial analysis of industrial WECS investments
- . Identification of incentives to stimulate the industrial market.

1. THE INDUSTRIAL MARKET IS EXPECTED TO APPLY STRINGENT CRITERIA ON WECS INVESTMENT RETURNS AND RISKS

The power of federal incentives to stimulate an industrial WECS market depends, to a large extent, on the specific capital budgeting technique employed by firms receiving the incentive benefits. To initiate an assessment of incentives, this section identifies the measures and criteria currently employed by industry.

(1) The Industrial Capital Budgeting Process Takes Into Consideration Financial Returns, Risks and Uncertainties, and a Host of Nonfinancial Factors

Commitment of capital in the expectation of returns over an extended period (ten to thirty years for WECS) is an action often characterized by considerable risk and uncertainty. Economic, political, environmental and regulatory factors make forecasting difficult, if not impossible in some cases.(1) Extended time horizons severely reduce the confidence placed in latter year cash flow forecasts. For this reason, industrial decisionmakers are often short-term oriented and typically limit analysis to ten years. This factor

alone represents a constraint to industrial investments in WECS, for which full benefits may be derived over a period of 20 years or more.

In most energy investment decisions, there are five economic/financial considerations which have been found to have particular importance to decisionmakers:

- . Return on investment
- . Average cost of capital to the firm
- . Prevailing economic conditions
- . Potential impacts on existing and/or future capital investment projects
- . Irreversibility of investment decisions.

Additionally, several nonfinancial (and frequently nonquantifiable) factors must also be considered in assessing risk:

- . Environmental, safety and health regulations
- . Impacts on product quality and firm reputation
- . Political, legal and social factors.

(2) In the Attempt to Consider Major Factors Properly, Firms Have Developed and Currently Employ a Variety of Capital Budgeting Techniques

While each firm uses a different process of capital budgeting according to management preferences, there are five techniques in widespread use today, as summarized in Exhibit VI-1:

- . Payback period, which measures the time for the cumulative receipts from the project to cover the expenditures necessary to implement the project
- . Internal rate of return, which is the discount rate which equates the present value of cash receipts (or cash savings) from a capital investment with the present value of cash outlays made to support the investment

EXHIBIT VI-1
Corporate Investment Decisionmaking Measures

MEASURE	QUANTITATIVE DEFINITION
1. <u>Payback Period (P)</u>	$P = X/Y$ <p>where: X = initial investment</p> <p>Y = average annual savings (before tax)</p>
2. <u>Internal Rate of Return (IRR)</u>	$IRR = R, \text{ where } 0 = \sum_{i=0}^N \frac{C_i}{(1+R)^i}$ <p>where: C_i = net cash flow in year i</p> <p>R = effective discount factor</p>
3. <u>Return on Investment (ROI)</u>	$ROI = Y/X$ <p>where: Y = average annual savings (before tax)</p> <p>X = initial investment</p>
4. <u>Net Present Value (NPV)</u>	$NPV = \sum_{i=0}^N \frac{(A-B)}{(1+R)^i}$ <p>where: A = cash income B = cash costs R = corporate discount rate N = useful life of investment</p>
5. <u>Benefit/Cost Ratio (B/C)</u>	$B/C = \frac{\sum_{i=0}^N A_i}{\sum_{i=0}^N B_i}$ <p>where: A = cash income B = cash costs N = useful life of investment</p>

- . Return on investment, which is measure of annual percentage return, calculated by dividing average annual income by the initial investment
- . Net present value, which is the positive (or negative) difference of the present value of outlays and receipts, each discounted at the company's investment "hurdle rate"
- . Benefit/cost ratio, which is calculated by dividing the present value of receipts by the present value of outlays.

(3) The Most Common Method of Analysis is Internal Rate of Return, Although a Number of Corporate Factors Influence the Type of Capital Budgeting Technique Employed by Each Firm

Techniques employed by each firm change over time, with growth, and with changes in management. The most common method in use by industry today is Internal Rate of Return (IRR), however. Of the many factors which influence the choice of technique, there are four key issues to consider:

- . Degree of financial stature and expertise. Large firms generally use more sophisticated techniques (for example, net present value and internal rate of return).
- . Liquidity posture. Payback is typically used by firms with liquidity problems, as the major concern is capital recovery.
- . Relative size of the capital budget. Multiple techniques are generally used by firms with large capital budgets, in terms of dollar value or number of proposed projects.
- . Forecasting capability. Payback is typically employed by firms which lack expertise in longer range forecasting.

(4) Larger, More Sophisticated Firms Often Employ Discounted Cash Flow Techniques and Risk Assessment

A number of risk/return analysis techniques have been developed through academic research. Two methods in use by large, sophisticated firms are as follows:

- . Expected monetary value, in which the expected values of future cash flows to the firm, and thus the expected net present value of a project, are calculated.
- . The mean-variance approach, which utilizes the expected values of future cash flows as the measure of return and the standard deviation of the returns about the trend as the measure of risk.

(5) The Effectiveness of Particular Federal Incentive Will Generally Depend Upon the Specific Capital Budgeting Technique Employed in the Industry/Firm

Economic incentives which operate to increase the inherent profitability of a project (e.g., tax credits) will have an effect if the firm uses any of the five major techniques:

- . These incentives work to increase a project's cash flow.
- . Each of the five major techniques discussed in this section involve a project's cash flow stream in their determination.

Conversely, economic incentives which reduce a firm's cost of capital (e.g., loan guarantees and elimination of double taxation on corporate profits) will have no effect in the case of a firm using the payback budgeting technique, and little effect if the WECS loan is "rolled into" the company's average cost of capital:

- . Payback does not utilize the cost of capital in its determination of the profitability inherent to a given project.

Firms which use a percentage return (e.g., internal rate of return) could, on the other hand, be affected by a cost of capital incentive since the overall corporate investment "hurdle rate" would be lowered by the infusion of low-cost funds.

Importantly, however, most corporations do not assess investment viability on the basis of the cost of capital for each investment. Rather, the amount of capital funds available each year is determined by profitability and financial objectives for debt and equity structure. Given an annual allocation of capital funds, alternative investments are evaluated on their own merits against each other and against the average cost of capital to the firm, which then serves as an absolute minimum below which no investments are made.

(6) To Stimulate Industrial WECS Purchases, Federal Incentives Must Improve Financial Benefits Beyond Corporate Investment Hurdle Rates Which May Exceed 30 Percent

Manufacturers return on total capital invested is about 10 percent today.(2) Typically, however, corporations establish investment criteria at a higher level to promote growth. As a general rule, corporate investment criteria include internal rates of return near 15 percent, although these criteria vary between industries and individual companies.

Corporate investment criteria also are a function of the type of investment(3):

- Investments which increase sales, production and profits will generally have to exceed a return of 15 percent.
- Investments which enhance profits by reducing costs, and do not provide growth will generally have to exceed a return of 30 percent.

By establishing higher investment hurdle rates for non-growth investments, managers are, in effect, expressing their higher priority on growth than on cost-cutting as a means to profitability.

* * * *

This section has briefly discussed the principal capital budgeting techniques employed currently by industry. The next section presents an assessment of the industrial market for WECS.

2. HISTORICAL PRECEDENT AND INDUSTRIAL ENERGY USE PATTERNS INDICATE THAT AN INDUSTRIAL WECS MARKET WILL BE DIFFICULT TO CREATE

A number of recent studies have concluded that industry is a major potential market for wind energy conversion systems (WECS). These market estimates, based on potential economic comparisons of WECS and alternative sources of industrial electricity, indicate that WECS has the potential to become an important source of energy to industry and can have significant impact on the national energy situation.

It is not, however, possible at this time to support an argument, in fact, for or against wind power for industry. There is no historical precedent, since WECS are not being used by industry today. Another uncertainty is in the technology, which is still emerging through government and private R&D. Finally, and importantly, the future conditions under which industry will make capital investment decisions are not known and, as illustrated by the 1973 and subsequent world oil events, can be difficult if not impossible to predict.

Recognizing these uncertainties, the following discussion is an appraisal of the industrial market for WECS, intended to define major constraints to a nationally significant market and serve as background for incentives analysis.

(1) The WECS Investment Decision is Made in the Context of Total Energy Planning for Each Plant

A company's planning process includes analysis of energy uses, suitable energy forms, and alternative energy sources. As shown in Exhibit VI-2, the energy planning process includes three major steps:

- . Total energy requirements for each function are determined

EXHIBIT VI-2
Industrial Energy Planning Process

- . Energy forms for each function are selected
- . The source(s) of each form of energy is selected; in this case, the form is electricity and there are three alternatives:
 - Purchase from utility
 - Generate with internal equipment
 - Purchase and generate in some mix.

Selecting the source of electricity is done in the context of corporate strategy and manufacturing policy. It represents a classic make-or-buy decision which is comparable to decisions to integrate upstream into other process inputs, such as materials supply or equipment manufacture. In the WECS case, industry is implicitly integrating upstream into the electric utility function.

(2) There Are Three Potential Uses of WECS in Industry: As a Primary Source, Backup Source, or Supplementary Source of Electricity

Primary sources are those that supply the bulk of a plant's electricity. Specifically, plant operations depend directly on the availability of primary power. For this reason, the criteria for selecting the primary source are typically as follows:

- . Management preferences
- . Reliability of supply
- . Economics.

Backup sources, the second major category, are used by industry to guard against failure of the primary source. Only a small percentage of industrial plants have backup systems installed. Where utilities are the primary source, failure can occur as brownout/blackout or line damage. For these cases, internal systems such as diesel or gas turbine generators are installed for stand-by capability. Conversely, where large internal systems provide primary power, utilities provide backup, typically.

Supplementary sources, the third major category, are internal systems which are selected and designed for economic reasons. In general, supplementary sources are selected for plant-specific reasons:

. Unique availability of low-cost energy, e.g.:

- Coal, oil or gas
- Steam for cogeneration
- Combustible waste materials
- Hydropower
- Solar (insolation)
- Geothermal energy
- Wind.

. Growth requirements to fill a gap between primary source limits and actual need

. Other plant-specific reasons.

In a broad sense, WECS could be considered for any of these three source functions. There are, however, clear limits to industry's use of WECS.

(3) WECS Will Likely Be Limited in the Industrial Market to Use as a Supplementary Source of Electricity, and Will Compete Against a Variety of Other Technologies

Wind systems have potential to be compatible with industry's criteria for supplementary sources of electricity. The key determinant of whether industry will invest in WECS technology is its relative advantages when compared to alternative supplementary systems.

As shown previously in Exhibit VI-2, industry has a number of technologies available, and proven, for supplementary electricity generation today:

- . Fossil-fired steam generators or cogenerators including coal, oil, and, in gas-producing states, natural gas
- . Waste materials-fired steam generators
- . Gas turbine generators
- . Diesel-driven generators.

In addition, federal and private R&D programs are developing new technologies besides WECS:

- . Fuel cells
- . Solar (thermal, photovoltaic, etc.)
- . Geothermal.

With the variety of alternatives available for internal generation systems, industrial firms will require evidence, not only of the advantages of generating electricity internally, but the advantages of investing in WECS rather than other equipment. An assessment of present industrial patterns provides important indicators for the future, as discussed in the next section.

(4) The Precedent Exhibited By Industry for Investing In Supplementary Source Technology Indicates That the Industrial WECS Market Will be Sporadic and Difficult to Define

In 1975, industry generated approximately 11 percent of its electricity needs. The percentage for individual industries varied, however, from zero to over 50 percent, as shown in Exhibit VI-3.

Only a small number of industries generate a major fraction of their electricity needs today. The 17 industry groups identified in Exhibit VI-3 account for 90 percent of industry's self-generated electricity while consuming only 60 percent of total industrial electricity. These 17 industry groups fall into four major categories:

- . Paper plants, including pulp, paper and paperboard mills
- . Sugar producers
- . Chemical plants, including industrial organics and inorganics, agricultural chemicals and drugs
- . Metal producers, including steel and non-ferrous metals (principally aluminum).

However, industry has not made major capital commitments to supplementary electricity sources unless unusually favorable conditions occur across an industry.

Importantly, each of the four key industry groups operates in a unique situation of cheap fuel, waste materials, waste heat, process steam, or hydropower that is common across the industry(4):

- . Paper-related plants and sugar plants have large amounts of waste materials that are difficult to dispose of, highly combustible, and easily used as boiler fuel for steam generators. Also, many paper plants are often located in isolated areas where utility power is not available.

Chemical plants utilize large volumes of steam that is easily adaptable to cogeneration, or large amounts of electricity on a constant basis which makes internal generation economically attractive.

- . Aluminum plants have been located to take advantage of cheap hydropower, since electricity is the major energy input to the aluminum process. Several companies own, or have joint ventures with utilities, in hydroelectric facilities.

In fact, most industrial companies rely almost entirely on utility power. All the remaining industry groups not shown previously in Exhibit VI-3 account for less than 10 percent of industry's self-generated electricity while consuming 40 percent of industry electricity. On average, these firms generated only 2.3 percent of their electricity needs, and a large number of industry groups generated none, or negligible amounts.

Further, it is crucial to note that the industries which are most heavily dependent on electricity do not generate supplementary power to a substantial degree. According to 1975 data(5), industries that generated a significant fraction of their electricity were only dependent on electricity for 10 to 20 percent of their total energy. In fact, there is a clear pattern that highly electricity-dependent industries do not generate substantial fractions of their needs, and, as industries become more highly dependent upon electricity, they increase their reliance on utilities. Complete explanations for this pattern are not available. There are, however, several reasonable causes:

EXHIBIT VI-3
Major Electricity Generating Industries
(1975)

SIC	INDUSTRY	TOTAL ELECTRICITY (MILLION kwh)	INTERNAL GENERATION (MILLION kwh) (PERCENT)
2631	Paperboard Mills	19,889.6	10,304.0 51.8%
2611	Pulp Mills	4,732.9	2,187.4 46.2%
2621	Papermills	29,334.4	11,729.8 40.0%
2060	Sugar, Confectionary	3,221.0	1,277.0 39.5%
2860	Ind. Organic Chemicals	30,679.0	7,369.8 24.0%
29	Petroleum & Coal Prod.*	30,621.7	4,223.3 13.8%
3310	Blast Furnace, Steel	58,970.1	7,778.8 13.2%
2040	Grain Mill Products	6,437.0	776.7 11.9%
3330	Primary Non-Ferrous	68,049.9	5,943.1 8.7%
2890	Misc. Chemical Prod.	2,667.8	208.7 7.9%
2870	Agricultural Chemicals	9,170.9	676.6 7.4%
2260	Textile Fin., Exc. wool	2,163.7	155.9 7.2%
2810	Ind. Inorganic Chem.	76,727.0	4,709.3 6.1%
2830	Drugs	3,377.6	154.3 4.6%
3510	Engines & Turbines	2,202.6	96.7 4.3%
3241	Cement, Hydrallic	9,189.1	394.7 4.2%
2661	Building Paper & Board	1,377.9	58.6 4.2%
SUBTOTAL		358,812.2	58,034.7 16.2%
All Other Industry		232,846.5	5,240.3 2.3%
TOTAL INDUSTRY		591,658.7	63,275.0 10.7%

* PETROLEUM REFINING ACCOUNTS FOR OVER 81 PERCENT OF ELECTRICITY CONSUMED IN SIC 29

SOURCE: U.S. DEPARTMENT OF COMMERCE, ANNUAL SURVEY OF MANUFACTURERS 1975:
FUELS AND ELECTRIC ENERGY CONSUMED, SEPTEMBER 1977

- . Companies that are heavily dependent on electricity have been able to locate plants where utility companies can guarantee supply or provide special incentive rates for volume purchases or constant demand.
- . Utility rates for industry, which are based on declining-block charges, offer economic advantages to large industrial customers and encourage high load factors and heavy kWh purchases.

(5) While Historical and Current Patterns are Important Indicators of the Future, New Industrial Patterns are Likely Since Energy Costs and Availability Are Changing Rapidly.

The industrial market for WECS will be determined by several key factors:

- . Utility rates and rate structures for industry
- . Extent that industry adopts the practice of generating supplementary electricity
- . Economic advantages of WECS over other supplementary source technologies
- . The extent to which corporate capital budgeting strategies permit investment in WECS.

There are considerable uncertainties associated with each of these factors.

* * * *

This section has assessed the industrial WECS market from the energy-use point of view, concluding that the market will be difficult to create for pragmatic business reasons. Nonetheless, the potential may be significant under changed conditions. To further explore this potential, the following section evaluates financial feasibility of industrial WECS, and identifies the key barriers which must be overcome.

3. THE MAJOR BARRIERS TO INDUSTRIAL WECS PURCHASES INVOLVE LOW FINANCIAL RETURNS AND HIGH APPARENT RISKS

This section identifies the key variables in the investment analysis, provides an illustrative case example, and assesses the barriers to a widespread WECS market.

(1) Economic Analysis of a Potential WECS Investment is a Complex Calculation of a Plant's Total Electricity Costs

If WECS were used as a primary or backup source, a straightforward calculation of cost per kilowatt-hour would provide adequate information to compare alternative sources.

However, because WECS is expected to be used as a supplementary source of electricity, its principal function is cost reduction. For this reason, the investment analysis is based on total plant electricity costs, with and without WECS. A large number of variables are important to the analysis:

- . Plant electric requirements
 - kWh usage
 - kW load; both average and peak.
- . Utility costs
 - Energy (kWh) rate structure
 - Demand (kW) rate structure
- . WECS costs
 - Investment costs (\$/kW)
 - Operating costs (\$/kW/year).
- . WECS performance
 - Capacity factor
 - Time correlation of load and power.
- . Company financial factors
 - Depreciation expense schedule
 - Cost of capital

- . Debt
- . Equity
- Income tax rate
- Investment tax credits.

(2) A Hypothetical Case Example Has Been Developed to Illustrate Corporate Financial Decisionmaking for a Potential WECS Purchase

A large industrial plant in the Potomac Electric Power Company's (PEPCO) Service area (Washington, D.C.) is assumed to have the characteristics shown in Exhibit VI-4.

Energy costs are calculated in the case example before WECS is installed and after installation of a WECS unit. The WECS unit is assumed to have the following characteristics:

- . Investment cost is \$200 per kWe, installed.
- . The system is designed to contribute 25 percent of the plant's electricity requirements (as a supplementary source).
- . Capacity factor is 30 percent.

The required size of WECS is 3,750 kWe for a plant with peak load of 5,000 kWe and average load of 4,500 kWe. Total installed cost is \$750,000.

Exhibit VI-5 illustrates the cost reduction calculation, using PEPCO's "GS-4" industrial rate structure with summer and winter rates averaged to an annual rate structure. The plant's internal energy and operating costs are assumed to be zero without the WECS units (the utility has responsibility for all operating, maintenance, depreciation and insurance costs of providing electricity to the plant before WECS is installed).

(3) The Key Constraint to Creating a Large Industrial Market is Achieving High Investment Returns

The financial results of the hypothetical WECS investment are summarized in Exhibit VI-6. Key results are as follows:

- . Paypack period is 14 years before taking into consideration income taxes and tax credits, based on first year gross savings
- . Return on Investment (ROI) is 7.2 percent before taxes, based on first year gross savings
- . Internal Rate of Return (IRR) is 11.1 percent, however, based on after-tax cash flows. The firm's cost of capital is assumed to be 12 percent, which serves as an investment "hurdle rate." The WECS investment is not likely to be made in this example, depending upon the relative positions of other, competing investment options.

(4) A Second Barrier to Industrial Use of WECS is the Inherently High Degree of Uncertainty in Economic Benefits

Capital investment decisions are made on the basis of Return on Investment (ROI), Internal Rate of Return (IRR), Payback, or other measures of financial return. The major problem facing investment decisionmakers is the risk associated with the results.

In the case of WECS, key risks are that the system will not deliver electricity when it is needed, or in the amounts that were assumed in decision analysis due to annual variations in wind speeds. These risks can be expected to be critically evaluated by corporate managers, who themselves are evaluated on the financial results of their investment decisions.

The criteria for assessing investment risks are focused less on whether or not they exist, than on their characteristics. The key questions are whether the risks are:

- . Understood
- . Measurable
- . Predictable
- . Controllable.

EXHIBIT VI-4
Case Example Assumptions

INVESTMENT FACTOR	ASSUMPTION
1. <u>Industrial Facility</u>	
. Operations	365 days/year; 24 hours/day
. Peak electric load	5,000 kWe
. Average electric load	4,500 kWe
. Annual electricity	39.42 million kWh/year
2. <u>Wind Energy Conversion System</u>	
. Capital cost, installed	\$200 per kWe
. Capacity factor	30 percent
. Energy contribution	25 percent (design criterion)
. System size required	3,750 kWe
. Total system cost	\$750,000
. Annual O&M	\$15,000 per year
. Useful life	20 years
3. <u>Financial Factors</u>	
. Price of displaced electricity	PEPCO "GS-4" rates
. Equipment depreciation	20 years, straight-line
. Income tax rate	48 percent
. Investment tax credit	10 percent
. Corporate cost of capital	12 percent
4. <u>Economic Factors</u>	
. Rate of electric rate increase	2 percent over inflation
. Inflation rate	5 percent per year

EXHIBIT VI-5
Case Example Utility Bill Savings

Utility Costs Per Month Without WECS

BLOCK	USAGE/MONTH	RATE	COST
Energy			
First	6,000 kWh	@ 4.85¢	\$ 291
Next	1,000,000 kWh	@ 2.49¢	24,900
Next	1,000,000 kWh	@ 1.49¢	14,900
Next	<u>1,279,000 kWh</u>	@ 1.20¢	<u>15,348</u>
Total	3,285,000 kWh		\$55,439
Demand	5,000 kW	@ \$4.60	\$23,030
Utility Cost Without WECS			\$78,469

Utility Costs Per Month With WECS

BLOCK	USAGE/MONTH	RATE	COST
Energy			
First	6,000 kWh	@ 4.85¢	\$ 291
Next	1,000,000 kWh	@ 2.49¢	24,900
Next	1,000,000 kWh	@ 1.49¢	14,900
Next	<u>457,750 kWh</u>	@ 1.20¢	<u>5,493</u>
Total	2,463,750 kWh		\$ 45,584
Demand	5,000 kW	@ \$4.60	\$ 23,030
Utility Cost with WECS			\$ 68,614
Monthly Cost Savings			\$ 9,855
Annual Cost Savings			\$118,260

EXHIBIT VI-6
Industrial WECS Investment
Case Example Cash Flows

Investment Factor*	Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Utility Cost Savings	-	\$118.3	\$126.6	\$135.4	\$144.9	\$155.0	\$165.9	\$177.5	\$190.0	\$203.2	\$217.5	\$232.7	\$248.9	\$266.4	\$285.0	\$305.0	\$326.4	\$349.2	\$373.6	\$399.8	\$427.8
Less: WECS O&M Costs	-	(15.0)	(15.8)	(16.5)	(17.4)	(18.2)	(19.1)	(20.1)	(21.1)	(22.2)	(23.3)	(24.4)	(25.7)	(26.9)	(28.3)	(29.7)	(31.2)	(32.7)	(34.4)	(36.1)	(37.9)
Equals: Savings Before Tax	-	103.3	110.8	118.9	127.5	136.8	146.8	157.4	168.9	181.0	194.2	208.3	223.2	239.5	256.7	275.3	295.2	316.5	339.2	363.7	389.9
Less: Income Tax (48%)	-	(49.6)	(53.2)	(57.1)	(61.2)	(65.7)	(70.5)	(75.6)	(81.0)	(86.9)	(93.2)	(100.0)	(107.1)	(114.9)	(123.2)	(132.1)	(141.7)	(151.9)	(162.8)	(174.6)	(187.2)
Equals: Savings After Tax	-	53.7	57.6	61.8	66.3	71.1	76.3	81.8	87.9	94.1	101.0	108.3	116.1	124.6	133.5	143.2	153.5	164.6	176.4	189.1	202.7
Plus: Depreciation Cash Flow	-	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2
Plus: Tax Credits	-	75.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Less: Investment Outlays**	(750.0)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Equals: Annual Cash Flow†	(\$750.0)	\$144.9	\$ 73.8	\$ 78.0	\$ 82.5	\$ 87.3	\$ 92.5	\$ 98.0	\$104.1	\$110.3	\$117.2	\$124.5	\$132.3	\$140.8	\$149.7	\$159.4	\$169.7	\$180.8	\$192.6	\$205.3	\$218.9

* See Exhibit VI-4 for key assumptions and Exhibit VI-5 for utility bill reduction (savings).
** Investment outlay is made from corporate capital funds which have been made available by debt and equity transactions.
† All dollars are current (inflated) dollars, utilizing a 5 percent average annual inflation rate on C&M costs and a 7 percent electric rate increase factor.

