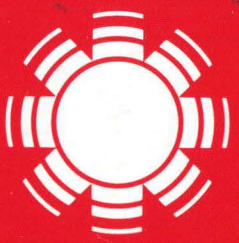
SERI/SP-730-674

April 1980

An Introduction to the Utilities and Industry Division

Solar Energy Research Institute



SERI

Solar Energy Research Institute
A Division of Midwest Research Institute

1536 Cole Boulevard
Golden, Colorado 80401

Operated for the
U.S. Department of Energy
under Contract No. EG-77-C-01-4042

NOTICE

SERI/SP-730-674

AN INTRODUCTION TO THE UTILITIES AND INDUSTRY DIVISION

SOLAR ENERGY
RESEARCH INSTITUTE

APRIL 1980

PREPARED UNDER TASK NUMBERS
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1617 Cole Boulevard
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SECTION 1.0

SUMMARY

The acceleration of the use of renewable energy sources confronts a barrier unlike that of other historic transitions, such as the one from wood and wind to fossil fuels about a century ago. In 1980, the energy supply infrastructure is greater than ever before. Estimates for replacing the national electric grid alone range in the trillions of dollars, not to mention gas pipelines, fossil fuel boilers, and other components of existing energy systems. Renewable energy technologies cannot ignore this infrastructure.

Solar and renewable energy systems can be introduced by integrating them into the existing utility and industry energy infrastructure. Renewables will replace exhaustible fossil fuels first in a few specialized applications; then as fossil fuel plants and equipment are retired.

Thus, solar energy systems must be developed in concert with the overall evolution of industrial and utility energy systems and with the burgeoning development of energy efficiency technologies. The next century will see, not a single energy supply system, but a diversity contributing in different ways. The synergistic combination of these contributions is the foremost technological challenge of the coming decades.

For these reasons, a Utilities and Industry Division has been established within the Analysis and Applications Directorate at the Solar Energy Research Institute (SERI). The mission of the Division is to speed adoption of solar and renewable energy systems, in proper combination with energy efficiency technologies, in the utility and industrial sectors.

The Division is administratively divided into three branches and one group: the Systems Development Branch, the Utility Applications and Policy Branch, the Industrial Applications and Policy Branch, and the Agriculture and Transportation Group. Expertise within the Utilities and Industry Division ranges from heat engines to economics, from electric generation planning to market development, and from manufacturing to finance. Members have established expertise and professional contacts within most of the specialized fields in utility and industry energy applications.

The functions performed in the Utilities and Industry Division fall under three headings: Technical Integration, Institutional Integration, and Government Policy Planning.

Technical Integration. Technical integration may be split into two categories: (a) the integration of components to form practical renewable energy systems, and (b) the integration of these renewable energy systems into utility, industrial, agricultural and transportation applications. The technical integration of components to form practical renewable energy systems is the province of the Systems Development Branch. The technical integration of renewable energy systems into the four sector applications is part of the Utility Applications and Policy Branch, the Industrial Applications and Policy Branch, and the Agriculture and Transportation Group.

Institutional Integration. Institutional integration covers all nontechnical aspects of introducing renewable energy systems into industries and utilities, including questions of economics and financing, the identification and development of markets, programs of information dissemination, and the overcoming of institutional barriers. Institutional integration is part of the Utility Applications and Policy Branch, the Industrial Applications and Policy Branch, and the Agriculture and Transportation Group.

Government Policy Planning. Analysis and recommendations of government policy to facilitate the technical and institutional integration of renewable energy systems into industries and utilities are part of the function of the Utility Applications and Policy Branch, the Industrial Applications and Policy Branch, and the Agriculture and Transportation Group.

The examples of Fiscal Year 1980 tasks given below will help to illustrate these functions of the Utilities and Industry Division and its administrative subdivisions.

SYSTEMS DEVELOPMENT BRANCH

The Systems Development Branch covers the technical integration of components to form practical renewable energy systems, including the description, analysis, costing, construction and testing of renewable energy systems for specific applications. The Systems Development Branch is kept informed by the Research and Development Directorate at SERI as to component subsystem technology, and by the other branches in the Utilities and Industry Division as to appropriate applications. Examples of FY80 tasks in the Systems Development Branch are:

Task 3455: Systems Evaluation and Ranking. This task's objective is to describe and comparatively rank small, generic solar thermal power systems for process heat applications on a common economic basis according to their potential for commercial deployment in the mid-1980s and mid-1990s.