The most important factor is the degree to which risks are controllable. Without control, the responsible manager is not capable of taking action to correct deteriorating or shortfall situations.

In the case of WECS, the key risk—wind speed variation—is not controllable. This important aspect of an industrial WECS investment represents the most significant barrier to actual deployment of WECS technology to industry.

(5) Today's Utility Rate Structures Are an Implicit Barrier, Since WECS Will Have to Deliver Electricity at an Average Cost That is Lower Than the Lowest Utility Rate

Currently utility rate structures for industry are typically one of three types(6):

- . Wright Demand Rate, in which demand charges are included in an initial high rate per kWh (applicable to a certain number of hours' use of a customer's load) with all excess kWh being at a lower rate.
- . Hopkinson Demand Rate, in which a demand charge is made for peak load, and, separately, a Block Meter Rate is charged for kWh usage at decreasing prices for each succeeding block.
- . Three Part Rate, in which a customer charge is added to the demand charges and energy charges of the Hopkinson Demand Rate.

Each of these industrial rate structures encourage constant-level energy consumption, and discourage investment in WECS:

- . As a supplementary source, WECS energy will replace the "last" kilowatt-hours that would have been bought from the utility, which is the lowest-priced electricity.

As an energy source without guaranteed power at any point in time, WECS will have little or no effect on demand charges, which are established in some cases by contract between the utility and the company, and in other cases by the peak load actually measured in a day or month.

While not a specific barrier to WECS deployment, utility rate structures are expected to discourage an industrial market for two reasons:

- Managements will find it difficult to rationalize making capital investments to displace their cheapest kilowatt-hours of electricity
- WECS will have to deliver kWh at an average cost that is lower than the lowest rates charged on the plant in question by electric utilities before the investments appear advantageous.

In addition to considerations of the economics of WECS, the major factor in industrial decisionmaking is the fit between the investment and corporate strategies and policies.

(6) Finally, the Principles of Strategic Planning May Preclude Investment in Apparently Economic WECS Units

Investments in production efficiency and cost-cutting are often less important to a growing company than one that has either reached a stage of stability or serves a declining market. The key question to management is how profits can best be leveraged through capital investment. In many cases, the greatest leverage is achieved through investments in sales growth and new products, rather than cost cutting. The following are hypothetical scenarios that illustrate situations which may preclude economical WECS investments:

Corporate management decides that the company is not "in the business of" generating electricity and chooses to rely entirely on electric utilities rather than integrate into that business.

The company is more interested in breaking into new markets than in competing efficiently in existing markets.

The company competes on the basis of product quality or customer service, and not on the basis of price. For this reason, it has little incentive to invest in efficiency.

The company is a financially-oriented operation that buys and sells smaller companies much as an individual buys and sells stock. Without long-term interest in the individual companies, the parent will allocate little funds for long-term investments like WECS. (The average life of all manufacturing equipment is 14 years. At an estimated life of 20 years, WECS is a long term investment.)(7)

Each company in the U.S. operates under a unique strategy, and for this reason it is difficult to generalize. The crucial issue is, however, that while no company can be expected to invest in WECS unless there is economic justification, there may be companies that would not make WECS investments even if they appeared economical.

* * * *

This section has assessed typical investment decision-making by exploring a case example. The key constraints to an industrial market have been identified as low financial returns (WECS cost and utility rates), high risk, and lack of strategic advantage through WECS purchases in some situations. In the next section, federal incentives to mitigate these constraints are identified and assessed.

4. FEDERAL INCENTIVES CAN EFFECTIVELY STIMULATE THE INDUSTRIAL MARKET BY INCREASING RETURNS ABOVE INVESTMENT HURDLE RATES, OR BY REDUCING RISKS AND UNCERTAINTIES

To encourage industrial use of WECS as a electricity source (to the extent of national energy significance) it will be necessary that WECS technology be proven to be a viable equipment option (i.e., clearly demonstrated), and further that WECS investments provide financial justification. There are two basic options for the federal government:

- . Allow the industrial market to develop over time as WECS costs decrease and utility rates increase, the combination of which will improve financial benefits
- . Provide financial incentives to improve returns and reduce risks, in order to stimulate the market.

Under the assumption that policy decisions may be made to incentivize the industrial market, this section provides a preliminary assessment of effective approaches.

(1) The Impact of Federal Incentives Will Depend Upon the Cost of WECS and the Value of Displaced Electricity to Each Industrial Plant.

The key trade-off variables to calculate IRR and other measures are: WECS capital cost, and the price of the displaced electricity.* In fact, financial returns are related strongly to each of these variables, as shown in Exhibit VI-7:

- . The exhibit (nomograph) relates two independent variables--WECS cost and displaced electricity price--to IRR, and is divided into three "bands" of investment viability (in addition, the case example of the previous section is identified).
- . Federal incentives are not needed in cases where IRR exceeds 30 percent (the assumed target return for cost-cutting investments, as discussed in Section 1 of this chapter)

* Capacity credits may be achievable, in some cases, against utility demand charges, but current data is inadequate to make generalized conclusions.

EXHIBIT VI-7
WECS Internal Rate of Return as a Function
of Capital Cost and Base-Year Cost of
Displaced Electricity

⊗ ILLUSTRATES CASE EXAMPLE FROM SECTION 3

ASSUMPTIONS:

- WECS INSTALLED COST: VARIABLE
- PRICE OF DISPLACED ELECTRICITY: VARIABLE
- WECS O&M COSTS: 2 PERCENT OF CAPITAL COST, PER YEAR
- WECS CAPACITY FACTOR: 30 PERCENT
- WECS USEFUL LIFE: 20 YEARS
- INFLATION RATE: 6 PERCENT
- ELECTRIC RATE ESCALATION: 2 PERCENT ABOVE INFLATION

EXHIBIT VI-8
Industry Views on the
Attractiveness of Federal Incentives

INDUSTRY	ECONOMIC INCENTIVES DEEMED MOST HELPFUL	ECONOMIC INCENTIVES DEEMED LEAST HELPFUL
Aluminum	Cost sharing/capital cost expensing Investment tax credits	Loan guarantees and grants Reduction of capital gains tax
Brick Manufacturing	Loan guarantees and grants Cost sharing/capital cost expensing	Reduction of capital gains tax Elimination of double taxation on corporate profits
Cement	Cost sharing/capital cost expensing Investment tax credits	Loan guarantees and grants 60-month amortization
Chemicals	Expensing capital costs Investment tax credits	Loan guarantees and grants Reduction of capital gains tax
Copper	Cost sharing/capital cost expensing Investment tax credits	Loan guarantees and grants Reduction of capital gains tax
Glass	Cost sharing/capital cost expensing Investment tax credits	Loan guarantees and grants Industrial revenue bond concept
Gray Iron Foundries	Loan guarantees and grants Cost sharing/capital cost expensing	Reduction of capital gains tax Elimination of double taxation
Grains and Flour	Smaller firms: Investment tax credits Smaller firms: Expensing of capital costs	Loan guarantees and direct grants Reduction in capital gains tax
Meat Packing Plants	Cost sharing/capital cost expensing Investment tax credit	Loan guarantees and grants Reduction in capital gains tax
Paper	Cost sharing/capital cost expensing Investment tax credits	Loan guarantees and grants Industrial revenue bond concept
Plastic Materials	Elimination of double taxation on corporate profits Cost sharing/capital cost expensing	Loan guarantees and grants Industrial revenue bond concept
Steel	Cost sharing/capital cost expensing Investment tax credits	Loan guarantees and grants 60-month amortization

SOURCE: Economic and Financing Options To Stimulate The Commercialization of Energy Conservation Technologies, Prepared for ERDA by Booz, Allen & Hamilton, May 1976.

- . Incentives are clearly needed when IRR is below 15 percent (the assumed general target return for all types of industrial incentives)
- . A band of uncertainty exists for returns between 15 percent and 30 percent--where incentives may improve returns to the acceptable criteria levels.

Because each industrial plant is likely to value its displaced electricity differently, and because each installation may be somewhat unique in cost, the nomograph shows that incentives will not have a clear-cut impact. Rather, incentives will affect each decision uniquely. An additional key issue to consider in incentives planning is that each industry has a different view on the value of incentive options.

(2) Each Industry Will Value Incentives Differently, Although Cost Sharing, Tax Credits and Accelerated Depreciation Are Generally Attractive to Most

A recent study concluded that most industry executives are against direct intrusion of the Federal Government in capital investment planning processes and, in general, against federal intervention in capital market forces(8):

- . They prefer across-the-board changes in existing incentives (e.g., higher level of investment tax credits) to encourage investment of all types by reducing the effective cost of growth.
- . They also favor incentives which act to increase the total amount of savings and thus increase capital investment in the economy.
- . They believe that the pricing mechanism should be allowed to function effectively to allocate capital, rather than the government attempting to ration or allocate capital away from or towards specific purposes.

However, due to its particular financial conditions and operating environment, each industry exhibits a unique attraction to certain types of incentives, as

summarized in Exhibit VI-8. Several key conclusions may be drawn from these findings:

- . Major industries such as the basic metals industries are very hesitant to participate in Federal programs for loan guarantees and grants because of the increased Federal control and administration that are usually associated with these programs
- . Major industries prefer incentives such as tax credits, accelerated depreciation and rapid amortization which enhance cash retention, improve profitability, and minimize contact with government agencies
- . Smaller fragmented industries find loan guarantees and grants to be effective, since one of the key problems of small business industries is attracting capital.

(3) Incentives Which Improve Investment Returns Directly Are Generally Superior to Those Which Reduce a Firm's Cost of Capital

Building on the case example which was developed in the Section 3, four types of incentives are analyzed in terms of their effect on Internal Rate of Return (IRR): tax credits, accelerated depreciation, capital cost amortization (expensing), and low cost loans. Each incentive option is discussed in the following four sections:

1. Direct Subsidies Decrease the Cost of WECS Equipment While Tax Credits Provide a Cash Flow in the First Year After WECS Investment

The Revenue Act of 1962 originated the concept of investment tax credits. This initial act allowed taxes to be reduced by an amount equal to 7 percent of the investment cost of certain depreciable assets. Presently, the general industry tax credit is 10 percent. It has been estimated that the 10 percent credit reduces national tax revenue by \$3.2 billion to \$3.7 billion per year.(9)

Impact of an additional 10 percent tax credit, and 10 percent cost sharing, for WECS investments are shown in Exhibit VI-9.(10)

- . Initial cost of equipment is reduced by the subsidy but unaffected by the tax credit, which is received via subsequent tax transactions.
- . Tax credit cash flow in the first year is increased in the tax credit case, but decreased in the cost sharing case (tax credits are calculated on investment cost less cost subsidy).
- . Depreciation expense, and hence cash flow from depreciation, is reduced in all years (depreciation expense is calculated on investment cost less credits and subsidies).

Clearly, special tax credits and subsidies can have a significant effect on WECS financial performance, as indicated by the case example:

- . Ten percent (base case) credit:
IRR = 11.1 percent
- . Twenty percent credit: IRR is improved to 12.4 percent
- . Ten percent cost sharing plus 10 percent tax credit: IRR is improved to 12.3 percent.

2. Accelerated Depreciation Pushes Cash Flows to the Early Years of the WECS Project to Improve Internal Rate of Return and Reduce Risks Concerning Capital Recovery

The 1954 Internal Revenue Code marked a significant change from previous law by permitting liberalized depreciation methods that increased deductions in the early years of service. Previously, the IRS had allowed only straight-line depreciation, by which depreciation expense is a fixed percentage of the net investment cost of an asset.

The Internal Revenue Service stipulates which type of equipment can be given accelerated depreciation. Two forms are in common use(11):

- . Double-declining balance method, by which the annual depreciation charge is a fixed percentage of the net book value of an asset (which changes each year).
- . Sum-of-the-years-digits method, by which the annual depreciation charge is a function of the age of an asset and its expected useful life. In this method, like the declining-balance method, a larger amount is written off during the early years and a smaller amount in the later years of an asset's life. It is based on the sum of the digits that correspond to the asset's estimated life. Thus, the numbers representing the periods of life are added and constitute the denominator of a fraction. The numerator is the same numbers in reverse order. For example, $1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 = 36$. For the first year, the fraction would be $8/36$; for the second $7/36$, and so forth. The total depreciation (cost minus salvage) is multiplied by each of these fractions.

Accelerated depreciation is important to investment decisionmaking when discounted cash flow methods are used. In the case example, the results are as follows, as shown in Exhibit VI-10:

- . Straight-line (base case):
IRR = 11.1 percent
- . Double-declining balance: IRR is improved to 11.8 percent
- . Sum-of-the-years-digits: IRR is improved to 12.0 percent.

3. Capital Cost Amortization Is the Quickest Way to Expense WECS Investment Costs

The effect of capital cost amortization is to significantly reduce corporate tax liabilities in the early years of a project's life.

EXHIBIT VI-9
Case Example: Cash Flow With Tax Credit and Subsidy Incentives

Cash Stream (\$ Thousands)	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
1. Base Case: 10 Percent Tax Credit. IRR = 11.1 Percent											
. Cost Savings*	-	53.7	57.6	61.8	66.3	71.1	76.3	81.8	87.9	94.1	101.0
. Depreciation*	-	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2
. Tax Credit	-	75.0	-	-	-	-	-	-	-	-	-
. First Cost	(750.0)	-	-	-	-	-	-	-	-	-	-
. Cash Flow	(750.0)	144.9	73.8	78.0	82.5	87.3	92.5	98.0	104.1	110.3	117.2
2. Tax Case: 10 Percent Additional Tax Credit. IRR = 12.4 Percent											
. Cost Savings	-	53.7	57.6	61.8	66.3	71.1	76.3	81.8	87.9	94.1	101.0
. Depreciation	-	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
. Tax Credit	-	150.0	-	-	-	-	-	-	-	-	-
. First Cost	(750.0)	-	-	-	-	-	-	-	-	-	-
. Cash Flow	(750.0)	218.1	72.0	76.2	80.7	85.5	90.7	96.2	102.3	108.5	115.4
3. Subsidy Case: 10 Percent Additional Costs Share. IRR = 12.3 Percent											
. Cost Savings	-	53.7	57.6	61.8	66.3	71.1	76.3	81.8	87.9	94.1	101.0
. Depreciation	-	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6
. Tax Credit	-	67.5	-	-	-	-	-	-	-	-	-
. First Cost	(675.0)	-	-	-	-	-	-	-	-	-	-
. Cash Flow	(675.0)	135.8	72.2	76.4	80.9	85.7	90.9	96.4	102.5	108.7	115.6

* Cost savings and depreciation cash flows are calculated after 48 percent corporate income taxes.

EXHIBIT VI-10
Case Example: Cash Flows With Accelerated Depreciation

Cash Stream (\$ Thousands)	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
1. Base Case: Straight-line depreciation. ⁽¹⁾ IRR = 11.1 Percent											
. Cost Savings	-	53.7	57.6	61.8	66.3	71.1	76.3	81.8	87.9	94.1	101.0
. Depreciation	-	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2
. Tax Credit	-	75.0	-	-	-	-	-	-	-	-	-
. First Cost	(750.0)	-	-	-	-	-	-	-	-	-	-
. Cash Flow	(750.0)	144.9	73.8	78.0	82.5	87.3	92.5	98.0	104.1	110.3	117.2
2. Depreciation is Double-Declining-Balance Method. ⁽²⁾ IRR = 11.8 Percent											
. Cost Savings	-	53.7	57.6	61.8	66.3	71.1	76.3	81.8	87.9	94.1	101.0
. Depreciation	-	32.4	29.2	26.3	23.6	21.3	19.2	17.2	15.5	14.4	12.5
. Tax Credit	-	75.0	-	-	-	-	-	-	-	-	-
. First Cost	(750.0)	-	-	-	-	-	-	-	-	-	-
. Cash Flow	(750.0)	161.1	86.8	88.1	89.9	92.4	95.5	99.0	103.4	108.5	113.5
3. Depreciation is Sum-of-Years-Digit Method. ⁽³⁾ IRR = 12.0 Percent											
. Cost Savings	-	53.7	57.6	61.8	66.3	71.1	76.3	81.8	87.9	94.1	101.0
. Depreciation	-	30.9	26.5	22.9	19.7	17.1	14.8	12.8	11.1	9.6	8.3
. Tax Credit	-	75.0	-	-	-	-	-	-	-	-	-
. First Cost	(750.0)	-	-	-	-	-	-	-	-	-	-
. Cash Flow	(750.0)	159.6	84.1	84.7	86.0	88.2	91.1	94.6	99.0	105.2	109.3

Notes:

- (1) Straight-line depreciation is 1/20 of first cost (net of tax credit)
- (2) Double-declining balance depreciation is an annual fixed percentage (in this case 1/10) of the depreciated book value of the asset at the beginning of that year.
- (3) Sum-of-the-years-digits depreciation is a varying percentage of the first cost (not of tax credit). In this case, term of depreciation is 20 years. 20 factorial is 210. First year depreciation is 20/210 of first cost; second year depreciation is 19/210 of first cost; and so on.

The Tax Reform Act of 1969 initiated capital cost amortizing, by authorizing the expensing of certified pollution control facilities over a five-year period. Importantly, use of the standard investment tax credit is not allowed when five-year amortization is selected.

There are two options for the amortization incentive: straight-line and accelerated amortization. Both options have been applied to the case example, as shown in Exhibit VI-11. Results are as follows:

- . Base case: IRR = 11.1 percent
- . Straight-line amortization: IRR is improved to 12.1 percent
- . Accelerated amortization: IRR is improved to 12.6 percent.

The major disadvantages of amortization is that the loss of tax credits nearly offsets the benefits of the rapid five-year capital expensing.

4. Low Cost Loans Do Not Affect WECS Profitability, but Lower Corporate Hurdle Rates

Federal low cost loans to industry will not affect the inherent profitability of WECS investments. There are, however, two possible impacts:

- . Corporate investment hurdle rates, typically equal to the firm's average weighted cost of all debt and equity capital, will be lowered to the extent that the cost of the WECS loan reduces weighted averages, or management elects to evaluate the WECS investment against the cost of capital for that particular loan (not expected in larger firms).
- . Firms which do not have access to new capital may make the investment for financial reasons rather than for economic reasons.

* * * *

Previous subsections have assessed the relative power of each federal incentive option. The analysis continues in the following section to develop conclusions on incentives plans for industry.

(4) The Optimum Sequence of Incentives to Industry is To Reduce Risks, Then Improve Returns, Then Provide Capital Funds, if Needed

The preceding analyses have shown that each incentive will improve investment returns. As summarized in Exhibit VI-12, however, the power of these incentives must be considered marginal, rather than substantial:

- . At best, IRR is improved from 11.1 percent (base case) to 12.6 percent (accelerated, five-year amortization)
- . Each of the incentives improves IRR, but generally in the range of 6 to 10 percent incrementally over the base case.

The anticipated level of improvement is difficult to assess, in terms of corporate investment decision-making. However, it is reasonable to assume that marginal improvements in investment returns will only have marginal influence on widespread decisionmaking. Conversely, it is reasonable that substantial impact on WECS investment measures will be needed to have substantial effects on corporate decisions. The only incentives which have the range of power to adjust WECS benefits to a large degree are subsidies. However, on the basis of relative merits, other incentives may be more attractive.

As a framework for reaching conclusions, it is crucial to recognize that incentives have three functions, as discussed earlier in Section 1 of the chapter:

- . Reduce risks
- . Improve investment returns, for any given level of risks

EXHIBIT VI-11
Case Example: Cash Flows with Five-Year Amortization*

Cash Stream (\$ Thousands)	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
1. Base Case: Straight-Line Depreciation. IRR = 11.1 Percent											
. Cost Savings	-	53.7	57.6	61.8	66.3	71.1	76.3	81.8	87.9	94.1	101.0
. Depreciation	-	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2
. Tax Credit	-	75.0	-	-	-	-	-	-	-	-	-
. First Cost	(750.0)	-	-	-	-	-	-	-	-	-	-
. Cash Flow	(750.0)	144.9	73.8	78.0	82.5	87.3	92.5	98.0	104.1	110.3	117.2
2. Five-Year Amortization of Capital Investment. IRR = 12.1 Percent											
. Cost Savings	-	53.7	57.6	61.8	66.3	71.1	76.3	81.8	87.9	94.1	101.0
. Depreciation	-	72.0	72.0	72.0	72.0	72.0	-	-	-	-	-
. Tax Credit	-	-	-	-	-	-	-	-	-	-	-
. First Cost	(750.0)	-	-	-	-	-	-	-	-	-	-
. Cash Flow	(750.0)	125.7	129.6	133.8	138.3	143.1	76.3	81.8	87.9	94.1	101.0
3. Five-Year Amortization with Accelerated Schedule. IRR = 12.6 Percent											
. Cost Savings	-	53.7	57.6	61.8	66.3	71.1	76.3	81.8	87.9	94.1	101.0
. Depreciation	-	144.0	86.4	51.8	31.1	46.7	-	-	-	-	-
. Tax Credit	-	-	-	-	-	-	-	-	-	-	-
. First Cost	(750.0)	-	-	-	-	-	-	-	-	-	-
. Cash Flow	(750.0)	197.7	144.0	113.6	97.4	117.8	76.3	81.8	87.9	94.1	101.0

* Amortization represents expensing of the capital investment (net of tax credits) over a specified period not related to the useful life of the asset (as is the case with standard depreciation).

EXHIBIT VI-12
Summary of Incentives Impacts on Case Example*
Internal Rate of Return

INCENTIVE CASE	INTERNAL RATE OF RETURN (PERCENT)																			
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
BASE CASE: 10% TAX CREDIT; STRAIGHT-LINE DEPRECIATION																				
BASE CASE PLUS 10% COST SHARING																				
BASE CASE PLUS 10% TAX CREDIT																				
ACCELERATED DEPRECIATION (DOUBLE-DECLINING)																				
ACCELERATED DEPRECIATION (SUM OF YEARS DIGITS)																				
5-YEAR AMORTIZATION (STRAIGHT-LINE)																				
5-YEAR AMORTIZATION (DOUBLE-DECLINING)																				
6% INTEREST GOVERNMENT LOAN																				

^
INVESTMENT HURDLE RATE
ASSUMED TO EQUAL 12 PERCENT
COST OF CAPITAL

*THE CASE EXAMPLE FOR THIS ANALYSIS IS A LARGE MANUFACTURING PLANT. WECS INSTALLED COST IS \$200 PER AVERAGE kWe. THE ALTERNATIVE ELECTRICITY RATE IS PEPCO RATE "GS-4" WITH A FOURTH-BLOCK RATE OF 1.2¢ PER kWh. IRR CALCULATED ON A TWENTY-YEAR CASH FLOW STREAM.

** COST OF CAPITAL (INVESTMENT HURDLE RATE) IS REDUCED TO 6 PERCENT WITH THE 6 PERCENT INTEREST LOAN.

. Provide capital funds when they are not otherwise available, given the existing risk/return relationship.

Considering risks, returns, and capital availability, it is possible to select incentives on their merits.

1. Incentives Which Reduce Risks are the Most Effective First-Level Incentives

Investments are made on the basis of confidence that returns can be achieved. For this reason, incentives which improve potential returns without affecting the risks inherent to WECS investments are likely to be less powerful than incentives which are targeted to reducing risks directly:

- . Demonstrations are a necessary preliminary "incentive" to mitigate basic risks of performance.
- . Accelerated depreciation is the most direct mechanism to improve the rate at which capital funds are recovered. These incentives can take two forms: shortened depreciation periods and accelerated depreciation schedules. A number of factors are central to the value of depreciation incentives, they:
 - Directly address risks
 - Are recognized by industry
 - Utilize standard mechanisms of business expensing.
- . Finally, risks on future returns can be mitigated by insuring for savings and against unexpected costs; incentives here would include:
 - Federally-insured technical performance to cover maintenance and repair costs

- Long-term contracts on utility rates, to provide certainty on the value of displaced electricity (savings).

These incentives to reduce risks are judged to be preliminary measures which simply establish an environment which is conducive to making WECS investment decisions.

2. Incentives Which Improve Potential Returns are a Viable Second-Level Encouragement to the Industrial Market

Once the key risks have been addressed, and mitigated, it may still be infeasible for industry to invest in WECS because of poor financial justification (low returns). There are two basic approaches to improving investment returns (for any given level of risk):

Savings which accrue from the investment can be increased through direct subsidies on kilowatt-hours saved (potentially requiring separate metering for the WECS).

Capital costs can be reduced through direct subsidy (tax credits or cost sharing).

Kilowatt-hour subsidies are considered to be an attractive government incentive since it rewards for the ultimate objective of WECS: displacing conventionally-generated electricity.

As a second option, capital cost subsidies are attractive, but they have the disadvantage of rewarding WECS purchases rather than energy performance.

3. Incentives Which Provide Capital Funds are Considered Inappropriate Since Industry Does Not Evaluate Investment Options on the Basis of Individual Financing

As discussed previously in Section 1, most corporations do not assess investment viability

on the basis of the cost of capital, or capital sources, for each investment. For this reason alone, the power of capital-related incentives is considered low.

Of course, each company operates differently, and there can be expected a number of exceptions where companies might buy WECS if more, or cheaper, capital were available. In terms of national impact, however, these exceptions are expected to be insignificant.

* * * *

This chapter has developed a preliminary incentives plan for industry by: identifying industrial investment methods and criteria; assessing energy-use patterns in industry that are relevant to WECS; evaluating financial feasibility through a case example calculation; and assessing the value of individual incentives to enhance financial returns of WECS investments.

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1. Economic Incentives and Financing Options to Stimulate the Commercialization of Energy Conservation Technologies, prepared for DOE by Booz, Allen & Hamilton, May 1976.
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9. Tax Reform Act of 1975 (HR 10612), House Ways and Means Committee, November 12, 1975.
10. Exhibits in this and following sections show cash flows for the first 10 years of the WECS project, for illustrative purposes. Internal Rates of Return are, however, calculated on the full 20-year life of WECS equipment.
11. Bogen, J.I., et al, Financial Handbook, The Ronald Press Company, New York, N.Y., 1968, revised edition.

APPENDIX A

WECS INCENTIVES WORKBOOK

1. PURPOSE OF THE WORKBOOK

This Workbook has been assembled to assist policy analysts in developing incentive strategies for accelerating the development of the WECS market and industry. As such, it extracts the analytical techniques from the body of this report and presents them in step-by-step fashion so that the analyses can be readily repeated as input data concerning WECS performance, costs and costs of alternatives change with time.

Three separate tools have been developed to address potential WECS applications in a variety of markets, since different markets (e.g., homeowners and electric utilities) apply substantially different criteria and analytical techniques to evaluating investment decisions.

Each of the techniques presented is based on the concept of a "rational man," who will choose that energy alternative which best meets his specific decision criteria. While these criteria vary for the different markets, all are basically quantitative and economic in nature. This raises the very substantial possibility of introducing "errors of omission" into the analysis by not considering:

- . Aesthetics
- . Biases concerning:
 - Perceived reliability of systems
 - Social desirability of wind power,
- . Environmental considerations,
- . Etc.

and represents an important limitation of this analysis. Insofar as economic indicators can be applied to the different potential markets, an effort has been made to capture them in this Workbook.

The Workbook is made up of three free-standing sections. In an attempt to avoid reliance on computer-based analysis, simplifying assumptions have been made in all

three sections. It is believed that the current uncertainties in the markets and in WECS technology limits the value of highly precise calculations; where detailed evaluation is desired, a computer-based financial model has been developed and is presented in Appendix B. The three sections presented are:

(1) The WECS Economic Estimator, a manual calculator which assesses the engineering economics of WECS systems. It is most appropriate for use in the residential sector where tax impacts of such incentives as:

- . Investment tax credit and
- . Accelerated depreciation

are not critical. Its chief advantage lies in its ability to encompass almost any base case assumption. The Estimator produces approximations for:

- . Net present value
- . Loss period and
- . Years to simple payback

as its output, indicators felt to be of particular interest in the residential and agricultural sectors.

(2) The Net Present Value Workbook provides substantially greater accuracy and a graphical technique to readily gauge the impact of combinations of incentives on the net present value of WECS in the residential and agricultural sectors.

This accuracy and output flexibility was gained at the expense of system specification flexibility where certain constraining assumptions were made concerning

- . Tax and depreciation treatment, and
- . Discount and interest rates.

These limitations were offset somewhat by creating a number of base cases. The other limitation of this analysis is that it produces only the single indicator of present value as its output.

The Present Value Workbook was developed from the financial model presented in Appendix B. Where greater

input and output flexibility is desired, the financial model can be exercised to produce

- . Net present value
- . Simple payback period.
- . Full payback period
- . Years to recover the downpayment
- . Loss period (years to positive cash flow)
- . Internal rate of return

for any set of input data for all sectors except the investor-owned utilities.

(3) The Electric Utility Sector analysis uses revenue requirements analysis to capture the impact of the accounting procedures unique to the utility sector. This analysis computes the single indicator, revenue requirements (which is closely related to net present value), for

- . Investor-owned utilities
- . Federal systems (TVA, etc.)
- . Non-federal systems (municipals, etc.) and
- . Cooperative systems,

and allows analysis of a variety of incentive strategies similar to that of the present value analysis.

* * * *

This section has presented a brief overview of the analytical tools presented in the Workbook. Each of these is presented in detail in the following sections.

2. THE WECS ECONOMIC ESTIMATOR

The WECS Economic Estimator allows WECS incentives analysts and potential purchasers of WECS to estimate the cost effectiveness of WECS as measured by various economic indicators under a broad range of assumptions. The user of this workbook can also estimate the relative effect of the implementation of economic incentives, such as:

- . Direct subsidies
- . Tax credits

- . Low interest loans
- . Property and sales tax exemptions, etc.

The presentation is divided into three sections; a technical description of each step of the methodology, a case example, and a workbook for independent analysis.

(1) Technical Description

This section presents a technical description of the WECS Economic Estimator, providing the analytical foundation of the methodology and a discussion of the simplifying assumptions required to estimate the following indicators associated with the economic evaluation of WECS.

- . Loss Period (also referred to as the years to Positive Cash Flow)
- . Simple Payback Period, and
- . Net Present Value.

It should be noted at the outset that these indicators are estimated, and not rigorously computed. The value of the workbook is that it allows a number of key economic parameters to be approximated for any set of input data, without relying on computer analysis, or extensive hand calculation that would require knowledge of engineering economics techniques. The methodology is completely transparent, easy to use and requires only a series of simple algebraic computations in its execution.

Eleven inputs are necessary for the analysis:

- . System Size. No systematic or standard rating system currently exists for wind turbines. For example, machine A may be rated at 6kW at 16mph, while machine B may be rated at 6kW at 19mph. Ratings should be equivalent if this analysis is to be used comparing several machines. If that is not the case, then the manufacturer's rating should be used and adjusted for average wind speed at the prospective site--noting that the key parameter will be the number of kWh usefully generated over the year.

- . Cost per Installed Kilowatt. The cost of a WECS is frequently expressed as \$/kW installed. This value includes the cost of transportation and all ancillary equipment (inverters, etc.) as well as on-site construction.
- . Annual O&M Costs. The average annual operation and maintenance costs of the WECS System.
- . Property Taxes. This tax is dependent on location as well as assessed valuation. Typically, annual property taxes are approximately 2 percent of installed cost.
- . Insurance Costs. Insurance will be required to cover system breakage and owner liability.
- . Loan to Value Ratio. This variable relates the amount of the loan to the total system cost. Example: if one borrows \$3000 for a WECS that has a total cost of \$4000, the "loan to value ratio" is then 75 percent.
- . Loan Interest Rate. Annual interest rate charged for the loan.
- . Loan Term. In this workbook, the user may specify loan terms of 5, 10, 15, 20, 25, or 30 years.
- . Alternative Fuel Costs. The current cost of the fuel (electricity or other) which is displaced by WECS generation is specified by this variable. The amount must be specified in cents per kilowatt-hour equivalent. Fuel cost equivalents are presented in Table I at the rear of this section.
- . Fuel Price Escalation Rate. The assumed annual escalation rate for fuel costs.
- . Discount Factor. The "time value of money." The user's discount factor (or discount rate) has two components:
 - Inflation rate, and a
 - Risk premium.

Of course, a key element in the analysis will be the annual amount of electricity produced. For the base case analysis, an effective WECS capacity factor of 30 percent is assumed. Actual capacity factors will vary depending on

- . The wind machine's characteristics (e.g., blade size, aerodynamic efficiency, etc.)
- . The average annual wind speed
- . The amount of energy which is lost in storage devices or cannot be used as it is produced.

The user of this workbook may wish to alter this variable to better represent changes in machine, site, and use parameters.

The key outputs of this analytical tool are:

- . Loss Period. The year in which annual savings exceed annual WECS costs.
- . Years to Simple Payback. The period at the end of which the cumulative benefits (i.e., dollar equivalent of fuel savings) are greater than the installed system cost (note that this neglects loan interest expenses).
- . Net Present Value. The difference between the present worth of fuel or electricity savings and the present worth of WECS costs over the life of the system.

Preceding the calculation of these three outputs are six basic steps. These basic calculations are described next.

Exhibit A-1 presents a summary "WECS Evaluation Sheet" prepared to assist in keeping track of the intermediate calculations and results in the economic evaluation process. Relevant input data are first entered in the left hand column, and results, as they are calculated, are entered on the right.

The first step of the methodology (after the listing of the relevant inputs) is the calculation of the system cost. Using sample input values, the workbook represents this calculation as:

EXHIBIT A-1
WECS EVALUATION SHEET
(Case Study #)

THIS SHEET WILL ALLOW THE USER TO KEEP TRACK OF THE INPUTS AND OUTPUTS CALCULATED ON THE FOLLOWING PAGES

INPUTS	OUTPUTS
1. SYSTEM SIZE _____ kW	STEP 1. SYSTEM COST <input style="width: 100px;" type="text"/> A
2. COST PER INSTALLED KILOWATT _____ \$/kW	STEP 2. WECS DELIVERABLE ENERGY <input style="width: 100px;" type="text"/> B
3. ANNUAL O&M COSTS _____ \$/YR	1st YEAR SAVINGS <input style="width: 100px;" type="text"/> C
4. PROPERTY TAXES _____ \$/YR	STEP 3. AMOUNT FINANCED <input style="width: 100px;" type="text"/> D
5. INSURANCE COSTS _____ \$/YR	DOWN PAYMENT <input style="width: 100px;" type="text"/> E
6. LOAN TO VALUE RATIO _____ %	ANNUAL LOAN PAYMENT <input style="width: 100px;" type="text"/> F
7. LOAN INTEREST RATE _____ %	STEP 4. FIRST YEAR'S WECS COST <input style="width: 100px;" type="text"/> G
8. LOAN TERM* _____ YRS	STEP 5. PRESENT VALUE OF FUTURE SAVINGS <input style="width: 100px;" type="text"/> H
9. ALTERNATIVE FUEL COSTS _____ ¢/kW	STEP 6. PRESENT VALUE OF FUTURE COSTS <input style="width: 100px;" type="text"/> I
10. FUEL PRICE ESCALATION RATE _____ %/YR	
11. DISCOUNT FACTOR _____ %/YR	STEP 7. LOSS PERIOD <input style="width: 100px;" type="text"/> J
	STEP 8. YRS TO SIMPLE PAYBACK <input style="width: 100px;" type="text"/> K
	STEP 9. NET PRESENT VALUE <input style="width: 100px;" type="text"/> L

* For use in this handbook, loan term and system life are assumed to be equal.

STEP 1. DETERMINATION OF WECS COST

$$\frac{3}{\text{System Size}} \text{ kW} \times \frac{2000}{\text{Installed Cost}} \text{ \$/kW} = \boxed{\$ 6000} \text{ A.}$$

System cost is designated as Box A, and entered on the evaluation sheet.

Second, the first year dollar savings are determined as:

STEP 2. DETERMINATION OF FIRST YEAR DOLLAR SAVINGS

$$\frac{3}{\text{System Size}} \text{ kW} \times \frac{0.3}{\text{Fractional Load Factor}} \times \frac{8760}{\text{Hours Per Year}} = \boxed{7884 \text{ kWh}} \text{ B.} \times \frac{0.04}{\text{Cost of Backup Fuel (See Table 1)}} \text{ \$/kWh} = \boxed{\$ 315} \text{ C.}$$

Two useful values result from the above calculation: the annual energy available from the WECS and the first year's utility savings. These results are designated as Box B and Box C, respectively.

The third step involves the calculation of annual loan payments and is calculated as follows:

STEP 3. DETERMINATION OF ANNUAL LOAN PAYMENT

$$\begin{aligned} & \frac{\$ 6000}{\text{System Cost } \boxed{\text{A}}} \times \frac{80}{\text{Loan to Value Ratio}} = \boxed{\$ 4800} \text{ D.} \times \frac{0.10}{\text{Loan Payment Factor (See Table. II)}} = \boxed{\$ 480 \text{ \$/yr}} \text{ F.} \\ & \frac{\$ 6000}{\text{System Cost } \boxed{\text{A}}} - \frac{\$ 4800}{\text{Amount Financed } \boxed{\text{D}}} = \boxed{\$ 1200} \text{ E.} \\ & \hspace{10em} \text{Down Payment} \end{aligned}$$

The loan payment factor is found in Table II (found at the rear of this Appendix with the other tables), a standard table of capital recovery factors. These factors allow one to calculate the annual principal plus interest payments given an interest rate and loan term. If A is the annual end of period payment, P the principal, i the interest, and n the loan term, then it can be shown that:

$$A = P \left[\frac{i(1+i)^n}{(1+i)^n - 1} \right]$$

This formula was used to generate Table II.

Step 4 determines the first year's costs (exclusive of the downpayment). The procedure is to sum the operation and maintenance costs, costs due to property taxes, costs due to insurance, as well as the annual loan payment calculated in Step 3. In the workbook, Step 4 is computed as follows:

STEP 4. DETERMINATION OF FIRST YEAR'S COSTS DUE TO WECS

$$\begin{array}{ccccccc} \$ 60 & + & \$ 120 & + & \$ 60 & + & \$ 480 \\ \text{O\&M} & & \text{Property} & & \text{Insurance} & & \text{Annual Loan} \\ & & \text{Taxes} & & \text{Costs} & & \text{Payments [F]} \end{array} = \boxed{\$ 720} \text{ G.} \\ \text{First Year} \\ \text{Annual} \\ \text{Expenses}$$

Step 5 involves computation of the present worth of the cumulative future savings resulting from decreased conventional energy usage. It allows one to assume that energy costs will increase beyond the inflation rate over the life of the WECS system. If E is the annual quantity of energy saved, f the first year unit price of that energy, e the annual escalation rate, n the system life, and r is the assumed discount rate, then the present value of a stream of future savings can be determined by:

$$\text{present worth} = (Ef) \left(\frac{1}{1+r} \right) \left[\frac{\left(\frac{1+e}{1+r} \right)^n}{\left(\frac{1+e}{1+r} \right) - 1} \right]$$

The expression (Ef) was determined in Step 2. The factor to the right of the (Ef) expression calculates the present worth of a geometrically increasing series of annual payments. Table III presents these factors for escalation rates (e) that vary from 0 to 10 percent and for terms (n) from 5 to 30 years, assuming a number of discount rates. The workbook expression for Step 5 is:

STEP 5. DETERMINATION OF THE PRESENT VALUE OF THE CUMULATIVE FUTURE SAVINGS

$$\begin{array}{ccc} \$ 315 & \times & 18.79 \\ \text{First Year} & & \text{PV Factor} \\ \text{Utility} & & \text{(See} \\ \text{Savings [C]} & & \text{Table III)} \end{array} = \boxed{\$ 5919} \text{ H.} \\ \text{Present value} \\ \text{of cumulative} \\ \text{future savings}$$

The last of the basic calculations is the determination of the present value of WECS costs over the system's life. For this calculation, the present value of the various annual costs of WECS is determined by taking the first year's component costs and multiplying them by the appropriate factor in Table III. The values are then summed to estimate the present value of future system costs. The present value of all loan payments may be found in the "0% Escalation" column of Table III. Note that while the loan term does not have to equal the system life, other annual cost items should. The summed costs, including the downpayment, represent the present value of all WECS costs for the life of the system. In the workbook, Step 6 appears as:

STEP 6. DETERMINATION OF THE PRESENT VALUE OF THE CUMULATIVE FUTURE COSTS

\$60 @ 5%	x	15.71	=	\$943	}	= \$9497 I.
O&M		PV Factor				
\$120 @ 5%	x	15.71	=	1885		
Prop Tax		PV Factor				
\$60 @ 5%	x	15.71	=	\$943		
Insurance		PV Factor				
\$480 @ 0%	x	9.43	=	\$4526		
Loan Payment		PV Factor				
		\$1200	=	\$1200		
Down Payment						

E

Following the six basic calculations the workbook presents a methodology to calculate the three economic indicators: Loss Period (Step 7), Years to Simple Payback (Step 8), and Net Present Value (Step 9).

To determine the years to positive cash flow or loss period, it is necessary to make certain assumptions. Specifically in the derivation of Table IV, it was assumed that O&M, Property Tax, and insurance costs typically amounted to about one-third the annual costs due to WECS. Consider the following examples:

Assume a WECS System Cost=\$10,000

Case 1. (Loan interest rate=11%; term=20 years)
...if

O&M = 1% of System Cost, or,	\$ 100
PT = 2% of System Cost, or,	200
INS = 1% of System Cost, or,	100
Loan Payment Factor = 0.12 or	<u>1,200</u>

Total First Years Costs =	\$1,600
(O&M + PT + INS)/(TOTAL) = 400/1600 or 25%	

Case 2. (Loan interest rate=9%; term=20 years)

...if

O&M = 1 1/2% of System Cost, or,	\$ 150
PT = 3% of System Cost, or,	300
INS = 1% of System Cost, or,	100
Loan Payment Factor = 0.11 or,	<u>1,100</u>

Total First Years Costs = \$1,650
(O&M + PT + INS)/(TOTAL) = 550/1650 or 33%

Case 3. (Loan interest rate=9%; term=25 years)

...if

O&M = 1% of System Cost, or,	\$ 100
PT = 2 1/2% of System Cost, or,	250
INS = 1% of System Cost, or,	100
Loan Payment Factor = 0.09	<u>900</u>

Total First Years Costs = \$1,350
(O&M + PT + INS)/(TOTAL) = 450/1350 or 33%

The O&M costs, Property Taxes, and Insurance Costs were assumed to escalate 5% per year (the assumed inflation rate). This assumption reduces the calculation shown in the workbook to:

STEP 7. DETERMINATION OF LOSS PERIOD

$$\frac{\$ 720}{\text{First Year's Costs } \boxed{G}} + \frac{315}{\text{First Year's Savings } \boxed{C}} = \frac{2.29}{\text{FYC/FYS}} \quad (\text{Find period in Table IV).} = \boxed{18} \text{ Yrs } J. \\ \text{Loss Period}$$

The impact of this assumption is as follows: if the case is such that the annual costs (excluding the loan payment) are less than one-third the total costs, then the period of negative cash flow, i.e., the loss period, is reduced. Conversely, should O&M property taxes, and insurance costs be greater than one-third the annual costs, then the loss period will increase. Similarly, if the inflation factor (assumed to be 5% in the above equation) is instead less than 5%, then the loss period is again less than that computed. If, however, the inflation factor for the annual costs is greater than the assumed 5%, then the loss period is greater than that indicated.

Similarly, Table V enables the workbook user to quickly determine the years to simple payback. The algebraic formula in this case is,

$$\sum_{j=1}^{T'} Ef(1+e)^j \geq P$$

where,

E = annual energy savings
 f = unit price of energy (first year)
 e = energy cost escalation rate
 P = system price
 T' = years until simple payback

This expression can be rewritten as,

$$\sum_{j=1}^{T'} (1+e)^j \geq \frac{P}{Ef}$$

thus explaining the format of the table. That is, given the first year's savings as a percent of the system price,

$$\frac{1}{(P/Ef)} \text{ or } \frac{Ef}{P}$$

then T', the years to simple payback, can be determined for any one of several energy cost escalation rates, e. In the workbook this is presented as,

STEP 8. DETERMINATION OF YEARS TO SIMPLE PAYBACK

$$\frac{\$ 315}{\text{First Year's Savings [C]}} \div \frac{\$ 6000}{\text{System Cost [A]}} = \frac{0.05}{\text{Ratio}} \quad (\text{Find years to simple payback in Table V}) = \boxed{13} \text{ Yrs K.}$$

Years to Simple Payback

Lastly is the determination of the Net Present Value of the WECS investment. The last two steps of the basic calculations, Steps 5 and 6, determined the present value of the cumulative future savings, and the present value of the cumulative future costs. All that remains to do in order to calculate the net present value is to subtract. This is done in the workbook as:

STEP 9. DETERMINATION OF NET PRESENT VALUE

$$\begin{array}{rcl} \$ 5919 & - & \$ 9497 \\ \text{PV of CFS [H]} & & \text{PV of CFC [I]} \end{array} = \boxed{\$ - 3578} \text{ L.}$$

Net Present
Value

This concludes the description of the WECS Economic Estimator. It must be reiterated that, as the title implies, the economic indicators derived by this workbook are only estimates, and that a more rigorous computation would be required where high precision is required.

The section to follow further demonstrates the use of the workbook methodology.

(2) Use of the WECS Economic Estimator

This section presents several hypothetical case studies to demonstrate the use and application of the Estimator. Given the inputs shown in Exhibit A-2, the intermediate output can be calculated by use of the workbook methodology as shown in Exhibit A-3. The economic indicators are calculated in Steps 7, 8, and 9, in the workbook, also shown in Exhibit A-3.

The Estimator is also used to investigate the variations on the Loss Period, Years to Simple Payback, and Net Present Value for the following cases:

- . Property Taxes are eliminated (Case 2)
- . The Loan Interest Rate is reduced from 9 to 3 percent (Case 3), and
- . The Cost of the System is reduced by 20%, as in a subsidy (Case 4)
- . Property Taxes are eliminated and the loan interest rate is reduced from 9 to 3 percent (Case 5).