Task 3510: Biomass Systems Analysis Research. This task's major objective is to demonstrate a prototype automobile system which operates on methanol that has been decomposed on-board to hydrogen and CO.

Task 3525.12: District Heating With Solar Ponds. This task's objective is to further the understanding of solar ponds for neighborhood scale district heating applications through analytical and experimental studies.

Task 3820.20: Cost Characterization. This task is part of a continuing activity designed to provide current detailed and well documented information about the costs and performance of specific solar energy systems.

UTILITY APPLICATIONS AND POLICY BRANCH

The Utility Applications and Policy Branch covers the technical and institutional integration of solar and renewable energy systems into the utility sector, and the federal government policies which may facilitate this integration. Examples of FY80 tasks in the Utility Applications and Policy Branch are:

Technical - Task 3532.15: WECS Utility Analytical Modeling. This task's objective is to provide computer programs analyzing the impact on electricity production scheduling resulting from the introduction of Wind Energy Conversion Systems (WECS) into the mix of electric generating plants.

Institutional - Task 5625: Regional Assessment Studies. The regional assessment studies identify near-term utility market opportunities that could lead to large-scale use of solar electric systems (both central and dispersed) on a regional basis in the United States.

Policy - Task 5640.10: Utility Financing and Regulation. This task's major objective is to explore methods for the analysis of utility regulatory policy options.

INDUSTRIAL APPLICATIONS AND POLICY BRANCH

The Industrial Applications and Policy Branch covers the technical and institutional integration of solar and renewable energy systems into the industry sector (except utilities and the agriculture and transportation industries), and the federal government policies which may facilitate this integration. Examples of FY80 tasks in the Industrial Applications and Policy Branch are:

Technical - Task 3473.20: IPH Case Studies. This task's major objective is to perform case studies of selected industrial plants to determine the near-term feasibility of using solar energy to provide industrial process heat (IPH).

Institutional - Task 6221.20: Infrastructure Support. This task's objective is to help identify and reduce institutional barriers that may slow industry's decision to use wood as a fuel.

Policy - Task 5634.30: Market Penetration Studies. This task's objective is to complement other SERI efforts to increase the accuracy of models of solar market penetration, and thus to increase the validity of policy analyses of alternative government programs to increase the rate of penetration.

AGRICULTURE AND TRANSPORTATION GROUP

The Agriculture and Transportation Group covers the technical and institutional integration of solar and renewable energy systems into the agriculture and transportation sectors, and the federal government policies which may facilitate this integration. Examples of FY80 tasks in the Agriculture and Transportation Group are:

Technical - Task 3346.60: Grain Drying/Residues. This task's major objective is to analyze the farm-level technical and economic feasibility of collecting crop residues and using them in several types of applications.

Institutional - Task 3346.40: New Markets for Biomass Feedstocks. This task's major objective is the identification of key near-term markets for biomass-derived petrochemical substitutes.

Policy - Task 3346.50: Alcohol Crops and Biomass Policy Analysis. This task's major objective is the identification and assessment of existing and proposed federal and state policies affecting the use of biomass fuels and chemicals.

A complete list of the Division's FY80 tasks is given in Section 4.0. Section 2.0 lists the personnel, their branches, and areas of expertise. Section 3.0 consists of the Mission Statements of the Division and its subdivisions. Section 5.0 is a list of approximately 200 SERI publications authored or co-authored by Division members.

SECTION 2.0

PERSONNEL

The Division Manager of the Utilities and Industry Division is Neil H. Woodley. Mr. Woodley holds a Master's degree in electrical engineering from Iowa State University. His background includes 15 years of experience in the electric utility industry and related activities including electric system planning, generation resource investigations, power plant siting, and long-range energy resource research and development. In these various positions he has been in routine contact with various utility, industry, university and government R&D efforts on advanced energy systems.

The Utilities and Industry Division is administratively divided into three branches and one group: the Systems Development Branch, the Utility Applications and Policy Branch, the Industrial Applications and Policy Branch, and the Agriculture and Transportation Group.

The Systems Development Branch is responsible for the technical integration of components to form practical renewable energy systems. The Systems Development Branch Chief is Charles J. Bishop. Dr. Bishop holds a Ph.D. in chemistry from the University of Washington. He has 11 years experience with solar energy systems, including heating/cooling, solar thermal, photovoltaics and wind. He has served as project manager for various DOE programs in solar systems analysis and development.

The Utility Applications and Policy Branch deals with the technical and institutional integration of solar and renewable energy systems into the utility sector, and the federal government policies which may facilitate this integration. Neil H. Woodley is the Acting Branch Chief pending the hiring of a permanent Branch Chief.

The Industrial Applications and Policy Branch deals with the integration of solar energy systems into the industry sector (except utilities and the agriculture and transportation sectors), and the federal government policies which may facilitate this integration. The Industrial Applications and Policy Branch Chief is David L. Feasby. Mr. Feasby holds a Master's degree in physics from the University of Michigan and a Certificate of Business from the University of California at Riverside. He has eight years of experience as a heat transfer and project engineer. In addition, for three years he operated a personal development business.

The Agriculture and Transportation Group deals with the integration of solar energy systems into the agriculture and transportation sectors, and the federal government policies which may facilitate this integration. The Agriculture and Transportation Group Manager is Herbert O. Mason. Dr. Mason holds a Ph.D. in agricultural economics from the University of California at Davis. His background includes seven years of research in applied and agricultural economics. He has been actively involved in several major research projects on labor and training requirements for all solar energy technologies, macroeconomic impacts of solar energy, and economic analysis of biomass production and conversion.

Figure 1 is the organizational structure of the Solar Energy Research Institute, showing the location of the Utilities and Industry Division. Figure 2 shows the organizational structure and personnel in the Utilities and Industry Division itself. Tables 1-A through 1-E list the areas and number of years of general experience of the Division members. Tables 2-A through 2-E list the areas and number of years of solar-related experience of the Division members.