EXHIBIT A-2
WECS EVALUATION SHEET
(Case Study # Base)

THIS SHEET WILL ALLOW THE USER TO KEEP TRACK OF THE INPUTS AND OUTPUTS CALCULATED ON THE FOLLOWING PAGES

INPUTS	OUTPUTS
1. SYSTEM SIZE _____ 3 kW	STEP 1. SYSTEM COST <input style="width: 100px;" type="text"/> A
2. COST PER INSTALLED KILOWATT _____ 2000 \$/kW	STEP 2. WECS DELIVERABLE ENERGY <input style="width: 100px;" type="text"/> B
3. ANNUAL O&M COSTS _____ 60 \$/YR	1st YEAR SAVINGS <input style="width: 100px;" type="text"/> C
4. PROPERTY TAXES _____ 120 \$/YR	STEP 3. AMOUNT FINANCED <input style="width: 100px;" type="text"/> D
5. INSURANCE COSTS _____ 60 \$/YR	DOWN PAYMENT <input style="width: 100px;" type="text"/> E
6. LOAN TO VALUE RATIO _____ 80 %	ANNUAL LOAN PAYMENT <input style="width: 100px;" type="text"/> F
7. LOAN INTEREST RATE _____ 9 %	STEP 4. FIRST YEAR'S WECS COST <input style="width: 100px;" type="text"/> G
8. LOAN TERM* _____ 30 YRS	STEP 5. PRESENT VALUE OF FUTURE SAVINGS <input style="width: 100px;" type="text"/> H
9. ALTERNATIVE FUEL COSTS _____ 4 ¢/kW	STEP 6. PRESENT VALUE OF FUTURE COSTS <input style="width: 100px;" type="text"/> I
10. FUEL PRICE ESCALATION RATE _____ 7 %/YR	
11. DISCOUNT FACTOR _____ 10 %/YR	STEP 7. LOSS PERIOD <input style="width: 100px;" type="text"/> J
	STEP 8. YRS TO SIMPLE PAYBACK <input style="width: 100px;" type="text"/> K
	STEP 9. NET PRESENT VALUE <input style="width: 100px;" type="text"/> L

* For use in this handbook, loan term and system life are assumed to be equal.

EXHIBIT A-3

WECS ECONOMIC ESTIMATOR . . .

THE BASIC CALCULATIONS

o STEP 1. DETERMINATION OF WECS COST

$$\frac{3}{\text{System Size}} \text{ kW} \times \frac{2000}{\text{Installed Cost}} \text{ \$/kW} = \boxed{\$ 6000} \text{ A.}$$

o STEP 2. DETERMINATION OF FIRST YEAR DOLLAR SAVINGS

$$\frac{3}{\text{System Size}} \text{ kW} \times \frac{0.3}{\text{Fractional Load Factor}} \times \frac{8760}{\text{Hours Per Year}} = \boxed{7884} \text{ kWh B.} \times \frac{0.04}{\text{Cost of Backup Fuel (See Table 1)}} \text{ \$/kWh} = \boxed{\$ 315} \text{ C.}$$

WECS Deliverable Energy

o STEP 3. DETERMINATION OF ANNUAL LOAN PAYMENT

$$\frac{\$ 6000}{\text{System Cost A}} \times \frac{80}{\text{Loan to Value Ratio}} \% = \boxed{\$ 4800} \text{ D.} \times \frac{0.10}{\text{Loan Payment Factor (See Table II)}} = \boxed{\$ 480} \text{ \$/yr F.}$$

Amount Financed

Annual Loan Payment

$$\frac{\$ 6000}{\text{System Cost A}} - \frac{\$ 4800}{\text{Amount Financed D}} = \boxed{\$ 1200} \text{ E.}$$

Down Payment

EXHIBIT A-3 (CONTINUED)

WECS ECONOMIC ESTIMATOR . . .

CALCULATION OF THE ECONOMIC INDICATORS

o STEP 7. DETERMINATION OF LOSS PERIOD

$$\frac{\$ 720}{\text{First Year's Costs [G]}} \div \frac{315}{\text{First Year's Savings [C]}} = \frac{2.29}{\text{FYC/FYS}} \quad (\text{Find period in Table IV}) = \boxed{18} \text{ Yrs J. Loss Period}$$

o STEP 8. DETERMINATION OF YEARS TO SIMPLE PAYBACK

$$\frac{\$ 315}{\text{First Year's Savings [C]}} \div \frac{\$ 6000}{\text{System Cost [A]}} = \frac{0.05}{\text{Ratio}} \quad (\text{Find years to simple payback in Table V}) = \boxed{13} \text{ Yrs K. Years to Simple Payback}$$

o STEP 9. DETERMINATION OF NET PRESENT VALUE

$$\frac{\$ 5919}{\text{PV of CFS [H]}} - \frac{\$ 9497}{\text{PV of CFC [I]}} = \boxed{\$ -3578} \text{ L. Net Present Value}$$

EXHIBIT A-3 (CONTINUED)

WECS ECONOMIC ESTIMATOR (Basic Calculations Continued) . . .

o STEP 4. DETERMINATION OF FIRST YEAR'S COSTS DUE TO WECS

$$\begin{array}{r} \$ 60 \\ \text{O\&M} \end{array} + \begin{array}{r} \$ 120 \\ \text{Property} \\ \text{Taxes} \end{array} + \begin{array}{r} \$ 60 \\ \text{Insurance} \\ \text{Costs} \end{array} + \begin{array}{r} \$ 480 \\ \text{Annual Loan} \\ \text{Payments [F]} \end{array} = \boxed{\$ 720} \text{ G.} \\ \text{First Year} \\ \text{Annual} \\ \text{Expenses}$$

o STEP 5. DETERMINATION OF THE PRESENT VALUE OF THE CUMULATIVE FUTURE SAVINGS

$$\begin{array}{r} \$ 315 \\ \text{First Year} \\ \text{Utility} \\ \text{Savings [C]} \end{array} \times \begin{array}{r} 18.79 \\ \text{PV Factor} \\ \text{(See} \\ \text{Table III)} \end{array} = \boxed{\$ 5919} \text{ H.} \\ \text{Present value} \\ \text{of cumulative} \\ \text{future savings}$$

o STEP 6. DETERMINATION OF THE PRESENT VALUE OF THE CUMULATIVE FUTURE COSTS

$$\begin{array}{r} \$ 60 @ 5\%/yr \\ \text{O\&M} \end{array} \begin{array}{r} 15.71 \\ \text{PV Factor} \end{array} = \boxed{\$ 943} \\ + \\ \begin{array}{r} \$ 120 @ 5\%/yr \\ \text{Prop Tax} \end{array} \begin{array}{r} 15.71 \\ \text{PV Factor} \end{array} = \boxed{\$ 1985} \\ + \\ \begin{array}{r} \$ 60 @ 5\%/yr \\ \text{Insurance} \end{array} \begin{array}{r} 15.71 \\ \text{PV Factor} \end{array} = \boxed{\$ 943} \\ + \\ \begin{array}{r} \$ 480 @ 0\%/yr \\ \text{Loan Payment} \end{array} \begin{array}{r} 9.43 \\ \text{PV Factor} \end{array} = \boxed{\$ 4526} \\ + \\ \begin{array}{r} \$ 1200 \\ \text{Down Payment} \end{array} = \boxed{\$ 1200} \\ \text{[E]} \end{array} = \boxed{\$ 9497} \text{ I.} \\ \text{Present} \\ \text{Value of the} \\ \text{Cumulative} \\ \text{Future Costs}$$

As a reference, the Base Case inputs and outputs are shown in Exhibit A-4. Exhibit A-5 displays the inputs and outputs of Cases 2 through 5. Note in Case 2 that the elimination of property taxes in the WECS reduced the first year's costs by \$120, reduced the present value of future costs by \$1,885, but only reduced the Loss Period from 18 to 14 years. The Years to Simple Payback is unchanged (at 13 years), but the Net Present Value was increased 47%, to \$-1,693, still negative.

The incentive assumed in Case 3 was the reduction of loan interest from 9 to 3%. The result of this was the reduction of the Loss Period, now 9 years instead of 18. Simple Payback is still 13 years. Net present has been increased to \$-1,315, a \$2,263 increase, yet is still negative.

Case 4, demonstrates the effect of a 20% cash subsidy as applied to the Base Case. The system cost was reduced from \$6,000 to \$4,800. The net effect of this incentive was to reduce the Loss Period from 18 to 15 years, reduce the Years to Simple Payback from 13 to 11 years, but only increase the Net Present Value by \$905, to \$-2,673.

Lastly, Case 5 investigates a combined incentive: the elimination of Property Tax and a low interest loan (3%). The net result was to reduce the Loss Period to 3 years. Simple Payback is again 13 years. But the Net Present Value is now positive, at \$+570.

* * * *

This exercise has illustrated the use of the WECS Economic Estimator, and has demonstrated its value as an easily used tool for both WECS life cycle cost and economic incentives analyses. The pages that follow comprise a separate analysis package that the reader may use to vary any parameters for use in this analysis. All forms and tables are included.

EXHIBIT A-4
WECS EVALUATION SHEET
(Case Study Base)

THIS SHEET WILL ALLOW THE USER TO KEEP TRACK OF THE INPUTS AND OUTPUTS CALCULATED ON THE FOLLOWING PAGES

INPUTS	OUTPUTS
1. SYSTEM SIZE 3 kW	STEP 1. SYSTEM COST 6000 A
2. COST PER INSTALLED KILOWATT 2000 \$/kW	STEP 2. WECS DELIVERABLE ENERGY 7884 B
3. ANNUAL O&M COSTS 60 \$/YR	1st YEAR SAVINGS 315 C
4. PROPERTY TAXES 120 \$/YR	STEP 3. AMOUNT FINANCED 4800 D
5. INSURANCE COSTS 60 \$/YR	DOWN PAYMENT 1200 E
6. LOAN TO VALUE RATIO 80 %	ANNUAL LOAN PAYMENT 480 F
7. LOAN INTEREST RATE 9 %	STEP 4. FIRST YEAR'S WECS COST 720 G
8. LOAN TERM* 30 YRS	STEP 5. PRESENT VALUE OF FUTURE SAVINGS 5919 H
9. ALTERNATIVE FUEL COSTS 4 ¢/kW	STEP 5. PRESENT VALUE OF FUTURE COSTS 9497 I
10. FUEL PRICE ESCALATION RATE 7 %/YR	
11. DISCOUNT FACTOR 10 %/YR	STEP 7. LOSS PERIOD 18 J
	STEP 8. YRS TO SIMPLE PAYBACK 13 K
	STEP 9. NET PRESENT VALUE -3578 L

* For use in this handbook, loan term and system life are assumed to be equal.

EXHIBIT A-5
WECS EVALUATION SHEET
(Case Study #2)

THIS SHEET WILL ALLOW THE USER TO KEEP TRACK OF THE INPUTS AND OUTPUTS CALCULATED ON THE FOLLOWING PAGES

INPUTS	OUTPUTS
1. SYSTEM SIZE - <u>3</u> kW	STEP 1. SYSTEM COST <u>6000</u> A
2. COST PER INSTALLED KILOWATT <u>2000</u> \$/kW	STEP 2. WECS DELIVERABLE ENERGY <u>7884</u> B
3. ANNUAL O&M COSTS <u>60</u> \$/YR	1st YEAR SAVINGS <u>315</u> C
4. PROPERTY TAXES <u>0</u> \$/YR	STEP 3. AMOUNT FINANCED <u>4800</u> D
5. INSURANCE COSTS <u>60</u> \$/YR	DOWN PAYMENT <u>1200</u> E
6. LOAN TO VALUE RATIO <u>80</u> %	ANNUAL LOAN PAYMENT <u>480</u> F
7. LOAN INTEREST RATE <u>9</u> %	STEP 4. FIRST YEAR'S WECS COST <u>600</u> G
8. LOAN TERM* <u>30</u> YRS	STEP 5. PRESENT VALUE OF FUTURE SAVINGS <u>5919</u> H
9. ALTERNATIVE FUEL COSTS <u>4</u> ¢/kW	STEP 6. PRESENT VALUE OF FUTURE COSTS <u>7612</u> I
10. FUEL PRICE ESCALATION RATE <u>7</u> %/YR	
11. DISCOUNT FACTOR <u>10</u> %/YR	STEP 7. LOSS PERIOD <u>14</u> J
	STEP 8. YRS TO SIMPLE PAYBACK <u>13</u> K
	STEP 9. NET PRESENT VALUE <u>-1693</u> L

* For use in this handbook, loan term and system life are assumed to be equal.

EXHIBIT A-5 (Continued)
WECS EVALUATION SHEET
(Case Study #3)

THIS SHEET WILL ALLOW THE USER TO KEEP TRACK OF THE INPUTS AND OUTPUTS CALCULATED ON THE FOLLOWING PAGES

INPUTS	OUTPUTS
1. SYSTEM SIZE _____ 3 kW	STEP 1. SYSTEM COST <div style="border: 1px solid black; padding: 2px 10px;">6000</div> A
2. COST PER INSTALLED KILOWATT _____ 2000 \$/kW	STEP 2. WECS DELIVERABLE ENERGY <div style="border: 1px solid black; padding: 2px 10px;">7884</div> B
3. ANNUAL O&M COSTS _____ 60 \$/YR	1st YEAR SAVINGS <div style="border: 1px solid black; padding: 2px 10px;">315</div> C
4. PROPERTY TAXES _____ 120 \$/YR	STEP 3. AMOUNT FINANCED <div style="border: 1px solid black; padding: 2px 10px;">4800</div> D
5. INSURANCE COSTS _____ 60 \$/YR	DOWN PAYMENT <div style="border: 1px solid black; padding: 2px 10px;">1200</div> E
6. LOAN TO VALUE RATIO _____ 80 %	ANNUAL LOAN PAYMENT <div style="border: 1px solid black; padding: 2px 10px;">240</div> F
7. LOAN INTEREST RATE _____ 3 %	STEP 4. FIRST YEAR'S WECS COST <div style="border: 1px solid black; padding: 2px 10px;">480</div> G
8. LOAN TERM* _____ 30 YRS	STEP 5. PRESENT VALUE OF FUTURE SAVINGS <div style="border: 1px solid black; padding: 2px 10px;">5919</div> H
9. ALTERNATIVE FUEL COSTS _____ 4 ¢/kW	STEP 6. PRESENT VALUE OF FUTURE COSTS <div style="border: 1px solid black; padding: 2px 10px;">7234</div> I
10. FUEL PRICE ESCALATION RATE _____ 7 %/YR	
11. DISCOUNT FACTOR _____ 9 %/YR	STEP 7. LOSS PERIOD <div style="border: 1px solid black; padding: 2px 10px;">9</div> J
	STEP 8. YRS TO SIMPLE PAYBACK <div style="border: 1px solid black; padding: 2px 10px;">13</div> K
	STEP 9. NET PRESENT VALUE <div style="border: 1px solid black; padding: 2px 10px;">-1315</div> L

* For use in this handbook, loan term and system life are assumed to be equal.

EXHIBIT A-5 (Continued)
WECS EVALUATION SHEET
(Case Study #4)

THIS SHEET WILL ALLOW THE USER TO KEEP TRACK OF THE INPUTS AND OUTPUTS CALCULATED ON THE FOLLOWING PAGES

INPUTS	OUTPUTS
1. SYSTEM SIZE _____ 3 kW	STEP 1. SYSTEM COST 4800 A
2. COST PER INSTALLED KILOWATT _____ 1600 \$/kW	STEP 2. WECS DELIVERABLE ENERGY 7884 B
3. ANNUAL O&M COSTS _____ 60 \$/YR	1st YEAR SAVINGS 315 C
4. PROPERTY TAXES _____ 120 \$/YR	STEP 3. AMOUNT FINANCED 3840 D
5. INSURANCE COSTS _____ 60 \$/YR	DOWN PAYMENT 960 E
6. LOAN TO VALUE RATIO _____ 80 %	ANNUAL LOAN PAYMENT 384 F
7. LOAN INTEREST RATE _____ 9 %	STEP 4. FIRST YEAR'S WECS COST 624 G
8. LOAN TERM* _____ 30 YRS	STEP 5. PRESENT VALUE OF FUTURE SAVINGS 5919 H
9. ALTERNATIVE FUEL COSTS _____ 4 ¢/kW	STEP 6. PRESENT VALUE OF FUTURE COSTS 8592 I
10. FUEL PRICE ESCALATION RATE _____ 7 %/YR	
11. DISCOUNT FACTOR _____ 10 %/YR	STEP 7. LOSS PERIOD 15 J
	STEP 8. YRS TO SIMPLE PAYBACK 11 K
	STEP 9. NET PRESENT VALUE -2673 L

* For use in this handbook, loan term and system life are assumed to be equal.

EXHIBIT A-5 (Continued)
WECS EVALUATION SHEET
(Case Study #5)

THIS SHEET WILL ALLOW THE USER TO KEEP TRACK OF THE INPUTS AND OUTPUTS CALCULATED ON THE FOLLOWING PAGES

INPUTS	OUTPUTS
1. SYSTEM SIZE _____ 3 kW	STEP 1. SYSTEM COST 6000 A
2. COST PER INSTALLED KILOWATT _____ 2000 \$/kW	STEP 2. WECS DELIVERABLE ENERGY 7884 B
3. ANNUAL O&M COSTS _____ 60 \$/YR	1st YEAR SAVINGS 315 C
4. PROPERTY TAXES _____ 0 \$/YR	STEP 3. AMOUNT FINANCED 4800 D
5. INSURANCE COSTS _____ 60 \$/YR	DOWN PAYMENT 1200 E
6. LOAN TO VALUE RATIO _____ 80 %	ANNUAL LOAN PAYMENT 240 F
7. LOAN INTEREST RATE _____ 3 %	STEP 4. FIRST YEAR'S WECS COST 360 G
8. LOAN TERM* _____ 30 YRS	STEP 5. PRESENT VALUE OF FUTURE SAVINGS 5919 H
9. ALTERNATIVE FUEL COSTS _____ 4 ¢/kW	STEP 6. PRESENT VALUE OF FUTURE COSTS 5349 I
10. FUEL PRICE ESCALATION RATE _____ 7 %/YR	
11. DISCOUNT FACTOR _____ 10 %/YR	STEP 7. LOSS PERIOD 3 J
	STEP 8. YRS TO SIMPLE PAYBACK 13 K
	STEP 9. NET PRESENT VALUE + 570 L

* For use in this handbook, loan term and system life are assumed to be equal.

AN
ECONOMIC ESTIMATOR WORKBOOK
FOR
WIND ENERGY CONVERSION SYSTEMS

A WORKBOOK FOR THE ESTIMATION OF THE ENGINEERING ECONOMICS
OF WIND ENERGY CONVERSION SYSTEMS

THE WECS ECONOMIC ESTIMATOR

- o THIS WORKBOOK WILL ENABLE THE READER TO PERFORM AN ENGINEERING ECONOMIC ANALYSIS OF WECS. THE ANALYSIS IS BASED ON STANDARD ECONOMIC PROCEDURES. CERTAIN ASSUMPTIONS ARE BUILT INTO THE WORKBOOK TO SIMPLIFY THE ANALYSIS: THUS, THE RESULTS ARE APPROXIMATIONS OF ANSWERS THAT A MORE RIGOROUS ANALYSIS WOULD DELIVER.
- o THERE ARE SIX BASIC STEPS TO THE ANALYSIS:
 - DETERMINATION OF WECS COST
 - DETERMINATION OF FIRST YEAR'S DOLLAR SAVINGS
 - DETERMINATION OF ANNUAL LOAN PAYMENTS
 - DETERMINATION OF THE FIRST YEAR'S COSTS
 - DETERMINATION OF THE PRESENT VALUE OF THE CUMULATIVE FUTURE SAVINGS
 - DETERMINATION OF THE PRESENT VALUE OF THE CUMULATIVE FUTURE COSTS
- o AFTER COMPUTING THE ABOVE, THE READER MAY CONTINUE AND COMPUTE ANY OR ALL OF THE FOLLOWING ECONOMIC INDICATORS:
 - CALCULATION OF THE LOSS PERIOD (YEARS TO POSITIVE CASH FLOW)
 - CALCULATION OF YEARS TO SIMPLE PAYBACK
 - CALCULATION OF THE NET PRESENT VALUE
- o THE NECESSARY INPUTS TO THE ANALYSIS ARE:

- THE SYSTEM SIZE	- THE COST PER INSTALLED KILOWATT
- THE ANNUAL O&M COSTS	- THE ANNUAL PROPERTY TAXES
- THE LOAN INTEREST RATE	- THE LOAN TO VALUE RATIO
- THE LOAN TERM	- THE ALTERNATIVE ENERGY COSTS
- THE ENERGY COST ESCALATION RATE	- THE DISCOUNT RATE
- THE INSURANCE COSTS	
- o A SUMMARY WECS EVALUATION SHEET IS PRESENTED ON THE FOLLOWING PAGE. INPUT TO ALL CASE DATA SHOULD BE ENTERED IN THE LEFT-HAND BOX.
- o THE SHEETS FOLLOWING THE EVALUATION SHEET PRESENT A SEQUENTIAL METHODOLOGY AND SUPPORTING DATA FOR THE CALCULATION OF THE OUTPUT PARAMETERS THAT ARE LISTED IN THE RIGHT-HAND BOXES.

3. NET PRESENT VALUE ANALYSIS

(1) Introduction

Present value analysis is one of several methods used to compare the costs of two alternative energy systems. In present value analysis, all costs are forecasted over the period of analysis and then discounted to an equivalent single cost in some base year (assumed here to be the first year of WECS operation). Based on present value calculations, the impact of Government incentives on WECS economics is presented in "workbook" format in this section.

The use of present value as an indicator implies that the "rational" man will choose the energy strategy which has the lowest discounted costs over its useful life. These costs result from:

- . Capital costs of WECS
- . Finance charges
- . Sales and property taxes
- . Insurance and operating and maintenance (O&M) expenses
- . Depreciation (not a factor in residential analysis)
- . Purchased energy expenses.

Under the base case assumptions, the present value of WECS costs and of its least costly alternative are calculated and compared. For the "rational" consumer to choose a WECS, its present value must be less than the alternative. If WECS is more costly, then economic incentives may be used to make WECS cost competitive. The level of incentive is determined by the difference between the present value of WECS costs and of its alternative.

WECS EVALUATION SHEET
(Case Study #)

THIS SHEET WILL ALLOW THE USER TO KEEP TRACK OF THE INPUTS AND OUTPUTS CALCULATED ON THE FOLLOWING PAGES

INPUTS	OUTPUTS
1. SYSTEM SIZE _____ kW	STEP 1. SYSTEM COST <input style="width: 100px;" type="text"/> A
2. COST PER INSTALLED KILOWATT _____ \$/kW	STEP 2. WECS DELIVERABLE ENERGY <input style="width: 100px;" type="text"/> B
3. ANNUAL O&M COSTS _____ \$/YR	1st YEAR SAVINGS <input style="width: 100px;" type="text"/> C
4. PROPERTY TAXES _____ \$/YR	STEP 3. AMOUNT FINANCED <input style="width: 100px;" type="text"/> D
5. INSURANCE COSTS _____ \$/YR	DOWN PAYMENT <input style="width: 100px;" type="text"/> E
6. LOAN TO VALUE RATIO _____ %	ANNUAL LOAN PAYMENT <input style="width: 100px;" type="text"/> F
7. LOAN INTEREST RATE _____ %	STEP 4. FIRST YEAR'S WECS COST <input style="width: 100px;" type="text"/> G
8. LOAN TERM* _____ YRS	STEP 5. PRESENT VALUE OF FUTURE SAVINGS <input style="width: 100px;" type="text"/> H
9. ALTERNATIVE FUEL COSTS _____ ¢/kW	STEP 6. PRESENT VALUE OF FUTURE COSTS <input style="width: 100px;" type="text"/> I
10. FUEL PRICE ESCALATION RATE _____ %/YR	
11. DISCOUNT FACTOR _____ %/YR	STEP 7. LOSS PERIOD <input style="width: 100px;" type="text"/> J
	STEP 8. YRS TO SIMPLE PAYBACK <input style="width: 100px;" type="text"/> K
	STEP 9. NET PRESENT VALUE <input style="width: 100px;" type="text"/> L

* For use in this handbook, loan term and system life are assumed to be equal.

WECS ECONOMIC ESTIMATOR . . .

THE BASIC CALCULATIONS

o STEP 1. DETERMINATION OF WECS COST

$$\frac{\text{System Size}}{\text{kw}} \times \frac{\text{Installed Cost}}{\text{\$/kw}} = \$ \boxed{} \text{ A.}$$

o STEP 2. DETERMINATION OF FIRST YEAR DOLLAR SAVINGS

$$\frac{\text{System Size}}{\text{kw}} \times \frac{0.3}{\text{Fractional Load Factor}} \times \frac{8760}{\text{Hours Per Year}} = \boxed{} \text{ kWh B.} \times \frac{\text{Cost of Backup Fuel (See Table I)}}{\text{\$/kWh}} = \$ \boxed{} \text{ C.}$$

WECS Deliverable Energy

o STEP 3. DETERMINATION OF ANNUAL LOAN PAYMENT

$$\begin{array}{l} \frac{\$ \text{ System Cost}}{\boxed{\text{A}}} \times \frac{\text{Loan to Value Ratio}}{\%} = \$ \boxed{} \text{ D.} \times \frac{\text{Loan Payment Factor (See Table II)}}{\text{\$/yr}} = \$ \boxed{} \text{ F.} \\ \text{Annual Loan Payment} \end{array}$$

$$\frac{\$ \text{ System Cost}}{\boxed{\text{A}}} - \frac{\$ \text{ Amount Financed}}{\boxed{\text{D}}} = \$ \boxed{} \text{ E.}$$

Down Payment

WECS ECONOMIC ESTIMATOR (Basic Calculations Continued) . . .

o STEP 4. DETERMINATION OF FIRST YEAR'S COSTS DUE TO WECS

$$\begin{array}{r} \$ \\ \text{O\&M} \end{array} + \begin{array}{r} \$ \\ \text{Property} \\ \text{Taxes} \end{array} + \begin{array}{r} \$ \\ \text{Insurance} \\ \text{Costs} \end{array} + \begin{array}{r} \$ \\ \text{Annual Loan} \\ \text{Payments} \end{array} = \$ \boxed{} \text{ G.} \\ \text{First Year} \\ \text{Annual} \\ \text{Expenses} \quad \boxed{\text{F}}$$

o STEP 5. DETERMINATION OF THE PRESENT VALUE OF THE CUMULATIVE FUTURE SAVINGS

$$\begin{array}{r} \text{First Year} \\ \text{Utility} \\ \text{Savings} \end{array} \boxed{\text{C}} \times \begin{array}{r} \text{PV Factor} \\ \text{(See} \\ \text{Table III)} \end{array} = \$ \boxed{} \text{ H.} \\ \text{Present value} \\ \text{of cumulative} \\ \text{future savings}$$

o STEP 6. DETERMINATION OF THE PRESENT VALUE OF THE CUMULATIVE FUTURE COSTS

$$\begin{array}{r} \$ \\ \text{O\&M} \end{array} \times \begin{array}{r} \text{PV Factor} \end{array} = \boxed{} + \\ \begin{array}{r} \$ \\ \text{Prop Tax} \end{array} \times \begin{array}{r} \text{PV Factor} \end{array} = \boxed{} + \\ \begin{array}{r} \$ \\ \text{Insurance} \end{array} \times \begin{array}{r} \text{PV Factor} \end{array} = \boxed{} + \\ \begin{array}{r} \$ \\ \text{Loan Payment} \end{array} \times \begin{array}{r} \text{PV Factor} \end{array} = \boxed{} + \\ \begin{array}{r} \text{Down Payment} \end{array} \boxed{\text{E}} = \boxed{} = \$ \boxed{} \text{ I.} \\ \text{Present} \\ \text{Value of the} \\ \text{Cumulative} \\ \text{Future Costs}$$

WECS ECONOMIC ESTIMATOR . . .

CALCULATION OF THE ECONOMIC INDICATORS

o STEP 7. DETERMINATION OF LOSS PERIOD

$$\frac{\$ \text{First Year's Costs } \boxed{G}}{\$ \text{First Year's Savings } \boxed{C}} = \frac{\text{FYC/FYS}}{\text{Ratio}} \quad (\text{Find period in Table IV}) = \boxed{\text{Yrs}} \text{ J.}$$

Loss Period

o STEP 8. DETERMINATION OF YEARS TO SIMPLE PAYBACK

$$\frac{\$ \text{First Year's Savings } \boxed{C}}{\$ \text{System Cost } \boxed{A}} = \frac{\text{Ratio}}{\text{Ratio}} \quad (\text{Find years to simple payback in Table V}) = \boxed{\text{Yrs}} \text{ K.}$$

Years to Simple Payback

o STEP 9. DETERMINATION OF NET PRESENT VALUE

$$\frac{\$ \text{PV of CFS } \boxed{H}}{\$ \text{PV of CFC } \boxed{I}} = \frac{\$ \text{Net Present Value}}{\$ \text{Net Present Value}} \text{ L.}$$

TABLE I
Fuel Cost Equivalents

Find the fuel cost on the left side of the matrix, then locate the \$/kWh equivalent under the appropriate use efficiency at the right side of the matrix.

Oil ¹ \$/Gallon	Natural Gas ² \$/10 ³ Cubic Ft.	Other \$/10 ⁶ Btu	\$/kWh Equivalent ⁴					
			100% effic.	75% effic. ³	50% effic.	35% effic.	20% effic.	10% effic.
0.20	1.44	1.48	0.005	0.007	0.010	0.014	0.025	0.050
0.30	2.16	2.21	0.008	0.011	0.016	0.023	0.040	0.080
0.40	2.88	2.95	0.010	0.013	0.020	0.029	0.050	0.100
0.50	3.59	3.68	0.013	0.017	0.026	0.037	0.065	0.130
0.60	4.31	4.42	0.015	0.020	0.030	0.043	0.075	0.150
0.70	5.03	5.16	0.018	0.024	0.036	0.051	0.090	0.180
0.80	5.75	5.89	0.020	0.027	0.040	0.057	0.100	0.200
0.90	6.47	6.63	0.023	0.031	0.046	0.066	0.115	0.230
1.00	7.19	7.37	0.025	0.033	0.050	0.071	0.125	0.250

1 1 bbl petrol = 42 gallons - 5.7×10^6 Btus

2 1 c.f. natural gas - 1025 Btu's

3 Typical of clean-burning furnace

4 3413 Btu = 1 KWHr

TABLE II (Step 3)
Loan Payment Factors

Find the factor in this matrix that correlates with the loan term and interest rate for the case study.
The factor times the principal results in the annual loan payment.

		<u>INTEREST RATES %</u>														
YEARS	TERM*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	5	.21	.21	.22	.23	.24	.24	.24	.25	.25	.26	.27	.27	.28	.29	.31
	10	.11	.12	.12	.13	.14	.14	.15	.15	.16	.17	.17	.18	.19	.19	.21
	15	.07	.08	.09	.10	.10	.11	.11	.12	.13	.14	.14	.15	.16	.17	.18
	20	.06	.07	.07	.08	.09	.09	.10	.11	.12	.12	.13	.14	.15	.16	.17
	25	.05	.06	.06	.07	.08	.08	.09	.10	.11	.12	.13	.14	.15	.15	.16
	30	.05	.05	.06	.07	.07	.08	.09	.10	.11	.11	.12	.13	.14	.15	.16

* Years = System Life = Loan Term.

TABLE III
Present Value Factors
(R = Discount Rate)

ESCALATION OR INFLATION RATES										
YEARS	0%	2%	4%	6%	8%	10%	12%	14%	16%	
5	3.99	4.14	4.30	4.46	5.00	4.80	4.99	5.17	5.37	
10	6.71	7.26	7.86	8.52	10.00	10.07	10.97	11.95	13.04	
15	8.56	9.60	10.81	12.23	15.00	15.84	18.14	20.84	24.01	
20	9.82	11.35	13.25	15.60	20.00	22.17	26.74	32.48	39.69	R = 8%
25	10.67	12.67	15.27	18.67	25.00	29.10	37.06	47.73	62.10	
30	11.26	13.67	16.94	21.46	30.00	36.70	49.43	67.72	94.14	
5	3.89	4.03	4.19	4.34	4.50	4.67	4.85	5.03	5.22	
10	6.42	6.93	7.49	8.12	8.80	9.56	10.40	11.32	12.33	
15	8.06	9.01	10.11	11.40	12.91	14.68	16.76	19.19	22.05	
20	9.13	10.50	12.18	14.26	16.83	20.04	24.04	29.05	35.32	R = 9%
25	9.82	11.57	13.82	16.74	20.58	25.65	32.38	41.37	53.43	
30	10.27	12.34	15.11	18.90	24.16	31.52	41.94	56.80	78.15	
5	3.79	3.93	4.08	4.23	4.38	5.00	4.71	4.89	5.07	
10	6.14	6.63	7.16	7.74	8.38	10.00	9.87	10.73	11.68	
15	7.61	8.47	9.48	10.66	12.03	15.00	15.52	17.72	20.30	
20	8.51	9.74	11.24	13.08	15.36	20.00	21.69	26.07	31.55	R = 10%
25	9.08	10.61	12.57	15.10	18.40	25.00	28.45	36.06	46.21	
30	9.43	11.20	13.57	16.77	21.17	30.00	35.85	48.00	65.33	
5	3.70	3.83	3.97	4.12	4.27	4.42	4.59	4.75	4.93	
10	5.89	6.34	6.84	7.39	7.99	8.65	9.38	10.19	11.07	
15	7.19	7.99	8.91	9.98	11.23	12.69	14.40	16.40	18.73	
20	7.96	9.06	10.40	12.04	14.06	16.56	19.65	23.49	28.28	
25	8.42	9.77	11.48	13.68	16.53	20.25	25.13	31.59	40.17	R = 11%
30	8.69	10.23	12.26	14.98	18.68	23.78	30.87	40.85	55.00	

TABLE III (continued)

YEARS	ESCALATION OR INFLATION RATES									
	0%	2%	4%	6%	8%	10%	12%	14%	16%	
5	3.60	3.74	3.87	4.01	4.16	4.31	5.00	4.63	4.79	R = 12%
10	5.65	6.03	6.54	7.06	7.62	8.24	10.00	9.68	10.51	
15	6.81	7.54	8.39	9.37	10.51	11.94	15.00	15.20	17.32	
20	7.47	8.45	9.66	11.13	12.92	15.13	20.00	21.24	25.44	
25	7.84	9.03	10.54	12.46	14.93	18.13	25.00	27.83	35.11	
30	8.06	9.40	11.15	13.47	16.60	20.88	30.00	35.03	46.64	
5	3.52	3.64	3.77	3.91	4.05	4.20	4.35	4.50	4.67	R = 13%
10	5.43	5.83	6.27	6.75	7.28	7.86	8.51	9.21	9.99	
15	6.46	7.13	7.91	8.81	9.86	11.07	12.48	14.13	16.05	
20	7.02	7.92	9.00	10.31	11.91	13.87	16.29	19.27	22.96	
25	7.33	8.39	9.72	11.40	13.55	16.32	19.93	24.64	30.84	
30	7.50	8.67	10.19	12.19	14.85	18.46	23.41	30.25	39.83	
5	3.43	3.55	3.68	3.81	3.95	4.09	4.23	5.00	4.54	R = 14%
10	5.22	5.59	6.01	6.46	6.96	7.51	8.11	10.00	9.50	
15	6.14	6.76	7.48	8.30	9.26	10.37	11.66	15.00	14.90	
20	6.62	7.43	8.41	9.58	11.01	12.76	14.91	20.00	20.80	
25	6.87	7.82	8.99	10.47	12.35	14.76	17.88	25.00	27.23	
30	7.00	8.04	9.36	11.09	13.38	16.44	20.60	30.00	34.25	
5	3.35	3.47	3.59	3.72	3.85	3.99	4.13	4.27	4.42	R = 15%
10	5.02	5.37	5.76	6.19	6.66	7.18	7.74	8.36	9.04	
15	5.85	6.42	7.08	7.84	8.72	9.73	10.91	12.28	13.87	
20	6.26	6.99	7.87	8.93	10.22	11.78	13.69	16.03	18.91	
25	6.46	7.31	8.35	9.66	11.31	13.42	16.12	19.61	24.17	
30	6.57	7.48	8.65	10.15	12.11	14.73	18.25	23.05	29.66	

TABLE III (Continued)

YEARS	ESCALATION OR INFLATION RATES									
	0%	2%	4%	6%	8%	10%	12%	14%	16%	
5	3.27	3.39	3.51	3.63	3.76	3.89	4.02	4.16	5.00	R = 16%
10	4.83	5.17	5.54	5.94	6.38	6.87	7.40	7.98	10.00	
15	5.58	6.11	6.71	7.41	8.22	9.15	10.23	11.48	15.00	
20	5.93	6.60	7.40	8.35	9.51	10.91	12.61	14.69	20.00	
25	6.10	6.86	7.79	8.95	10.41	12.25	14.60	17.63	25.00	
30	6.18	6.99	8.02	9.33	11.03	13.28	16.28	20.33	30.00	
5	3.20	3.31	3.42	3.54	3.66	3.79	3.92	4.06	4.20	R = 17%
10	4.66	4.98	5.32	5.70	6.12	6.58	7.08	7.63	8.23	
15	5.32	5.82	6.38	7.02	7.77	8.62	9.61	10.76	12.08	
20	5.63	6.24	6.96	7.83	8.87	10.13	11.65	13.51	15.77	
25	5.77	6.45	7.29	8.32	9.61	11.23	13.29	15.92	19.31	
30	5.83	6.56	7.47	8.62	10.10	12.04	14.60	18.04	22.70	
5	3.13	3.23	3.34	3.46	3.58	3.70	3.83	3.96	4.10	R = 18%
10	4.49	4.79	5.12	5.48	5.88	6.31	6.78	7.29	7.86	
15	5.09	5.55	6.07	6.67	7.35	8.14	9.05	10.10	11.31	
20	5.35	5.91	6.57	7.36	8.30	9.43	10.80	12.46	14.48	
25	5.47	6.09	6.84	7.76	8.91	10.34	12.15	14.44	17.39	
30	5.52	6.17	6.98	8.00	9.30	10.98	13.18	16.12	20.06	
5	3.06	3.16	3.27	3.38	3.49	3.61	3.74	3.86	4.00	R = 19%
10	4.34	4.62	4.93	5.27	5.64	6.05	6.49	6.98	7.51	
15	4.88	5.30	5.78	6.34	6.97	7.70	8.53	9.49	10.61	
20	5.10	5.61	6.22	6.93	7.78	8.81	10.04	11.52	13.33	
25	5.20	5.76	6.44	7.27	8.29	9.56	11.15	13.16	15.73	
30	5.23	5.82	6.55	7.45	8.60	10.06	11.97	14.48	17.84	
5	2.99	3.09	3.19	3.30	3.41	3.53	3.65	3.77	3.90	R = 20%
10	4.19	4.46	4.76	5.08	5.43	5.81	6.23	6.69	7.19	
15	4.68	5.07	5.52	6.03	6.62	7.29	8.06	8.95	9.97	
20	4.87	5.34	5.89	6.55	7.32	8.25	9.35	10.69	12.31	
25	4.95	5.46	6.08	6.82	7.74	8.86	10.27	12.04	14.29	
30	4.98	5.51	6.16	6.97	7.98	9.26	10.92	13.09	15.96	

TABLE IV
Loss Period*

1ST YEAR COST/SAVINGS	FUEL ESCALATION RATE (%)							
	5%	6%	7%	8%	9%	10%	11%	12%
1.0	1	1	1	1	1	1	1	1
1.1	3	3	3	3	2	2	2	2
1.2	6	5	4	4	4	3	3	3
1.3	9	7	6	5	5	4	4	4
1.4	11	9	8	7	6	5	5	5
1.5	14	11	9	8	7	6	6	5
1.6	16	12	10	9	8	7	6	6
1.7	19	14	12	10	9	8	7	7
1.8	21	16	13	11	10	9	8	7
1.9	24	17	14	12	10	9	8	8
2.0	26	19	15	13	11	10	9	8
2.1	29	20	16	14	12	11	10	9
2.2	--	22	17	14	13	11	10	9
2.3	--	23	18	15	13	12	11	10
2.4	--	24	19	16	14	12	11	10
2.5	--	26	20	17	15	13	12	11

* Assumes O&M, Property Tax, Insurance Costs are one-third the annual cost.
Assumes these same costs escalate 5% per year

TABLE V
Years to Simple Payback

1st Year Energy Saving As a Percent Of System Cost	Energy Price Escalation Rate, Percent/Year							
	5	6	7	8	9	10	11	12
2	26	24	23	21	20	19	18	18
4	17	16	15	15	14	14	13	13
6	13	12	12	12	11	11	10	10
8	10	10	10	10	9	9	9	9
10	9	9	8	8	8	8	8	7
12	8	7	7	7	7	7	7	7
14	7	7	6	6	6	6	6	6
16	6	6	6	6	6	6	6	5
18	6	5	5	5	5	5	5	5
20	5	5	5	5	5	5	5	5
22	5	5	5	5	4	4	4	4
24	4	4	4	4	4	4	4	4
26	4	4	4	4	4	4	4	4
28	4	4	4	4	4	4	3	3
30	3	3	3	3	3	3	3	3
32	3	3	3	3	3	3	3	3
34	3	3	3	3	3	3	3	3
36	3	3	3	3	3	3	3	3
38	3	3	3	3	3	3	3	3
40	3	3	3	3	3	3	3	3

A broad variety of incentives could potentially be adopted for reducing WECS costs. These may be utilized singly or in various combinations. Based on historical precedent, the following six incentive approaches were assessed:

- . Direct cash subsidy
- . Tax credit
- . Sales tax exemption/reduction
- . Property tax exemption/reduction
- . Low interest loan
- . Accelerated depreciation

These incentives were evaluated using a computer-based financial model which examined the cash flows on a detailed (month-by-month) basis. On the basis of the computer model, incentive nomographs were prepared for the residential and agricultural sectors. The use of these nomographs will be discussed in the following section. Program documentation and a user's guide for the model are presented in Appendix B.

(2) Use of the Incentive Nomographs

The following six steps are used to estimate the reduction of WECS capital costs required to make WECS economically competitive with its least costly alternative.

STEP 1: Calculate the Present Value of Electricity Costs Avoided by Installing WECS. The PV of alternative electricity expenses that would have been incurred over the 30 year WECS lifetime with 10 and 15 percent discount rates can be calculated using Exhibit A-6. Multiplying the output (\$/kWh) by the annual electrical load displaced by the WECS yields the present value of energy cost savings.

STEP 2: Calculate the Present Value of WECS Costs. The PV of WECS capital costs for the various base cases can be calculated using Exhibit A-7. Multiplying the net present cost (\$/kW) by the system size (kW) results in the present value of all future WECS costs.

STEP 3: Estimate the Required Impact of the Incentive(s). The impact of the required incentive(s) is determined by the difference between the PV of WECS and the PV of the alternative electricity expenses. If this value is less than or equal to 0, an incentive is not necessary from the perspective of the economic "rational" man.

STEP 4: Estimate the Required Reduction in WECS Costs. The ratio formed by dividing the level of incentive (Step 3) required by the PV of WECS costs (Step 2) results in the percentage reduction of WECS costs needed to equalize the PV's of WECS and its alternative.

Exhibits A-8 through A-12 are nomographs which combine the various incentives in a dimensionless format. The following four steps are used to apply an incentive or combinations of incentives to achieve the required reduction.

STEP 5: Select the Appropriate Nomograph. The nomographs analyze the base cases for residential and agricultural WECS purchases developed in Chapters IV and V. Use of the same set of incentives in the different markets will result in differing impacts.

STEP 6: Enter the Nomograph at the Right Hand Abscissa. The incentives analysis begins at the right hand abscissa. The combined impact of applying both direct cash subsidies and tax credits is additive.

STEP 7: Movement Around the Nomograph Is Counterclockwise. The effect of combinations of incentives can be examined by moving horizontally or vertically around the nomograph in a counterclockwise direction in horizontal or vertical steps. Diagonal movement is not permitted.

STEP 8: Exit the Nomograph at the Axis Titled "Reduction in WECS Costs."

EXHIBIT A-6
Present Value
of Electricity Costs
Over 30 Years

7

EXHIBIT A-7
Present Value of WECS Costs
(Base Case)

EXHIBIT A-8 Homeowner's Long-Term Loan Investment Nomograph

EXHIBIT A-9
Homeowner's Short-Term Loan
Investment Nomograph

EXHIBIT A-10
Rental Property Owner's Long Term
Loan Investment Nomogram

EXHIBIT A-11
Rental Property Owner's
Investment Nomogram

EXHIBIT A-12 Agricultural Investment Nomogram

Base case assumptions for these nomographs are presented in Exhibit A-13.

To demonstrate the use of these nomographs, a hypothetical example case is presented in Exhibits A-14 and A-15. The example is self-explanatory, leading the reader step-by-step through the assumptions and analysis.

4. INCENTIVE ANALYSIS IN THE ELECTRIC UTILITY SECTOR

(1) Introduction-Overview of Revenue Requirement Analysis

This section presents a "workbook" methodology for evaluating the impact of Government incentives on the electric utility market for WECS. Chapter III, in the body of this report, presents a detailed discussion of the utility sector. This section provides a tool for analyzing the various incentives, both in terms of their impact on utility decision-making and in terms of their cost to the government.

Utilities will select the generation option which satisfies the criterion of minimizing revenue requirements. Revenue requirements consist of:

- . Depreciation
- . Interest costs
- . Property and other non-income taxes
- . Pre-tax income required for the desired return on equity
- . Operation and maintenance costs

Investor-owned utilities raise capital for new generation projects through a combination of increasing the company's liabilities (i.e., issue bonds) and/or increasing its ownership (issuing stock). Every utility's financial structure is different, but for each there exists some "weighted cost of capital" pool covering repayment of debt and a regulated rate of return on equity.

Analyses were also prepared for publicly-financed utilities. Because these utilities do not earn taxable income, the potential range of incentives is more restricted than for investor-owned utilities. Three categories of publicly-financed utilities were examined:

- . Federal systems (TVA, Bonneville Power Administration, etc.)
- . Public non-federal systems (municipals, state power authorities, etc.)
- . Cooperatives (financed through the Rural Electrification Administration).

The bulk of electrical generation (roughly 75%) takes place within the investor-owned category, and this sector offers the most promise for incentive application, as discussed in Chapter III.

For the purpose of this analysis, the following assumptions were made.

- . Utilities will select that generation option with the lowest revenue requirements—that is, the lowest cash flow required to cover the accounts listed above for a given generation increment.
- . A kilowatt-hour (kWh) of WECS generation is as valuable to the utility as a kWh of alternative generation. This may or may not be realistic, depending on the particular circumstances of each installation.

For a utility to select WECS under these assumptions, the revenue requirements of the wind system must be lower than those of its least costly alternative. If the base case wind system cannot compete under these circumstances, the use of incentive(s) may be in order.

Referring to the elements of the revenue requirements calculation (discussed in detail in Chapter III), it can be seen that all elements except operation and maintenance expenses are directly associated with the capital investment in the wind system, and can then be influenced by the application of financial incentives.