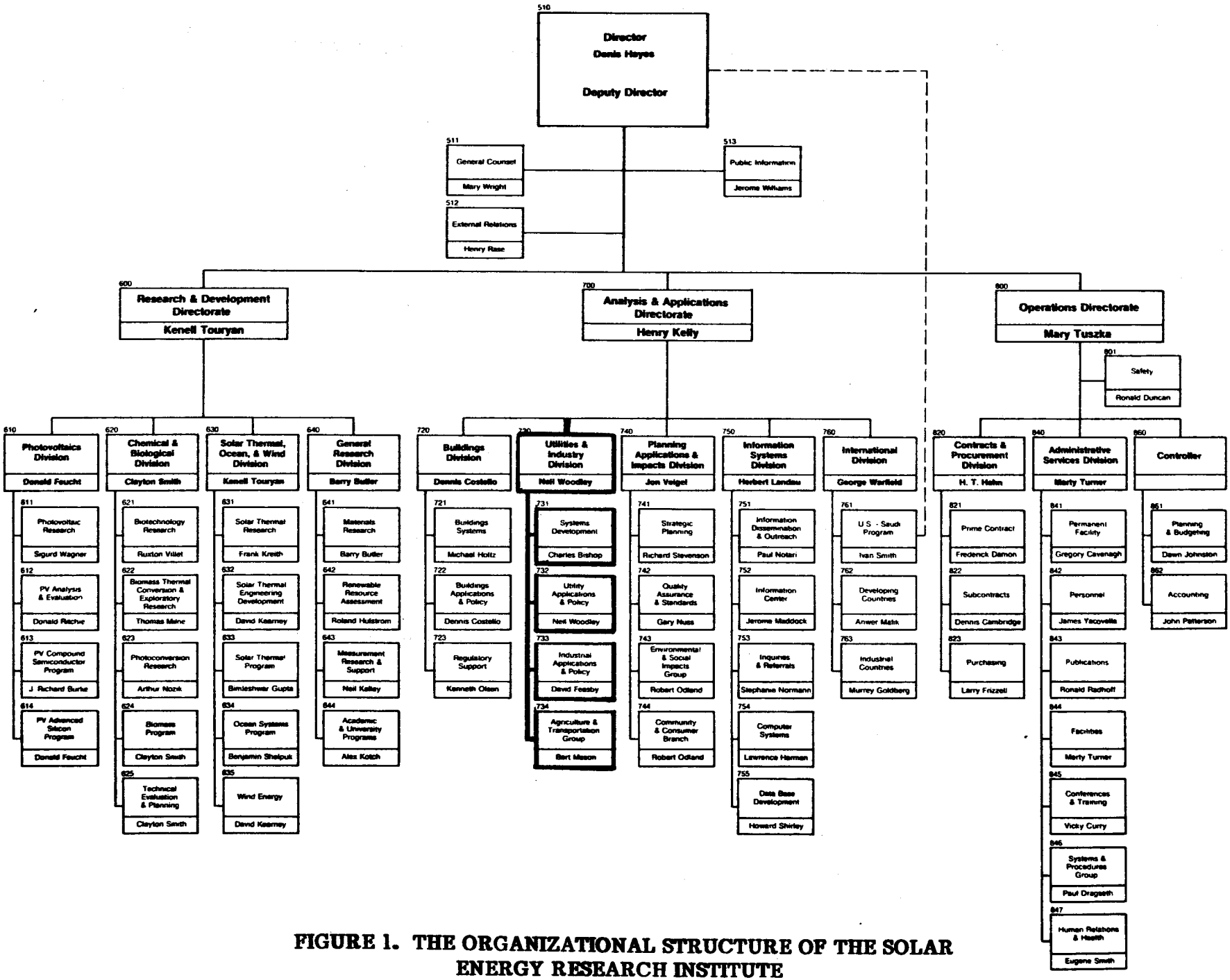

FIGURE 1. THE ORGANIZATIONAL STRUCTURE OF THE SOLAR ENERGY RESEARCH INSTITUTE

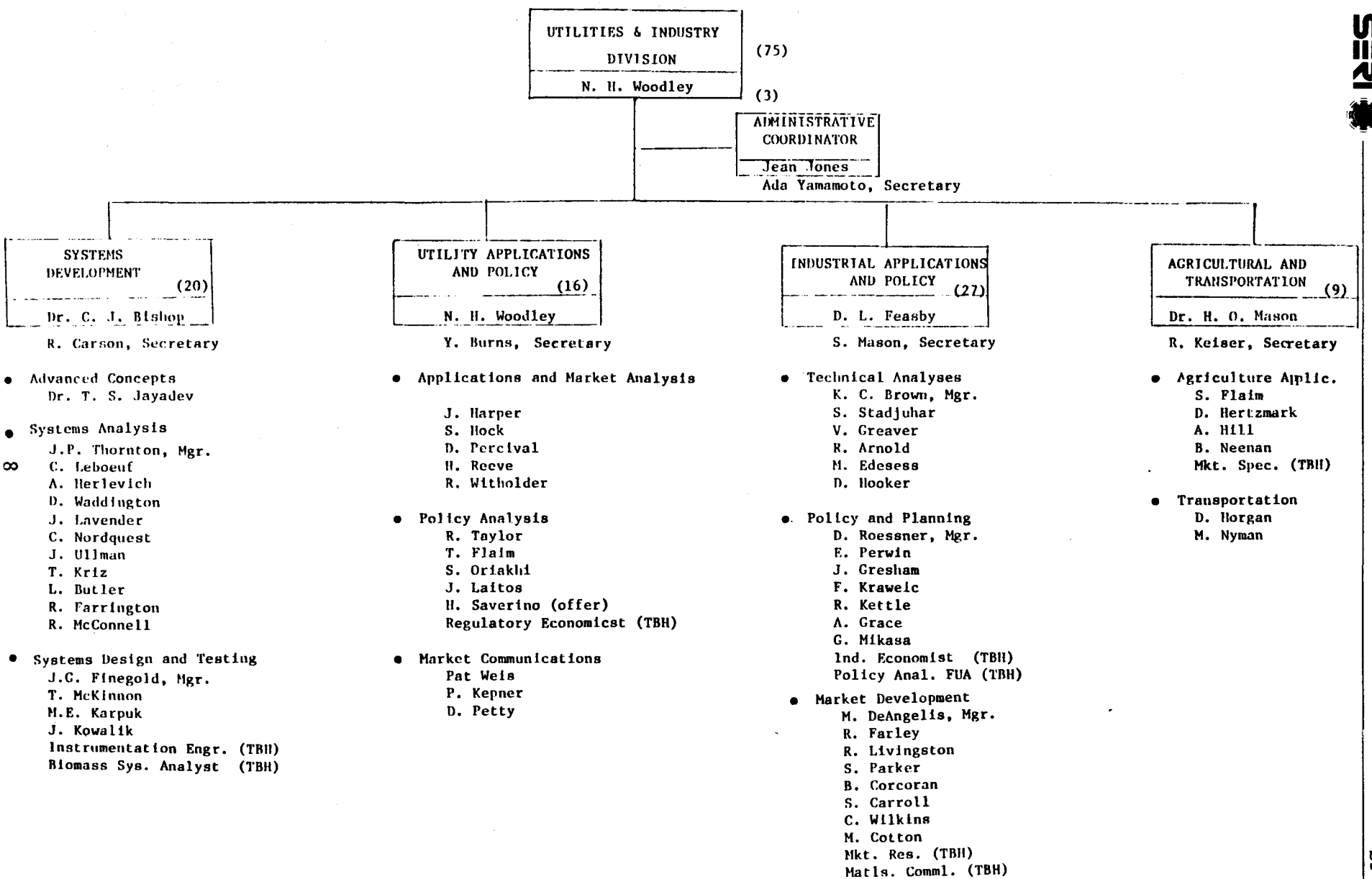

FIGURE 2. THE ORGANIZATIONAL STRUCTURE AND PERSONNEL OF THE UTILITIES AND INDUSTRY DIVISION

Table 1-A. GENERAL EXPERIENCE
(In Years)

	Utilities and Industry Division Totals																								
	Mechanical Design	Civil Engineering (Structures)	Manufacturing	Heat Transfer	Chemical & Process Engineering	Heat Engines	EE-Power & Industry Electronics	Applied Physics & Optics	ME - Power	Wind Energy & Aerodynamics	Cost Analysis	Engineering Economics	Electric Utility Planning	Energy System & Resources	Operations Research	Mathematics & Statistics	Computer Applications	Control Theory	Thermodynamics	Nuclear Engineering	Marketing	Technical Writing & Information Dissemination	Finance & Investment	Policy Analysis	Economics
Systems Development Branch	48	5	43	37	12	15	55	58	12	10	42	34		81	16	15	55	17	25	2					
Industrial Applications & Policy Branch							30		6		2	5	10	9	17	10	10		6	5	23	15	8	18	30
Utility Applications & Policy Branch	7		11	10	3	12	31	7	7	4	6	31	28	17	19	15	39	5	13		15				6
Agriculture & Transportation Group	1		3				1		1	3	11	6	6	7	8	12	4	7	2		2				21
Total	56	5	57	47	15	27	117	65	26	17	61	76	44	114	60	52	108	29	46	7	40	15	8	18	57

Table 1-B. GENERAL EXPERIENCE