EXHIBIT A-13
Summary of Base Case Assumptions¹

	PRIVATE RESIDENTIAL		RENTAL PROPERTY		AGRICULTURAL
	New Housing (Exhibit A-8)	Existing Home (Exhibit A-9)	New Construction (Exhibit A-10)	Retrofit (Exhibit A-11)	Agricultural (Exhibit A-12)
FINANCING					
. Down Payment	20%	20%	20%	20%	15%
. Loan Term	30 years	5 years	30 years	5 years	15 years
. Annual Interest Rate	9%	15%	9%	15%	9%
. Depreciation	-	-	Straight Line	Straight Line	DDB ²
. Owner's Income Tax Rate	25%	25%	50%	50%	20%
. Discount Rate (for Future Cash Flows)	10%	10%	15%	15%	10%
ANNUAL COSTS					
. Sale Tax Rate	5% of System				
. Operation/Maintenance	2% of System				
. Property Taxes	2% of System				
. Escalation Rate	5% Annual				
CONVENTIONAL ENERGY COST ESCALATION RATE	7% Annual				
SYSTEM LIFE	30 Years				
USEFUL CAPACITY FACTOR	30%				

¹ Base case assumptions are discussed in detail in Chapter IV (Residential) and Chapter V (Agricultural).

² Double-declining Balance

EXHIBIT A-14
Example Calculations to Estimate the Reduction
in WECS Capital Costs

Step 1: Calculate the Present Value of Conventional Energy Source

- . Cost of Electricity: 4¢/kwh
- . Annual electrical output: 7884 kwh
- . Calculate PV of Electricity Using Exhibit IV-6

PV of Electricity per kwh	x	Electrical Load	=	Total PV of Electricity
<u>\$0.75/kwh</u>	x	<u>7884 kwh</u>	=	<u>\$5913</u>

Step 2: Calculate the Present Value of WECS Costs

- . Homeowners, 30-year loan: 25%
- . Initial WECS Cost: \$2000/kw
- . Calculate PV of WECS Capital Costs Using Exhibit IV-7

PV of WECS Cost per kwh	x	System Size	=	PV of WECS
<u>\$2700/kwh</u>	x	<u>3 kW</u>	=	<u>\$8100</u>

Step 3: Estimate the Level of Incentive

PV of WECS (Step 2)	-	PV of Electricity =	Level of Incentive
<u>\$8100</u>	-	<u>\$5913</u>	<u>\$2187</u>

Step 4: Estimate the Required Production in WECS Capital Costs

Level of Incentive (Step 3)	÷	PV of WECS Costs (Step 2)	=	Reduction in WECS Costs
<u>\$2187</u>	÷	<u>\$8100</u>	=	<u>27% of PV</u>

EXHIBIT A-14
(Continued)

STEP 5: Select the Appropriate Nomograph

- . For this case, use Exhibit A-8, reproduced for convenience in Exhibit A-15.

STEP 6: Enter the Nomograph at the Right Hand Abscissa

- . Assume a no Direct Subsidy (Point A)

STEP 7: Move Counterclockwise Around the Nomograph

- . From Point A, move vertically up to a 6 percent interest rate (Point B)
- . From Point B, move horizontally to a 0 percent property tax rate (Point C)
- . From Point C, move vertically down to a 5 percent sales tax rate (Point D)
- . From Point D, move horizontally to the axis titled "Reduction in WECS Costs."

STEP 8: Exit the Nomograph

- . The combined effect of a 6 percent interest rate (a reduction of 3 percent from a base case of 9 percent) and a property tax exemption (from the base case of 2 percent) is a 27 percent reduction in WECS costs
- . Any other combination of incentives which satisfies the target cost reduction (27%) can similarly be generated. The cost effectiveness of the various incentives is discussed in the body of this report.

EXHIBIT A-15
 Homeowner's Long-Term Loan
 Investment Nomograph
 With Case Example

(2) Impact of Incentives on Revenue Requirements

Clearly, an infinite range of incentive possibilities actually exists, but the major options, in terms of past usage, impact on system economics and use of Government administration are:

- . Direct cash subsidies
- . Loan subsidies
- . Tax credits and/or exemptions, and
- . Tax deferrals (liberalized accounting).

The remainder of this section will present a methodology for estimating the cost of wind generation and thereby examining the impact of various incentive strategies on utility decision-making.

Revenue requirements are normally expressed in terms of the percentage of the installed capital cost of the plant which must be covered by revenues each year for the utility to recover its appropriate return on its investment. This discussion will follow that convention, keying on the impact of each subsidy on the various components of the revenue requirement calculation.

. Direct Cash Subsidies. Direct subsidies were assumed to take place through Governmental provision of some percentage of the installed capital cost of the WECS unit(s) installed by each participating utility. Each unit was assumed to enter the rate base at the utility's actual capital investment. Accordingly, revenue requirements for

- Depreciation
- Return on capital and
- Income taxes (investor-owned utilities only)

were assumed to be reduced by the fraction of capital invested by the Government. Property taxes, which are typically levied by state or local government, were assessed on the full capital investment.

Low Interest Loans. Low interest loans were assumed to enter the utilities' books solely as a lowering of the cost of capital for the WECS unit. Units were assumed to enter the rate base as though they were conventionally financed otherwise.

Investment Tax Credit (Investor-Owned Utilities Only). The investment tax credit enters the utilities' books as a reduction in the first year's tax liabilities. Since current tax law already permits a 10% credit, an effective WECS credit would require an increase above this base rate.

The capital exempted from tax liabilities is then presumed to be reinvested in income-producing assets (which are, in turn, subject to later tax liabilities), but the net effect of increasing the tax credit beyond some point would be that this future reinvestment would produce income sufficient to more than cover the original plant's revenue requirements for income taxes. Accordingly, the investment tax credit provides a potent incentive for those utilities which have taxable income.

Accelerated Depreciation (Investor-Owned Utilities Only). Accelerated (or "liberalized") depreciation permits utilities to defer their income tax liabilities by depreciating the bulk of their investment in WECS during the early years of its life. This reduces income taxes and increases cash flow during the early years of a project's life, allowing productive use of the capital until the liabilities ultimately become due.

A number of accelerated depreciation schedules are in current use; the most common of these are the sum-of-years' digits and double-declining balance schemes. Sum-of-years was selected for this analysis because annual payments could be unambiguously calculated. Double declining amortization would not yield substantially different results.

Increasing levels of depreciation incentive can also be provided by shortening the depreciation term while the system (book) life is held constant. In the extreme case, utilities could be permitted to expense WECS units in their first year of operation for tax purposes while maintaining them on their books for the full 20 years service life for rate purposes. This would have the additional benefit to utilities of reducing their risk in WECS by allowing them to rapidly recoup their WECS investment.

Accelerated depreciation can be an effective incentive mechanism given two conditions:

- That the depreciable life of the WECS facility can be reduced significantly as compared to its actual operating life
- That the utility has taxable income against which the accelerated depreciation can be credited. This situation is similar to the condition which exists with the investment tax credit incentive.

Property Tax Elimination. Property taxes are normally levied by state or local government; therefore, elimination of these taxes would cost the Federal Government nothing (unless, of course, one postulates a Federal reimbursement program). This incentive will benefit utilities by reducing their annual cost of operating the WECS unit. In the case of investor-owned utilities, these expenses are deductible from income taxes so the incentive will have a lower impact.

(3) Utility Sector Incentive Nomographs

Based on the base case assumptions for

- . Investor-owned utilities
- . Federal systems
- . Public & non-Federal, and
- . Cooperative systems

(shown in Exhibit A-16) revenue requirements as a function of installed capital cost were calculated for each of the utility markets. These base case requirements are presented graphically in Exhibit A-17.

Exhibits A-18 through A-21 present nomographs which permit varieties of incentive strategies to be developed to achieve predetermined reductions in capital-related revenue requirements for the four utility markets. The steps in the analysis are as follows:

- Determine base case WECS revenue requirements (r_b) from Exhibit A-17 (mills/kWh).
- Determine (or estimate) the maximum revenue requirements at which WECS will be competitive (r_r mills/kWh).
- Calculate the reduction in revenue requirements (r_p) which must be achieved to make WECS competitive as shown:

$$r_n = r_b - r_r;$$

- Calculate the capital-related revenue requirements (r_y) from the formula

$$r_y = \frac{Y(R_Y)}{876(CF)}$$

where

- r_y : Capital-related revenue requirements (mills/kWh)
- Y: Installed capital cost (\$/kW)
- R_Y : Capital-related revenue requirements rate (% of capital cost per year)
 - Investor-owned utilities, $R_Y = 16.15\%$
 - Federal systems, $R_Y = 13.11\%$
 - Public non-Federal systems, $R_Y = 11.72\%$

EXHIBIT A-16
Base Case Revenue Requirements for the
Electric Utility WECS Market (1)

	Investor Owned	Federal	Public Non-Federal	Cooperative
Return on Capital (% capitalization; cost)				
Debt	50%; 8%	100%; 8%	100%; 6%	100%; 8.75%
Preferred Equity	12%; 8.5%	--	--	--
Common Equity	38%; 12%	--	--	--
WACC (k)	9.58%	8%	6%	8.75%
Depreciation (i) (20-Year Project Life)	1.83%	2.19%	2.72%	2.01%
Income Taxes (T) (See Note (2) Below)	1.88%	--	--	--
Annual Expenses (See Note (3) Below)				
Property Taxes	2.86%	--	--	2.89%
Payments in Lieu of Taxes	--	2.92%	3.01%	--
Operation and Maintenance	2.86%	2.92%	3.01%	2.89%
Total Revenue Requirements	19.01%	16.03%	14.74%	16.54%

Notes: (1) Based on Methodology in Preceding Section

(2) Book Depreciation Rate = 5%

(3) Property Taxes, Payments in Lieu of Taxes, and Operation/Maintenance Expenses are levelized revenue requirements based on a 2% first-year charge, escalating 5% annually over the 20-year system life.

EXHIBIT A-17
Base Case Revenue Requirements for WECS

EXHIBIT A-18
Incentives Analysis Nomograph
for Investor-Owned Utilities

EXHIBIT A-19
Incentives Analysis Nomogram for Publicly
Financed Federal Utilities

EXHIBIT A-20
Incentives Analysis Nomogram for
Publicly Financed Nonfederal Utilities

EXHIBIT A-21 Incentives Analysis Nomograph for Cooperative Utilities

EXHIBIT A-22
Hypothetical Electric Utility Incentive Analysis
(Investor-Owned)

Base Case Data

- . WECS cost: \$750/kW
- . Revenue requirements (maximum) at which WECS will be competitive (exogenously estimated): 35 mills/kWh
- . Estimated WECS capacity factor = 30%

Step 1: Estimate base case WECS revenue requirements from Exhibit A-17

$$r_b = 54 \text{ mills/kWh}$$

Step 2: Calculate the required reduction in revenue requirements

$$r_n = r_b - r_r = 54 - 35 = 19 \text{ mills/kWh}$$

Step 3: Calculate the base case capital-related revenue requirements

$$r_y = \frac{\$750/\text{kW} (R_y = .1615)}{876 (.3)} = 46 \text{ mills/kWh}$$

Step 4: Calculate the total reduction in capital-related revenue requirements

$$T_{cc} = \left(\frac{r_n}{r_y} \right) 100\% = \frac{19}{46} 100\% = 41\%$$

Step 5: Select incentive strategies which achieve the required reduction (41%) on the investor-owned utility nomograph

- Cooperative systems, $R_y = 13.65\%$

CF: WECS capacity factor (decimal,
base case value = 0.3).

- . Calculate the total reduction in capital-related revenue requirements (T_{cc}) which the incentives must achieve to equate r_b with r_r as shown:

$$T_{cc} = \frac{r_n}{r_y} 100\%$$

where

T_{cc} : Total reduction in capital-related revenue requirements (%)

- . Locate T_{cc} on the appropriate incentives nomograph
- . Beginning at the "other end" of each nomograph and proceeding in a clockwise direction,
- . Map out incentive strategies on the nomograph which achieve the required reduction (T_{cc}). The rules which must be followed in mapping out strategies are as follows:
 - Travel around the nomograph must be either horizontal or vertical
 - One option must be selected in each incentive quadrant, either the base case or some level of incentive, and at that point a 90° (clockwise) change of direction must take place
 - Each path so selected must end at the required T_{cc} .

Intermediate incentives (i.e. a 33% direct purchase subsidy) are acceptable; fixed incentives are mapped out solely for reference purposes.

To display the use of the nomograph, Exhibits A-22 and A-23 present a hypothetical case study of an investor-owned utility analysis.

Exhibit A-23 displays two strategies which achieve the required 41% reduction in capital-related revenue requirements determined in Step 4, Exhibit A-22. Any number of other strategies could be created with the nomograph. The final selection should be based on a determination on which incentives are preferred:

* * * *

This Appendix has presented the WECS Incentives Workbook, a user oriented, step by step, set of analytical techniques for assessment of the impact of incentives on WECS economics.

APPENDIX B

PROGRAM DOCUMENTATION AND USER INSTRUCTIONS

A computer program has been developed to implement the methodology for the economic evaluation of WECS and WECS incentives. This program is described in this Appendix, which is divided into the following sections:

- . Program Description
- . Operating Instructions
- . Program Listing.

The program is coded in FORTRAN and is designed for interactive execution on a time-sharing terminal.

1. PROGRAM DESCRIPTION

The system flow chart of the computer program is presented in Exhibit B-1. The use of the program consists of three distinct phases:

- . Loading of input data and data base
- . User data manipulations and analysis commands
- . Model computation and output.

Each of these phases is described in the discussion which follows.

(1) Loading of Input Data and Data Base

In using the program, the user first sets up a data base consisting of 41 variables. These variables describe the economic and financial environment in which the WECS is being studied. A listing of these variables appears in Exhibit B-2. Explanatory notes on some selected variables are presented below:

- . System Useful Energy Delivery: The energy delivered by the WECS should be determined by machine and site analysis. Without such data, an assumed value for the WECS capacity factor must be selected.

- . Ratio: Loan to System Sales Price: This ratio is used for the computation of the cash flow economic indicators:

- Full payback
- Years to positive cash flow
- Years to recover downpayment.

- . Discount Rate for NPV Calculations: The NPV calculations are performed using standard formulas. The period in which the cash flows are discounted is selected as follows:

- If the period of analysis specified is greater than the system useful service life, the discounting is done over the useful life of the system
- If the loan term is longer than the period of analysis, the debt repayment schedule is adjusted to correspond to the period of analysis
- If the period of analysis is shorter than the useful service life, discounting is done over the period of analysis
- In all other cases, discounting is performed over the period of analysis.

The user can select any discount rate for the analysis. He should determine the discount rate by a careful examination of the relevant market (for base case purposes, a discount rate of 0% was used throughout).

- . Depreciation Method: The program can handle depreciation in one of three ways:

- No depreciation
- Straight line depreciation method
- Double-declining balance method (DDB).

EXHIBIT B-1
Flowchart of Generic Model Computer Program

EXHIBIT B-2
Program Variables

<u>Variables</u>	<u>Typical Value</u>	<u>Variable Description</u>
1	10000.	SYSTEM SALES PRICE, \$
2	10000.	SYSTEM ANNUAL USEFUL ENERGY DELIVERY, KWH
3	20.	SYSTEM USEFUL SERVICE LIFE, YRS
4	5.	UNIT COST OF UTILITY ENERGY, CENTS/KWH
5	7.	ENERGY COST ESCALATION RATE, %/YR
6	80.	RATIO : LOAN TO SYSTEM SALES PRICE
7	9.	ANNUAL INTEREST RATE, COMPUTED MONTHLY, %
8	20.	LOAN TERM, YRS
9	30.	OWNER MARGINAL INCOME TAX RATE, %
10	9.	DISCOUNT RATE FOR NPV CALCULATIONS
11		DEPRECIATION METHOD 0 NONE 1 STLINE 2 DDB
12	10.	PERIOD OF DEPRECIATION
13	20.	PERIOD OF ANALYSIS
14	1.	ENERGY EXPENSE DEDUCTIBLE 0 NO 1 YES
15	50.	CHARGES< O&M, VALUE
16	30.	CHARGES< O&M, TYPE
17	5.	CHARGES< O&M, ESCALATION RATE, %/YR
18	2.	CHARGES< PROPERTY TAX, VALUE
19	41.	CHARGES< PROPERTY TAX, TYPE
20	5.	CHARGES< PROPERTY TAX, ESCALATION RATE, %/YR
21	5.	CHARGES< SALES TAX, VALUE
22	21.	CHARGES< SALES TAX, TYPE
23		CHARGES< SALES TAX, ESCALATION RATE, %/YR
24		CHARGES< OTHER (1), VALUE
25		CHARGES< OTHER (1), TYPE
26		CHARGES< OTHER (1), ESCALATION RATE, %/YR
27		CHARGES< OTHER (2), VALUE
28		CHARGES< OTHER (2), TYPE
29		CHARGES< OTHER (2), ESCALATION RATE, %/YR
30		CREDITS< DIRECT CASH SUBSIDY, VALUE
31	70.	CREDITS< DIRECT CASH SUBSIDY, TYPE
32		CREDITS< DIRECT CASH SUBSIDY DURATION
33		CREDITS< TAX CREDIT, VALUE
34		CREDITS< TAX CREDIT, TYPE
35		CREDITS< TAX CREDIT, DURATION, YRS
36		CREDITS< OTHER (1), VALUE
37		CREDITS< OTHER (1), TYPE
38		CREDITS< OTHER (1), DURATION, YRS
39		CREDITS< OTHER (2), VALUE
40		CREDITS< OTHER (2), TYPE
41		CREDITS< OTHER (2), DURATION, YRS

Period of Depreciation: The user can specify a depreciation period different from the useful service life of the system by using this variable. If straight line or DDB depreciation method is specified and the period of depreciation is not specified, the program defaults this value to the system life.

Energy Expense--Deductible: 0 No; 1 Yes: Since for an investment property the energy expense is tax deductible and for an owner-occupied property it is not, energy savings from a WECS should account for the income tax effect depending upon the analysis being performed. This variable allows the user to designate the tax treatment for energy expenses.

Charges and Credits: The model is capable of modelling cash inflows and outflows that can arise in addition to the energy savings and system amortization: for example, additional cash outflows are property taxes and O&M charges. The program can model five different cash outflows and three different cash inflows. Any subsidy such as a tax credit can be modeled as a cash inflow. Each charge (outflow) or credit (inflow) is identified by three variables.

For charges, the variables are:

- Value (absolute or a percentage of price)
- Transaction type (described below) - two digits
- Escalation rate (percent/year).

The transaction type is a two-digit number. The units position of the transaction type may be:

- 0: Not tax deductible
- 1: Tax deductible.

The tens position of transaction types are defined as follows:

- 1: A charge applied in year 0 only, with value expressed in dollars.
- 2: A charge applied in year 0 only, with value expressed as a percentage of the system price.
- 3: A charge that is recurring throughout the system life. The base year value is expressed in dollars and the escalation rate (zero or non-zero) is specified.
- 4: A charge that is recurring throughout the system life. The base year value is expressed as a percentage of the system price.

To illustrate the design of an expense variable, O&M charges may be defined as follows:

Value: \$50
Type: 30
Escalation Rate: 5%

This means that the computer program will recognize a charge whose value is \$50, expressed in dollars and recurs every year, escalating at a rate of five percent annually. The 0 in the transaction type indicates that this charge is not tax deductible.

The credits are also described in terms of three variables:

- Value (Absolute or a percentage of price)
- Transaction type (two digits)
- Duration, years.

The units position of the transaction type may be 0 or 1:

0: Not taxable
1: Taxable

The tens position type identifier is as follows:

- 6: A credit applied to systems price in year 0 only, the value expressed in dollars.
- 7: A credit applied to systems price in year 0 only, the value expressed as percentage of the price.
- 8: A credit recurring for the specified duration, the value expressed in dollars.
- 9: A credit recurring for the specified duration, the value expressed as a percentage of the price.

The use of the transaction type is illustrated below:

An investment tax credit may be specified as:

Value: 20
Transaction type: 70
Duration: 0

(2) Model Computation and Output

After the data base for the analysis has been set up, the user can obtain the economic indicator's for the WECS being analyzed by giving a 'RUN' command. The following economic/financial indicators are computed by the program:

- . Sample payback
- . Full payback
- . Years to positive cash flow
- . Years to recover down payment
- . Net present value
- . Internal rate of return.

A sample print out of this input is shown in Exhibit B-3. Definitions of the economic indicator is presented elsewhere in the text.

The same output is produced when the user performs a sensitivity analysis by calculating the economic indicators when one or two of the data base variables is varied. An example of this report appears in Exhibit B-4.

2. OPERATING PROCEDURE

The model is presently implemented on a Univac 1108 system. The operating instructions for execution will be slightly different for other systems. The procedure for operating the model consists of the following steps after the data base has been constructed.

1. Log on
2. Assign unit 7 to the file containing the data base. In the Univac 1108-Exec 8, this is accomplished by the command: @ USE 7; WECSDT. where WECSDT is the filename of the data base.
3. Execute the program. In the Univac 1108 the program is executed by the following command:
@XQT PGM
where PGM is the object element, identified by filename element name.
4. The computer, when under program execution, will respond with the message:
WECS SYSTEM ECONOMIC ANALYSIS ...HELLO
READY;
5. Throughout the execution of this program, whenever the computer types READY; it means that the user command has been successfully executed and the computer is awaiting further instruction. If the user command is incorrect for some reason, the computer is programmed to respond with 'COMMAND UNCLEAR'.

EXHIBIT B3
Sample Output

READY
>ALTER
HOW MANY?

>1

VAR NO & VALUE?

>1 10000

SYSTEM SALES PRICE, \$

10000.00

READY

>RUN

MAJOR	MINOR	PRICE	NPV	S/PB	F/PB	YRDP	YRDCF	IRR
◆◆◆◆◆◆◆◆	◆◆◆◆◆◆◆◆	10000.	-40.	13.	17.	14.	5.	7.10

READY

EXHIBIT B4
Sensitivity Analysis

>REPEAT
ENTER NO. OF VARIABLES I.E. 1 OR 2

>2
ENTER ♦MINOR♦ VARIABLE

>1
FIRST, LAST & STEPS?

>5000 10000 1000

ENTER ♦MAJOR♦ VARIABLE

>4
FIRST, LAST & STEPS?