(In Years)

	Systems Development Branch																							
	Mechanical Design	Civil Engineering (Structures)	Manufacturing	Heat Transfer	Chemical & Process Engineering	Heat Engines	EE-Power & Industry Electronics	Applied Physics & Optics	ME - Power	Wind Energy & Aerodynamics	Cost Analysis	Engineering Economics	Electric Utility Planning	Energy Systems & Resources	Operations Research	Mathematics & Statistics	Computer Applications	Control Theory	Thermodynamics	Nuclear Engineering	Marketing	Technical Writing & Information Dissemination	Finance & Investment	Policy Analysis	Economics
Bishop			1		10			6		1	10	10		11			10								
Farrington				1					1					1			1		1						
Finegold	8			2		10											4		10						
Herlevich	2	1		2		2			2		1	2		2		3	2		2						
Jayadev							15	15						10				8							
Karpuk				4					5					4				2	5	2					
Kowalik	2		1	3		2			1			1		3			4		2						
Kriz					1			3			1	4		5	5	12	10								
Lavender	3	3	2							2	7	2		7	1										
Leboeuf				3								2					5		3						
McConnell				10			2	17		5		3		5											
McKinnon	1		1	1	1									1				1	1						
Nordquest	20		32	10							15	10		5	10										
Thornton	6		6				8	15			7			17			15	5							
Ullman	1			1						1	1						3		1						
Waddington	5	1				1	30	2	3	1				10			1	1							
Total	48	5	43	37	12	15	55	58	12	10	42	34		81	16	15	55	17	25	2					