>2 10 2

ITERATED VARIABLE IS SYSTEM SALES PRICE, \$

ITERATED VARIABLE IS UNIT COST OF UTILITY ENERGY, CENTS/KWH

MAJOR	MINOR	PRICE	NPV	S/PB	F/PA	YRDP	YRPF	IRR
-------	-------	-------	-----	------	------	------	------	-----

2.	5000.	5000.	-3599.	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦♦♦♦♦♦	
2.	6000.	6000.	-4620.	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦♦♦♦♦♦	
2.	7000.	7000.	-5642.	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦♦♦♦♦♦	
2.	8000.	8000.	-6663.	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦♦♦♦♦♦	
2.	9000.	9000.	-7685.	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦♦♦♦♦♦	
2.	10000.	10000.	-8706.	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦♦♦♦♦♦	

4.	5000.	5000.	-1432.	17.	♦♦♦♦♦	♦♦♦♦♦	12.	3.31
4.	6000.	6000.	-2454.	19.	♦♦♦♦♦	♦♦♦♦♦	16.	1.26
4.	7000.	7000.	-3475.	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	19.	♦♦♦♦♦
4.	8000.	8000.	-4497.	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦♦♦♦♦♦	
4.	9000.	9000.	-5518.	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦♦♦♦♦♦	
4.	10000.	10000.	-6540.	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦	♦♦♦♦♦♦♦♦♦♦	

6.	5000.	5000.	734.	12.	15.	11.	3.	8.83
6.	6000.	6000.	-287.	13.	18.	15.	6.	6.57
6.	7000.	7000.	-1309.	15.	20.	19.	9.	4.75
6.	8000.	8000.	-2330.	17.	♦♦♦♦♦	♦♦♦♦♦	12.	3.21
6.	9000.	9000.	-3352.	18.	♦♦♦♦♦	♦♦♦♦♦	14.	1.88
6.	10000.	10000.	-4373.	20.	♦♦♦♦♦	♦♦♦♦♦	17.	.69

8.	5000.	5000.	2901.	9.	12.	6.	1.	13.11
8.	6000.	6000.	1880.	10.	14.	8.	1.	10.57
8.	7000.	7000.	858.	12.	16.	11.	3.	8.56
8.	8000.	8000.	-163.	13.	17.	14.	5.	6.90
8.	9000.	9000.	-1185.	14.	19.	17.	8.	5.49
8.	10000.	10000.	-2206.	16.	20.	20.	10.	4.26

10.	5000.	5000.	5068.	7.	9.	4.	1.	16.83
10.	6000.	6000.	4046.	9.	11.	5.	1.	13.96
10.	7000.	7000.	3025.	10.	13.	7.	1.	11.74
10.	8000.	8000.	2003.	11.	14.	9.	1.	9.93
10.	9000.	9000.	982.	12.	16.	11.	3.	8.41
10.	10000.	10000.	-40.	13.	17.	14.	5.	7.10

READY

6. The user has the choice of six commands in executing the program. Each of these commands is explained below.

ALTER When the program receives this command, the computer responds with HOW MANY? The user then can type in the total number of variables whose values need to be altered.

The variable numbers are as shown in Exhibit B-2. The variable number and value can be entered in free format, i.e., a comma or a space should separate the two numbers which may be integer or real. The user may input the numbers in either mode. When all the alterations have been made the program returns to the user with a READY; message.

BEGIN If the user wants to return all the variables to their initial values this is accomplished by a BEGIN command.

INPUT This command will allow the user to obtain a listing of all or a selected portion of the input variables. The program will prompt for the beginning and ending input variables in response to this command and list the variable values and the description. (Exhibit B-4).

RUN This command directs the program to compute and print the economic indicators for the system under study.

REPEAT This command allows the user to obtain a summary report of results when any one of the 39 variables is varied. In response to this command the program will first prompt for number of variables being iterated i.e., one or two; followed by the variable(s) number, followed by a prompt for the beginning value, ending value and the step increment. After the iteration is completed the iterated variable(s) is automatically restored to its original value.

STOP This command terminates program execution.

* * * *

These commands can be given at any point in the terminal session when this program is being run. The output reports are printed in the same terminal. The minimum terminal line size required is 80 characters. Exhibit B-5 is a listing of the program code. It is annotated with comment statements throughout for ease of interpretation.

EXHIBIT B-5
Program Listing

>OLD WECSM12

->LIS

```

100 C      WECS ECONOMIC ANALYSIS JOB
110 C      THIS PROGRAM AIDS IN GENERATING PARAMETRIC ECONOMIC DATA FOR
120 C      WECS SYSTEMS.
130 C      THIS PROGRAM CAN ALSO BE APPLIED TO ANY MARGINAL INVESTMENT
140 C      ANALYSIS
150 C      MAIN PROGRAM FOLLOWS
160      COMMON/SYSVAR/VAR(41)
170      COMMON/CASH/FLOW(30,15)
180      COMMON/TITLE/NAMES(7,41)
190      COMMON/XITER/IT,ITV(2),DT(3,2),VALOLD(2)
200      DIMENSION COOMD(6)
210      DATA COOMD /'STOP ','ALTER ','INPUT ','REPEAT','BEGIN ',
215      1'RUN '
220      WRITE(6,1)
230 1      FORMAT(1X,'WECS ECONOMIC ANALYSIS SESSION *** HELLO')
240 1000   READ(7,2) (VAR(I), (NAMES(J,I), J=1,7), I=1,41)
250 2      FORMAT(F10.0,7A6)
260 100    WRITE(6,3)
270 3      FORMAT(1X,'READY ')
275      IT=0
280      READ(5,4) ACTION
290 4      FORMAT(A6)
300      DO 110 J=1,6
310      IF (ACTION.EQ.COOMD(J)) GO TO 120
320 110    CONTINUE
330      WRITE(6,5)
340 5      FORMAT(1X,'COMMAND UNCLEAR')
350      GO TO 100
360 120    GO TO (130,141,150,160,170,180),J
370 C      END JOB
380 130    GO TO 999
390 C      ALTERATIONS
400 141    CALL CHANGE
410      GO TO 100
420 C      INPUT LISTING
430 150    DO 190 I=1,41
440 190    WRITE(6,6) I, (NAMES(J,I), J=1,7), VAR(I)
450 6      FORMAT(1X,I3,2X,7A6,2X,F12.2)
460      GO TO 100
470 C      ITERATION OPTION
480 160    IEND=1
490      CALL ITPR
495      WRITE(6,8)
500 200    CALL FEED(IEND)
505      IF (IEND.EQ.0) GO TO 100
510      CALL COMPUT(IEND,VAR(ITV(1)),VAR(ITV(2)))
530      GO TO 200
540      RESTART
550 170    REWIND 7
560      GO TO 1000
570 C      ONE SHOT REPORT
575 180    WRITE(6,8)
580      CALL COMPUT(IEND,VAR(ITV(1)),VAR(ITV(2)))
590      GO TO 100
600 C      JOB TERMINATION
610 999    WRITE(6,7)
620 7      FORMAT(1X,'JOB OVER *** GOOD BYE')
625 8      FORMAT(1X,'      MAJOR      MINOR      PRICE      NPV      S/PB      F/PB',
626      1' YRDP YRPF      IRR')
630      STOP
640      END
END OF FILE

```

EXHIBIT B-5 (continued)

OLD WECS112

->LIST

```

100      SUBROUTINE COMPUT(IEND,V1,V2)
110 C      SUBROUTINE TO PERFORM AND OUTPUT ALL CALCULATIONS
120 C      THIS SUBROUTINE CALCULATES THE FOLLOWING.....
130 C      NET PRESENT VALUE, INTERNAL RATE OF RETURN, SIMPLE PAYBACK,
140 C      FULL PAYBACK, YRS TO BE EVEN, AND YRS TO + CASH FLOW
150      COMMON/CASH/FLOW(30,15)
160      COMMON/XITER/N,ITY(2),DT(3,2),VALOLD(2)
170      COMMON/SYSVAR/PRICE,ENERGY,XLIFE,ECSST,EESC,RLV,AIR,
180      1TERM,XITAX,DISCT,DEP,PDDEP,PERIOD,ENTX,CH(3,9)
190      DIMENSION DEBT(30),PRIN(30),XINT(30),FNET(39),D(30)
200      DIMENSION FPMET(30)
210      DOUBLE PRECISION XI,Y,XYIRR,SUM1,SUM2
220      VAL=PRICE
230      DO 221 J=1,9
240      ITY=CH(2,J)/10.
250      XX=CH(1,J)
260      KL=CH(2,J)-FLOAT(10*ITY)
270      IF(KL.GT.0)XX=(1.-.01*XITAX)*XX
280      K=I-1
290      IF(ITY.GT.4)KK=CH(3,J)
300      IF(ITY.GT.4)GO TO 231
310      IF(ITY.EQ.2.AND.I.EQ.1)VAL=VAL-.01*PRICE*XX
320      IF(ITY.EQ.1.AND.I.EQ.1)VAL=VAL-XX
330 231  IF(ITY.EQ.7.AND.I.EQ.1)VAL=VAL+.01*PRICE*XX
340      IF(ITY.EQ.6.AND.I.EQ.1)VAL=VAL+XX
350 221  CONTINUE
360      NPD=PERIOD
370      LIFE=XLIFE
380      IF(NPD.GT.LIFE)NPD=LIFE
390 C      COMPUTE MORTGAGE AND OTHER MORTGAGE RELATED CASH FLOWS
400      XRLV=RLV
410      IF(RLV.GT.1)XRLV=RLV/100.
420      IF(XRLV.NE.0)GO TO 110
430      ZFLOW=VAL
440      GO TO 139
450 110  L=TERM
460      IF(L.LE.0.)L=30
470      ZFLOW=VAL*(1.-XRLV)
480      ZLOAN=VAL-ZFLOW
490      IF(AIR.GT.0.)GO TO 120
500      AAA=ZLOAN/(FLOAT(L))
510      DO 130 I=1,L
520 130  FLOW(I,1)=AAA
530      GO TO 139
540 120  R=.01*AIR/12.
550      LL=12*L
560      BBB=(1+R)**LL
570      Q=ZLOAN*R*(1./(1.-(1/BBB)))
580      BAL=ZLOAN
590      DO 140 I=1,L
600      IF(I.GT.1)BAL=DEBT(I-1)
610      CCC=0.
620      DDD=0.

```

EXHIBIT B-5 (continued)

```

630      DO 150 J=1,12
640      CCC=CCC+BAI*AR
650      DDD=DDO+(Q-BAL*AR)
660      BAL=BAL-(Q-BAL*AR)
670 150  CONTINUE
680      XINT(I)=XINT(I)+CCC
690      PRIN(I)=PRIN(I)+DDD
700      DEBT(I)=BAL
710      FLOW(I,1)=PRIN(I)+(1.-XITAX*.01)*XINT(I)
720 C      WRITE(6,971)CCC,DDD,PRIN(I),XINT(I),DEBT(I),FLOW(I,1)
730 140  CONTINUE
740 C      SAVINGS AND OTHER CASHFLOWS
750 139  ZFLOW=-ZFLOW
760      NPDEP=PDDEP
765      IF(NPDEP.EQ.0)NPDEP=XLIFE
770      DO 170 I=1,LIFE
780      FLOW(I,2)=.01*ECOST*ENERGY*(1.+.01*EESC)*((I-1))
785      IF(ENTX.GT.0.)FLOW(I,2)=FLOW(I,2)*(1.-XITAX*.01)
790      IDEP=DEP
795      VALX=VAL
800      IF(IDEP.EQ.0)GO TO 210
810      IF(IDEP.EQ.1)GO TO 200
820      DDB=2./PDDEP
830      IF(NPDEP.LE.LIFE)FLOW(I,3)=.01*XITAX*VALX*DDB
840      VALX=VALX-VALX*DDB
850      GO TO 210
860 200  IF(NPDEP.LE.LIFE)FLOW(I,3)=.01*XITAX*VAL/PDDEP
870 210  FLOW(I,1)=-FLOW(I,1)
880      DO 220 J=1,9
890      ITY=CH(2,J)/10.
900      XX=CH(1,J)
910      KL=CH(2,J)-FLOAT(10*ITY)
920      IF(KL.GT.0)XX=(1.-.01*XITAX)*XX
930      K=I-1
940      IF(ITY.GT.4)KK=CH(3,J)
950      IF(ITY.GT.4)GO TO 230
960      IF(ITY.EQ.3)FLOW(I,J+3)=-XX*((1.+.01*CH(3,J))*K)
970      IF(ITY.EQ.4)FLOW(I,J+3)=-.01*PRICE*XX*((1.+.01*CH(3,J))*K)
980 230  IF(ITY.EQ.8.AND.I.LE.KK)FLOW(I,J+3)=XX
990      IF(ITY.EQ.9.AND.I.LE.KK)FLOW(I,J+3)=.01*PRICE*XX
1000     FNET(I)=FNET(I)+FLOW(I,J+3)
1010 220  CONTINUE
1020     FNET(I)=FNET(I)+FLOW(I,1)+FLOW(I,2)+FLOW(I,3)
1025     FPNET(I)=FNET(I)-FLOW(I,1)
1030 170  CONTINUE
1040     IF(L.GT.LIFE)FNET(LIFE)=FNET(LIFE)-DEBT(LIFE)
1050     IF(NPD.LT.L.OR.NPD.LT.LIFE)FNET(NPD)=FNET(NPD)-DEBT(NPD)
1060 C
0070 C      END CASH FLOW CALCULATIONS. COMPUTE INDICATORS
1080 C      WRITE(6,971)Q,ZFLOW
1090 C      WRITE(6,971)(FNET(I),(FLOW(I,J),J=1,8),I=1,30)
1100 971  FORMAT(1X,9F8.0)
1110 C      NET PRESENT VALUE
1120     XNPV=ZFLOW
1125     IF(DISCT.GT.0.)XNPV=-VAL
1130     D(1)=1./(1.+.01*DISCT)
1140     DO 240 I=1,NPD
1150     IF(I.GT.1)D(I)=D(I-1)/(1.+.01*DISCT)
1155     IF(DISCT.GT.0)XNPV=XNPV+FPNET(I)*D(I)
1160 240  IF(DISCT.EQ.0)XNPV=XNPV+FNET(I)*D(I)
1170 C      COMPUTE PAYBACK, SIMPLE
1180     SUM=(ZFLOW-ZLOAN)

```

EXHIBIT B-5 (continued)

```

1190      DO 250 I=1,LIFE
1200      SUM=SUM+FLOW(I,2)
1210      SUMX=0.
1220      DO 255 J=1,9
1230 255  SUMX=SUMX+FLOW(I,J+3)
1240      SUM=SUM+SUMX
1250      IF(SUM.GT.0)GO TO 260
1260 250  CONTINUE
1270 260  SPB=I
1280      IF(I.GE.LIFE.AND.SUM.LT.0.)SPB=999999999.
1290 C    COMPUTE FULL PAYBACK
1300      SUM=ZFLOW
1310      DO 270 I=1,LIFE
1320      SUM=SUM+FNET(I)
1330      IF(SUM.GE.DEBT(I))GO TO 280
1340 270  CONTINUE
1350 280  FPB=I
1360      IF(SUM.LT.DEBT(I).AND.I.GE.LIFE)FPB=999999999.
1370 C    YEARS TO RECOVER DOWN PAYMENT
1380      SUM=ZFLOW
1390      DO 300 I=1,LIFE
1400      SUM=SUM+FNET(I)
1410      IF(SUM.GE.0.)GO TO 290
1420 300  CONTINUE
1430 290  YRDP=I
1440      IF(SUM.LT.0..AND.I.GE.LIFE)YRDP=999999999.
1450 C    COMPUTE YRS TO + CASH FLOW
1460      DO 310 I=1,LIFE
1470      IF(FNET(I).GT.0.)GO TO 320
1480 310  CONTINUE
1490      GO TO 325
1500 320  YRPCF=I
1510 325  IF(I.GE.LIFE)YRPCF=999999999.
1520 C    COMPUTE INTERNAL RATE OF RETURN
1530      CALL IRR(VAL,FPNET,NPD,XIRR)
1690 C    END OF COMPUTATION OF ECONOMIC INDICATORS.
1700 C    OUTPUT FOLLOWS....
1710      B=999999999.
1720      A=999999999.
1730      IF(N.GE.1)B=V1
1740      IF(N.EQ.2)A=V2
1750      WRITE(6,999)A,B,PRICE,XNPV,SPB,FPB,YRDP,YRPCF,XIRR
1760 999  FORMAT(1X,4(1X,F8.0),4(1X,F5.0),F7.2)
1770      DO 400 I=1,30
1780      DEBT(I)=0.
1790      XINT(I)=0.
1800      PRIN(I)=0.
1810      FNET(I)=0.
1815      FPNET(I)=0.
1820      DO 400 J=1,12
1830 400  FLOW(I,J)=0.
1840      RETURN
1850      END
END OF FILE
->

```


EXHIBIT B-5 (continued)

OLD WECS212

->LIST

```

100      SUBROUTINE ITPR
110 C      SUBROUTINE TO PROMPT FOR ITERATION
120      COMMON/SYSVAR/VAR(41)
130      COMMON/XITER/N,ITV(2),DT(3,2),VALOLD(2)
140      COMMON/TITLE/NAMES(7,41)
150      WRITE(6,1)
160 1      FORMAT(1X,'ENTER NO. OF VARIABLES I.E. 1 OR 2')
170      READ(5,2)N
180 2      FORMAT()
210 91     WRITE(6,3)
220 3      FORMAT(1X,'ENTER ♦MINOR♦ VARIABLE')
230      READ(5,2)ITV(1)
235      IF(ITV(1).GT.41)GO TO 93
240      WRITE(6,4)
250 4      FORMAT(1X,'FIRST, LAST & STEPS?')
260      READ(5,2)(DT(I,1),I=1,3)
261      IF(DT(1,1).LT.DT(2,1).AND.DT(3,1).NE.0.)GO TO 111
262 93     WRITE(6,7)
263 7      FORMAT(1X,'INVALID VALUES')
264      GO TO 91
265 111    IF(N.EQ.1)GO TO 130
270 92     WRITE(6,6)
280 6      FORMAT(1X,'ENTER ♦MAJOR♦ VARIABLE')
290      READ(5,2)ITV(2)
295      IF(ITV(2).GT.41)GO TO 94
300      WRITE(6,4)
320      READ(5,2)(DT(I,2),I=1,3)
321      IF(DT(1,2).LT.DT(2,2).AND.DT(3,2).NE.0.)GO TO 130
322 94     WRITE(6,7)
323      GO TO 92
325 130    CONTINUE
330      DO 120 I=1,N
335      K=2
336      IF(I.EQ.2)K=1
340      VALOLD(I)=VAR(ITV(I))
350      VAR(ITV(I))=DT(1,I)
360 120    WRITE(6,5)(NAMES(J,ITV(I)),J=1,7)
370 5      FORMAT(1X,'ITERATED VARIABLE IS',1X,7A6)
375      VAR(ITV(1))=DT(1,1)-DT(3,1)
380      RETURN
390      END
END OF FILE
->

```

EXHIBIT B-5 (continued)

OLD WECS312

->LIST

```
100      SUBROUTINE FEED(IEND)
110 C      SUBROUTINE TO FEED VALUES DURING ITERATION
120      COMMON/SYSVAR/VAR(41)
130      COMMON/XITER/N,I1,I2,DT(3,2),VALOLD(2)
140      VAR(I1)=VAR(I1)+DT(3,1)
150      IF(VAR(I1).LE.DT(2,1))GO TO 150
160      IF(N.EQ.1)GO TO 110
165      WRITE(6,1)
166 1      FORMAT(1X)
170      VAR(I2)=VAR(I2)+DT(3,2)
180      VAR(I1)=DT(1,1)
190      IF(VAR(I2).LE.DT(2,2))GO TO 150
200      VAR(I2)=VALOLD(2)
210 110    VAR(I1)=VALOLD(1)
220      IEND=0
230 150    CONTINUE
240      RETURN
250      END
END OF FILE
```

->

EXHIBIT B-5 (continued)

OLD WECS412

->LIST

```

100      SUBROUTINE CHANGE
110 C    SUBROUTINE TO MAKE ALTERATIONS IN VAR VALUES.
120      COMMON/SYSVAR/VAR(41)
130      COMMON/TITLE/NAMES(7,41)
160 130  WRITE (6,1)
170 1    FORMAT (1X,'HOW MANY?')
180      READ (5,2) XND
190 2    FORMAT (1)
200      NO = XND
210      IF (NO.LE.0.OR.NO.GT.41) GO TO 110
220      DO 100 I = 1,NO
230        WRITE (6,3)
240 3    FORMAT (1X,'VAR NO & VALUE?')
250      READ (5,4) XJ,VAL
260 4    FORMAT (1)
270      IF (XJ.LE.0.) GO TO 120
280      J = XJ
290      VAR(J) = VAL
310      WRITE (6,5) (NAMES(K,J),K=1,7),VAR(J)
320 5    FORMAT (1X,7A6,F12.2)
330 100  CONTINUE
340      GO TO 120
350 110  WRITE (6,6)
360 6    FORMAT (1X,'WHAT?')
370      GO TO 130
380 120  CONTINUE
390      RETURN
400      END
END OF FILE
->

```

EXHIBIT B-5 (continued)

OLD WECS512

->LIST

```

100      SUBROUTINE IRR(A,B,N,X)
110 C      A IS THE INITIAL CASH FLOW: MUST BE NEGATIVE
120 C      B IS THE CASH FLOW ARRAY MAX SIZE 30
130 C      N IS THE PERIOD OF ANALYSIS
140 C      C IS THE INTERNAL RATE OF RETURN COMPUTED
150 C      SOLUTION USES THE REGULA FALSI METHOD
160 C      IF IRR IS NEGATIVE SUBROUTINE RETURNS A VALUE OF 9999999.99
180      DIMENSION B(30)
185      A=-A
190      XL1=1000.
200      XR1=0.
210      SUM=A
230      DO 100 I=1,N
240 100    SUM=SUM+B(I)
250      IF (SUM.GT.0.) GO TO 110
260      X=999999.99
270      GO TO 140
280 110    CONTINUE
290      DO 120 J=1,50
300      SUM=A
310      SUM1=A
320      SUM2=A
330      DO 130 I=1,N
340      SUM1=SUM1+B(I)*((1./((1+.01*XL1)**(I))))
350 130    SUM2=SUM2+B(I)*((1./((1+.01*XR1)**(I))))
360      X=(XL1*SUM2-XR1*SUM1)/(SUM2-SUM1)
370      DO 133 I=1,N
380 133    SUM=SUM+B(I)*((1./((1+.01*X)**(I))))
390      IF (SUM.GT.0..AND.SUM1.GT.0.) XL1=X
400      IF (SUM.LT.0..AND.SUM1.LT.0.) XL1=X
410      IF (SUM.GT.0..AND.SUM2.GT.0.) XR1=X
420      IF (SUM.LT.0..AND.SUM2.LT.0.) XR1=X
430      IF (ABS(SUM).LE..0005) GO TO 140
440 120    CONTINUE
450 140    CONTINUE
460      RETURN
470      END
END OF FILE
->

```

APPENDIX C

GOVERNMENT PROCUREMENT OF WECS INSTALLATIONS

With the emphasis placed by representatives of so many market sectors on demonstrations of WECS technical feasibility and operational reliability, it was felt to be especially important to consider the use of Government procurement as an incentive to WECS commercialization. This paper on Government procurement is the result of a brief investigation of some of the advantages and disadvantages of this type of incentive.

1. INTRODUCTION

Government procurement of WECS, and their installation at selected Government facilities around the country can have significant impacts on potential equipment manufacturers, potential system operators, and potential end-product users or energy consumers. The extent of the impact is highly dependent on the choice of systems, site locations, and extent/ method of integration with existing power sources.

Future development of WECS as an industry and an adjunct to other power sources, would be enhanced by Government procured installations which:

- . Demonstrate and develop satisfactory operational history and design standards for safety, reliability, performance and lifetime
- . Demonstrate dependable acquisition, operating and maintenance economics
- . Demonstrate electrical generation capabilities as a function of time of day, time of year and geographic location, to permit more dependable assessment of output and tie-in with utility operations
- . Make generated electricity available to utilities or direct to consumers at no risk

- . . . Make generating plant available to utilities at no development or acquisition cost
- . . . Make reliable economic designs available to manufacturers at no development cost
- . . . Provide basis for training designers, manufacturers, operators, and maintenance personnel
- . . . Provide basis for long range planning for WECS/utility integration and long lead procurement decisions for materiel, land purchases, and other investment decisions
- . . . Provide basis for long term financing of integrated WECS/utility projects
- . . . Result in identification of institutional constraints that need change or introduction, in order to permit development of a nationally-beneficial, profitable WECS industry.

These possible results of Government procurement constitute significant incentives to those who would form a WECS industry, since any or all of them would provide an improved climate for entry into a developing, uncertain market.