Table 1-C. GENERAL EXPERIENCE
(In Years)

	Industrial Applications and Policy Branch																								
	Mechanical Design	Civil Engineering (Structures)	Manufacturing	Heat Transfer	Chemical & Process Engineering	Heat Engines	EE-Power & Industry Electronics	Applied Physics & Optics	ME - Power	Wind Energy & Aerodynamics	Cost Analysis	Engineering Economics	Electric Utility Planning	Energy Systems & Resources	Operations Research	Mathematics & Statistics	Computer Applications	Control Theory	Thermodynamics	Nuclear Engineering	Marketing	Technical Writing & Information Dissemination	Finance & Investment	Policy Analysis	Economics
Feasby											1								6		5				
Arnold							14																		
Brown									6			4			3					1		7			
Carroll																									
Corcoran							15						10												
Cotton																						5			
DeAngelis														7							3				
Edesess															10	10					2		7		
Farley																					3			5	
Grace																					2	2			
Greaver											1	1			2										
Gresham															2										4
Hooker																				4					
Krawiec														2							8				17
Livingston																					2			3	2
Mikasa																									6
Parker																						1	1	1	
Perwin																								2	
Roessner							1																	7	
Stadjuhar																	10								
Wilkins																						1			
Total							30		6		2	5	10	9	17	10	10		6	5	23	15	8	18	30

Table 1-D. GENERAL EXPERIENCE (In Years)

Utility Applications and Policy Branch

	Mechanical Design	Civil Engineering (Structures)	Manufacturing	Heat Transfer	Chemical & Process Engineering	Heat Engines	EE-Power & Industry Electronics	Applied Physics & Optics	ME - Power	Wind Energy & Aerodynamics	Cost Analysis	Engineering Economics	Electric Utility Planning	Energy Systems & Resources	Operations Research	Mathematics & Statistics	Computer Applications	Control Theory	Thermodynamics	Nuclear Engineering	Marketing	Technical Writing & Information Dissemination	Finance & Investment	Policy Analysis	Economics
Woodley							10						12												
Flaim													3	3											2
Harper																									
Hock							1					1		2											
Kepner	1							2			1					3	2								
Laitos													2												
Oriakhi			5	2		1					1			1		2									4
Percival				2					3	2		7	6	4	3		10	2	2						
Petty			1	1	3						1	1													
Reeve							15			1		15			15		15				15				
Taylor	1					6			4	1		4	2	4			6		6						
Weis																									
Witholder	5		5	5		5	5	5			3	3	3	3	1	10	6	3	5						
Total	7		11	10	3	12	31	7	7	4	6	31	28	17	19	15	39	5	13		15				6

Table 1-E. GENERAL EXPERIENCE
(In Years)

	Agriculture and Transportation Group																							
	Mechanical Design	Civil Engineering (Structures)	Manufacturing	Heat Transfer	Chemical & Process Engineering	Heat Engines	EE-Power & Industry Electronics	Applied Physics & Optics	ME - Power	Wind Energy & Aerodynamics	Cost Analysis	Engineering Economics	Electric Utility Planning	Energy Systems & Resources	Operations Research	Mathematics & Statistics	Computer Applications	Control Theory	Thermodynamics	Nuclear Engineering	Marketing	Technical Writing & Information Dissemination	Finance & Investment	Policy Analysis	Economics
Mason																									10
Flaim											3	1		2			1	1							
Hertzmark											2			3	1	1	1	1	2						5
Hill	1		1						1	3	3	3	2	1							2				
Horgan			2				1				2	2	4		4			3							
Neenan											1				1	3	1	1							6
Nyman														1	2	8	1	1							
Total	1		3				1		1	3	11	6	6	7	8	12	4	7	2		2				21

Table 2-A. SOLAR-RELATED EXPERIENCE (In Years)