2. THE IMPACT OF THESE INCENTIVES ON THE WECS MARKET

(1) Permanence of the Demonstration is Assured

As long as Government facilities are in place, the market they serve is closed to the outside, unless the facilities are taken over by commercial operators or public utilities. Long term operations are an essential element of this demonstration effort. The results of the long term operation would more than offset the closed market by encouraging manufacturers and users to proceed with confidence to develop the rest of the market. However, if in running the Government-facilities system, maintenance becomes inadequate, and system performance is poorly monitored through inadequate training, funding or supervision, then the demonstration may fail, and a strong counter incentive may develop.

(2) Local Non-Government Applications May be Encouraged

Appropriate applications for WECS result from a balance of wind energy potential, local applications, and acceptable economics. Government installations could be made in an area where there are few applications outside of the facility, or where the facility application is different from all others in the region. In this case, local promotion or technology transfer will not result, and the facility would have to be justified on its own merits, and for application of its experience to other areas. If the Government and local area applications do match, then a clear incentive is provided that would promote local WECS use.

Demonstration of satisfactory WECS operations and standards mitigates against later development of sub-optimal products, provided the standards are properly developed and quality control applied during the subsequent manufacture and acceptance. Sub-optimal WECS performance could result however, if the early WECS components were used as off-the-shelf in later designs when they were not optimal, just to save money.

This last problem can be avoided by ensuring that WECS standards are written in terms of performance and operations as well as in terms of hardware.

(3) Inhibition of Competition Can Be Avoided with Proper Attention

The development of standards and operating data permits all potential competitors in a WECS manufacturing market place to start even and proceed in a truly competitive fashion. Provided innovation in the competition is not stifled by archaic and unnecessary constraints and a number of manufacturers are permitted to serve the market, no inhibition should exist, except that resulting from any uncertainty in defining the user marketplace.

WECS procurement by the Government should remove inhibitions in the user marketplace since if properly

selected and concluded, each facility would be a model of how a user would be satisfied, and would, therefore, encourage other users to solicit WECS as partial solutions to their energy needs.

(4) Effectiveness Measures of the Government Procurement Should Be Formulated

These need to be measurable characteristics of the WECS industry that can be isolated with respect to the items discussed above. A possible way of developing such a measure would be to keep track of potential manufacturers/users who show interest in programs and results of the Government facilities and operations, to see if they become motivated to move toward WECS themselves, either by independent study, or purchase or development of systems. Other elements to keep track of would include the willingness of investors to provide capital (correlated with the introduction of Government WECS facilities) and the proliferation rate of WECS, regionally and nationally.

3. THE IMPACT OF THESE INCENTIVES ON THE GOVERNMENT

(1) Cost of the Procurement Will Include Many Items

The cost of studies, specific development projects, surveys, evaluation of facilities, are all necessary to select candidates for successful initiation and demonstration of WECS to potential manufacturers and users. The cost of system planning, design, long lead procurement, construction, installation, checkout, operation, maintenance and repair, training, administration and spares, including quality control will, of course, make up the bulk of the expenditures.

Additional costs will include monitoring these operations and maintenance of the facilities to ensure that they run at peak efficiency and do not show unnecessarily poor performance or high costs. Maintaining proper records and documentation of performance, maintenance and economics for review by potential users and manufacturers, will result in still further costs.

It is difficult to estimate the total impact of these additional costs. Experience with the Department of Housing and Urban Development's Solar Heating Demonstration Program indicates that total program costs may be in excess of 300% of direct installation costs.

(2) An Administrative Coordination Body Will be Desirable

If DOE decides to go ahead with a phased plan for installation of WECS in selected Government facilities across the country, it will immediately face a need to coordinate with the agencies responsible for the facilities. Subject to agreement with these agencies, design, development and installation of each facility could proceed. In order to make such installations a thorough test of community, industry, utility, state and federal acceptance, it would be wise to involve as many agencies as would be involved if the facilities were being built and operated through the non-Government marketplace. These agencies would provide inputs that the design development and operational process would have to respond to in the non-Government marketplace; they would not normally be binding for a Government facility.

Consequently, a major administrative cost for Government procured WECS would be the organization required to provide the liaison, coordination and joint monitoring necessary to be able to document the extent to which regulatory compliance can be achieved without loss of economic effectiveness of the WECS. In addition, this coordinating body would have the responsibility for identifying possible solutions to unacceptable losses in effectiveness, either through institutional or technological changes.

For such a coordinating function to work, the coordinating body would need to establish working arrangements among all parties involved. The only Government agency that appears to interact with all other agencies is the GSA. However, the modus operandi of the GSA is not one that fosters innovative systems or action. Its normal operations have historically become somewhat restricted to purchasing common supplies used by all agencies, at the lowest price that will satisfy federal specifications. These specifications are written to describe minimum acceptable performance

or material standards of existing items regularly procured by the government, thus allowing maximum competition and lowest prices, but automatically restricting innovation. Consequently, it would seem more likely that an interagency body should be set up at the department level, chaired by DOE, with monitoring teams assembled as required to match the needs of the several categories of WECS applications in Government facilities. These teams would be responsive to the innovative requirements and operational possibilities of WECS when used in conjunction with existing energy sources.

(3) Government Control/Leverage on Costs and Market Can be Achieved by Careful Planning

Once the Government has decided to embark on a WECS procurement program as an incentive, the first significant decision point is reached for each major application when it can be shown positively that WECS is or is not effective in reducing overall dependence on fossil fuels. If it is, then more costs are justified in pursuing installations to the next step, which is probably a small regional demonstration, which through its implementation will aid in initial manufacturing industry growth. If these demonstrations are successful, then the Government can likely continue justification for further installations to a "critical level" beyond which WECS economies exceed Government costs. At this point, Government procurement has a momentum of its own for nationwide completion of installations, and provides a durable basis for establishing a stable, self-supporting industry.

One "point of diminishing returns" (p.o.d.r.) for installations as demonstrations arises when the "critical level" is reached; up to that point the government is still paying out, would not be committed to large scale nationwide installations, and a major market might not have materialized. Beyond that point, the need for demos is essentially over. Another "p.o.d.r." can occur in situations where through lack of convincing demonstration results or institutional constraints or lack of suitable financing mechanisms, no amount of added Government effort would be able to stimulate a self-sufficient level of WECS industry. If this were to be allowed to occur, then the Government program would have to be revised to tackle the outstanding problems before proceeding with further demos. From a "public relations" point of view, it would be far preferable to so plan and monitor the original demo

program so that such a problem was avoided, by ensuring that suitable sequential milestones are defined and passed successfully.

If the critical level described above can be reached, then the Government financial risk is certainly not open-ended, since its WECS costs would be recovered in the long run through energy savings at its facilities.

4. MECHANICS ASSOCIATED WITH IMPLEMENTING, ADMINISTERING, AND DISASSEMBLING INCENTIVE

(1) Implementation Will Require Careful Planning and Legislation

The following steps are necessary to implement procurement of WECS installations on Government facilities.

- . Clear evidence of the long term economic and resource gain to manufacturers, users and the Government
- . Identification of facilities for installations for each major WECS application, and ranking by greatest potential for success
- . Identification of all agencies involved for each preferred installation, and assurance of their cooperation
- . Assessment of construction and O & M costs to define budget line items for fiscal year planning
- . Approval of budgets and appropriation of funds
- . Preparation of plans and schedules for development, design, construction, test, start-up, and all required training
- . Definition of responsibilities of all cooperating agencies
- . Formation of an interagency body with responsibility for project management.

To support these steps, one body of legislation that might be required would be that required to modify agencies charters to allow them to cooperate fully. Some agencies may be restricted in the extent to which they can participate in other agency activities or in any activities that infringe on the private sector. Such adjustments should be relatively simple to identify; if the results of cooperation are clearly for the common good, a strong moral and economic argument would exist in favor; it is to be hoped no technical legal niceties would prevent appropriate legislation. A second area for legislation would be that required to establish an enabling charter and operating roles and responsibilities for the interagency body. The same potential for success, or legal pitfalls, would exist, but at a Federal level, possibly even at the Congressional level. If this is the case, careful planning must be developed to prevent unexpected delays in the Congressional legislative, budget and appropriation cycle.

(2) Proper Administration of the Program Will be Key to its Success

Once it is clearly established to DOE's satisfaction that WECS have a major role to play in the Nation's energy future, it becomes very important not to allow the program to fail by default, as has happened to other important programs in the past that have been innovative and thus contrary to entrenched experience. The important aspects of program control that must be pursued are:

- . Definition of performance specifications
- . Definition of reliability and maintenance specifications
- . Training of operational and maintenance personnel
- . Quality control throughout the program, from initial design, through selection and testing of materials, components, subsystems to production and testing of complete systems

- . Supervision to ensure rigorous application of required maintenance of the operating system
- . Accurate, regular collection of operating and economic data, and analysis to describe actual performance and costs, to compare them with estimates, and to feed back any discrepancies for detailed examination and action.

By this means, confidence is engendered in the equipment, and the characteristics and savings of WECS are clearly evident, without recourse to analysis of "what would have happened if the WECS had been designed, operated and maintained properly."

Since DOE has the responsibility for developing WECS, it would seem a clear requirement that DOE have responsibility and authority for selection and training of personnel, monitoring design, testing operations and maintenance. Such close control by DOE is necessary, through the highest level of any and all cooperating agencies to prevent the situation arising where agency/facility authorities may not allow the WECS to be operated or maintained as required for good performance, either through lack of information or misunderstandings.

Conflict of interest in Government procurement of these facilities is guarded against by not involving contractors (or other potential profit makers or empire builders) in the definition of WECS or selection of installations. The selection process must take into account local economic conditions, but not at the expense of increasing the cost or decreasing the effectiveness of any WECS demonstrations. Achieving this freedom from unwarranted political influence may prove difficult.

(3) Disassembly of the Incentive Can Be Adjusted to Address Government and/or Market Needs

If Government procurement is for the purpose of improving the energy economics of Government facilities, as well as to provide demonstration of WECS capability,

then no "disassembly of the incentive" is needed, since procurement will be governed as much by the Government incentive to save energy, as it will be by the need to provide an incentive to a WECS industry.

If the procurement is intended purely to demonstrate the WECS capability, then the "incentive" would be self limiting, by the DOE and Congressional budget process.

If the procurement is allowed to develop and to react in a dynamic way with the development of a WECS market such that additional incentives are introduced as needed to maintain the momentum of WECS industry growth, then "disassembly" or withdrawal of this form of industry support would be appropriate when the industry has developed a:

- . Good source of materials
- . Reliable, economic design base
- . Efficient manufacturing base
- . WECS-educated potential market.

These are all the ingredients for the industry to move ahead on its own to market its products in a competitive environment. The disassembly procedure takes the form of no further funding of demonstration installations.

5. TIMING ISSUES

(1) Lead Times Associated With the Procurement Process Can Be Substantial

One main requirement for extensive lead times for Government procurement as an incentive arises from the development of the necessary funds to support the incentive. If a new interagency group is formed to oversee and guide development, funds for its operation must be appropriated in addition to the new line items for demonstration installations, all precedent work, and operating costs once installed, that must be introduced into the budget process. This process may take as long as two years and will encompass a great deal of debate within and between agencies, the OMB and Congress.

Some of the potentially long lead time may be reduced if some elements of funding can be supported out of existing, or some form of discretionary funds, through re-programming.

(2) Duration Time to Maximum Effectiveness Will Depend on Industry Development

Selected application of procurement as an incentive can have great effect at the early stages of development of a WECS industry, when uncertainty on the part of potential users and manufacturers results in substantial inertia to be overcome. Once industry shows signs of being self generating, i.e., users begin to see the value of WECS and manufacturers can perceive a profitable product line, then extensive use of WECS by the Government in its facilities becomes a most effective way of establishing an industry, to whatever level is required to be self sustaining.

6. STRATEGIES

(1) Government Procurement Can Address Key Concerns in Each Market Sector

The electric utility market, potentially the largest in terms of WECS power output, needs to be convinced of many features of WECS before it becomes a willing partner in an overall industry. The user's uncertainties relate to WECS as an unproven product (performance, safety, reliability, and operating lifetime), potentially large land requirements for WECS, the shortage of available capital, and large incremental revenues required to offset WECS costs. Government procurement can, directly or indirectly have a favorable impact on each of these, since properly conducted and monitored demonstrations on a large number of Government facilities will lead to considerable confidence in the product, reduction in manufacturing costs, an accurate basis for estimating revenues and developing financing, and experience with multiple land use as a means for reducing real estate costs.

The manufacturers' uncertainties relate again to the unproven product (with emphasis on product liability

or warranty questions, and on the uncertain market) and the availability of resources. Government demonstrations will accumulate lifetime data, develop a market, and stimulate accumulation of the required resources. For both user and manufacturer, the experience of Government installations will be instrumental in uncovering and establishing responses to the regulatory and institutional barriers that would have to be faced with the introduction of a new system.

In a similar way, residential applications are faced with barriers to implementation, against which Government demonstrations on a significant scale would be effective, particularly in developing experience and confidence. These barriers include the unproven product (performance etc. as before, plus interfaces with utilities, and load sharing problems) high initial cost, aesthetics, and utility penalties for when WECS is not providing power. Government installations will provide considerable working experience with these concerns, and basis for rational solutions.

The industrial sector has similar concerns to those of the utility companies, while the agriculture and remote community sectors' problems are more akin to those of the residential section.

(2) Government Procurement Can be Seen as One Element in an Overall Commercialization Strategy

The need to develop a WECS industry is presumed and predicated on the capability of WECS to reduce national dependence on imported and domestic exhaustible fuels. Consequently, a viable WECS industry could be of national significance, and its development an appropriate subject for Government support.

Commercialization of a new technology has historically proven to be difficult to achieve unless return on investment (ROI) for the manufacturers and users can be clearly foreseen at an acceptable level. Forecasting ROI requires forecasting research, development, materials, design testing, production, training, maintenance, market characteristics, costs and risks for the new technology. Not until these factors can be assessed with an acceptably low level of uncertainty,

will commercial interests adopt the new technology. Government procurement activities, such as those discussed above, provide a means for reducing the uncertainties in these factors at low cost to the commercial interests.

An optimum process for incorporating these Government procurement activities into an overall commercialization strategy would be to apply appropriate Government activities with maximum leverage for each stage of WECS industry development, where maximum leverage is in the sense of providing maximum encouragement and incentive for commercial interests to participate.

7. CURRENT EXAMPLES OF GOVERNMENT PROCUREMENT ACTIVITIES IN ENERGY

Several precedents for a WECS Government procurement are described below.

(1) National Program for Solar Heating & Cooling

This program is strongly analogous to a potential WECS program, in its significance to national energy goals, and its use of solar power. Its application is far more focused to residential situations, and its technology is limited to direct use of solar energy as heat, without intermediate conversion to electrical or mechanical forms of energy.

The program has two major components, one funded in whole or in part by the Federal Government, and the other funded by industry and non-Federal organizations. The Federal program component has as its goal the stimulation of an industrial and commercial capability for producing and distributing solar heating and cooling systems for use in residential and commercial buildings. The Federal Program has been prepared by an Interagency Task Force chaired by ERDA, with HUD, NASA, NBS, DOD, NSF, and FEA.

The Federal program began in 1975, and is planned to proceed for about five years in yearly cycles, with Federal procurement being issued for each cycle to allow new ideas and new technologies to be incorporated in later cycles. DOD is conducting a substantial number

of residential and commercial demonstrations on military installations, while GSA is doing the same on Federal buildings. The program is facing many of the same uncertainties that would face a Government funded WECS program, including hardware development, economic competitiveness and willingness of the private sector to invest in R & D. The program also addresses the same concerns for scope, timing, success criteria, program effectiveness, funding, and policy for promoting widespread commercialization and accelerated use.

(2) DOD Photovoltaic Systems Market Inventory and Analysis

This study referred to a proposed Federal Photovoltaic Utilization Program, under which Federal procurements would result in a considerable number of installations in the next five years to guarantee the large markets needed to support the use of mass production techniques and the future rapid growth of the industry. Under the same program, the Federal government would absorb the engineering expenses of developing applications for photovoltaics, resulting in lower prices to the private sector, and more rapid market penetration. An additional thought expressed in this report was the supply of Government furnished equipment to speed industry development. The study also identified a set of barriers and Government procurement actions to overcome them that are broadly similar to those outlined earlier.

8. POTENTIAL FOR WECS INSTALLATION ON GOVERNMENT MILITARY FACILITIES

A nationwide comparison between military facility locations, and the distribution of wind regimes favorable to WECS (using data from General Electric's Mission Analysis report) is shown in Exhibit C-1.

9. GOVERNMENT PROCUREMENT PRACTICES RELATIVE TO PROCUREMENT AS AN INCENTIVE

Government procurement procedures, i.e., Federal Procurement Regulations (FPR) and Armed Services Procurement Regu-

EXHIBIT C-1
Potential for WECS Use at Military Facilities

Wind Regimes (MWh/m ² /yr)	Percent & Number of Facilities (Approx.)							
	Total		Air Force		Navy		Army	
	%	N	%	N	%	N	%	N
>7, High	0.8	4	0.6	3	0.2	1	0.0	0
4-7, Medium	5.7	29	2.5	13	2.0	10	1.2	6
2-4, Low	32.0	162	11.3	57	10.7	54	10.0	51
1-2, No value	41.5	210	14.8	75	11.3	57	15.4	78
<1, No value	20.0	101	8.3	42	4.0	20	7.7	39
(Not including Alaska, Hawaii, Puerto Rico)								
Totals	100	506	37.5	190	28.2	142	34.3	174

lations (ASPR) do not in themselves present any inherent bar to the use of procurement as an incentive; in fact there have been many instances where Federal purchase of systems have been used to establish a government market. The FPR spell out procedures allowing for specific exemption for a "policy or procedure which is being instituted on an experimental basis for a reasonable period." Such exemptions generally require fairly high level endorsement. In any event, the agencies involved and their procurement officers must still follow the major provisions of the Federal procurement system.

Procurement for the Government seems to separate into two divisions, one through the GSA for widely used multiple purchase items, large volume purchase items, and the other through individual agencies for items that do not fall into the first category. It appears to be very important not to purchase things through the GSA if at all possible, when innovation is critical to the success of the item involved. GSA procurement is done through specifications that are written to describe the minimum acceptable performance or material status of existing items that are regularly procured in order to maximize competition and minimize cost, which is an approach that tends to inhibit innovation.

The procurement officers of the individual agencies have the ultimate responsibility and must use their judgment to justify actions in going forward with a particular procurement in accordance with procurement regulations as established. In general the procurement officer is not likely to be technically qualified in the area in which he has to make contractual judgments and therefore needs all assistance and guidance that can be provided him as to the purposes of the procurement and the best way of meeting its requirements. His position becomes quite difficult when he is dealing with either justification for a non-negotiated procurement where costs are higher than those for equipment having similar capabilities in the open market, or when he is dealing with a negotiated procurement where other, non-innovative items have lower costs. Under these conditions, the pressures on him are very strong to move in the direction of the lower cost, more readily available, items. Consequently, he needs to be thoroughly supported and indoctrinated in all aspects of the problem, the innovative gains, technology, social and life cycle characteristics of both the innovative system of interest and its non-innovative competitors.

Good examples of procurement processes that are currently under development in the energy area are those for solar heating and cooling, and photovoltaic conversion systems. These systems are innovative in the same way that wind energy systems are innovative and have required the kind of interaction referred to above. Their development to date provides a good model for comparable use of procurement as incentives in the wind energy systems. One particular action that has been taken that provides considerable support to the procurement officer in examining and choosing in favor of innovative systems, is the passage by Congress of a public law which helps by advocating the choice of systems on a life-cycle cost basis rather than an investment cost basis. The particular law that has been passed refers to the solar heating and cooling area, and is a model for other laws that might be passed to aid other innovative energy areas.

The dynamics of the procurement process over a period of time are critical to the effectiveness of procurement as an incentive, and are very dependent on the current state of WECS development. It is important to develop through the initial activities in procuring WECS, a significant momentum towards continuing the development of WECS, rather than to overestimate the capability of the current state of WECS, resulting in a loss of confidence in the system and consequent termination of the program. It becomes essential not to procure, on a one time basis, all installations which may be required to provide a sufficient volume for a good industry base. Rather it is more important to tailor the procurement rate as confidence grows in WECS. Initial purchases of WECS should be strictly demonstrations to prove the economic validity of established WECS devices, and to assess those concepts not yet fully tested. This cycle could be followed by a second larger volume cycle, to install more proven devices and to demonstrate the economic validity of the second generation concepts. The final cycle or two would then be to install throughout the requisite number of government facilities, WECS systems selected on the basis of effectiveness with respect to life-cycle costs. Throughout this process it is most important that the procurement process foster a healthy competition among potential industry members.

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In summary, procurement by the Government can provide incentives of considerable value if conducted at several levels with proper timing. Opportunities for such procurement exist in many facilities around the U.S. For this approach to providing WECS incentives to be successful, the Government must be very sure that the first concepts, once installed, will be successful, and will fulfill the anticipated promise of national and industry economic benefit. Therefore the Government must have done its planning, technical, economic, institutional and regulatory homework well before embarking on the program.

Statement of Work

The study will include two (2) major elements: (1) WECS technology implementation scenarios and (2) assessment of incentives as specified below.

A. WECS Technology Implementation Scenarios

Where the federal government is not the major market for the application of technology resulting from federally funded R&D, the responsibility for implementing the technology cannot be borne alone by the federal agency funding the R&D. For purposes of this RFP, "technology implementation" refers to the method for commercialization of WECS when WECS R&D has been specifically directed toward eventual civilian use but paid for by the federal government. In accord with this consideration, the contractor shall:

- (1) define a scenario for each of the four (4) potential markets for wind energy systems in sufficient depth and detail to allow a complete understanding of how incentives will influence each scenario.
- (2) diagram each scenario to provide a clear, visual presentation of the interacting components.
- (3) show how the results of B (below) relate to the scenario diagrams, including the relationship between timing and effectiveness.

B. Assessment of Incentives

Some of the barriers to wind energy system implementation identified in earlier studies include (1) large capital needs and lack of a demonstrated market for WTG manufacturers and (2) large capital investments required of potential users. These are complicated by doubts regarding performance, cost-effectiveness and reliability. One type of incentive which has been proposed for large-scale systems is a straight subsidy to make up the difference between the "break-even" cost for WECS and the current cost for WECS as dictated by small production runs and other temporary factors.

The contractor shall review all applicable ERDA studies which identify economic barriers to wind system implementation and shall:

- (1) identify and analyze government incentives which can be applied to mitigate these economic barriers for each application category, including consideration of timing effects on the efficacy of government options.
- (2) provide an estimate of the level of federal cost-sharing or cost contribution for each type of incentive which would mediate between extremes by stimulating an active commitment by private industry to wind systems technology, without constituting outright support of that industry (i.e., to assure that industry has a sufficient financial stake in WECS technology to stimulate a lasting commitment to its commercialization).
- (3) determine likely cost to the government of various incentives, and indicate if selection of particular incentives would have beneficial or detrimental impact on other incentive costs.
- (4) indicate anticipated effects on the WECS market of various types and levels of incentives individually and in recommended combinations, and rank in order of desirability by impact and cost.
- (5) enumerate other benefits or problems which may be created by application of the various incentives or government actions.
- (6) define criteria for selecting high potential incentives for each market based on cost and likelihood of success.

Study Deliverables

The study should provide a realistic assessment of incentive scenarios and alternatives which is sufficient to enable ERDA decisions regarding the use, cost and effect of various types of incentives. Report requirements for the contract include monthly administrative reports, draft final report sections submitted at the end of each task and a final report. The draft of the final report, detailing and assessing the various incentives in the manner, specified above, will be submitted at the end of the contract period. There will be a one (1) month period for ERDA review and a one (1) month period for final report revision by the contractor following ERDA review.