	Utilities and Industry Division Totals								
	Solar Technologies					Solar Applications			
	PV	Bio/Chem	Thermal	Wind	Storage	SHACOB	AIPH	Electric Power	Fuels & Chemicals
Systems Development Branch	52.5	9	39	18	23.5	10	1.5	79	16
Utility Applications & Policy Branch	1.3		14	9.8	6.5	14.3	5.0	15.8	3.5
Industrial Applications & Policy Branch	2.2	7.5	20	1.5		14.5	25.2	13	
Agriculture & Transportation Group	1.5	10.5	3.6	3.7	1.1	6.3	2.7	5.2	5.0
Total	57.5	27.0	76.6	33.0	31.1	45.1	34.4	113.0	24.5

Table 2-B. SOLAR-RELATED EXPERIENCE (In Years)

	Systems Development Branch								
	Solar Technologies					Solar Applications			
	PV	Bio/Chem	Thermal	Wind	Storage	SHACOB	AIPH	Electric Power	Fuels & Chemicals
Bishop	11	1	4	1	3	2		11	
Farrington			1		0.5	1	0.5		
Finegold		2	4					2	10
Herlevich	0.5		2					2	
Jayadev	10		2	6				15	
Karpuk					1			5	
Kowalik	1		2						
Kriz			1		1		1	2	
Lavender	1	5		2	6			3	5
Leboeuf			2			2			
McConnell	6		6	6	4	4		8	
McKinnon		1							1
Nordquest	1		5	1	5	1			
Thornton	12		5					16	
Ullman			1	1	1				
Waddington	10		4	1	2			15	
Total	52.5	9	39	18	23.5	10	1.5	79	16

Table 2-C. SOLAR-RELATED EXPERIENCE (In Years)

	Utility Applications & Policy Branch								
	Solar Technologies					Solar Applications			
	PV	Bio/Chem	Thermal	Wind	Storage	SHACOB	AIPH	Electric Power	Fuels & Chemicals
Flaim							2	1.5	1.5
Harper									
Hock			2	0.3	0.3	2		0.3	
Kepner	0.3			0.3		0.3			
Laitos						2		2	
Oriakhi				0.2	0.2			2	
Percival	1		1	2	1	1		6	
Petty									2
Reeve				1					
Taylor			6	1	2	6		4	
Weis				2					
Witholder			5	3	3	3	3		
Total	1.3		14	9.8	6.5	14.3	5	15.8	3.5

Table 2-D. SOLAR-RELATED EXPERIENCE (In Years)

	Industrial Applications and Policy Branch								
	Solar Technologies					Solar Applications			
	PV	Bio/Chem	Thermal	Wind	Storage	SHACOB	AIPH	Electric Power	Fuels & Chemicals
Feasby						2.5			
Arnold							7.5	9	
Brown			1				3		
Carroll	1.2								
Corcoran		3	2						
Cotton			1.5						
Edesess			1.5	1.5			1	1	
deAngelis						5	1		
Farley		2				1	2		
Grace		1.5					1		
Greaver		0.5	1				1.5		
Gresham			2				1		
Hooker			1			1			
Krawiec			2				2		
Livingston						1.5	1.5		
Mikasa						1			
Parker		0.5				0.5	0.25		
Perwin						1			
Roessner						1	1		
Stajudhar			8				2.5	3	
Wilkins	1								
Total	2.2	7.5	20	1.5		14.5	25.2	13	

Table 2-E. SOLAR-RELATED EXPERIENCE (In Years)

	Agriculture and Transportation Group								
	Solar Technologies					Solar Applications			
	PV	Bio/Chem	Thermal	Wind	Storage	SHACOB	AIPH	Electric Power	Fuels & Chemicals
Mason		2					2		
Flaim	0.1	2.5	0.1	0.1	0.1	0.1	0.1	0.1	0.5
Hertzmark		1.5							2
Hill	0.2	2	0.5	3	1	0.2	0.5	3	0.5
Horgan	1	1	2			1		2	1
Neenan	0.2	0.5	1	0.6		5	0.1	0.1	
Nyman		1							1
Total	1.5	10.5	3.6	3.7	1.1	6.3	2.7	5.2	5.0

SECTION 3.0

MISSION STATEMENTS FOR THE UTILITIES AND INDUSTRY DIVISION

Mission Statement

The mission of the Utilities and Industry Division is to accelerate the use of renewable energy in the utility, industrial, agricultural and transportation sectors of the economy in a balanced program which integrates solar energy and efficiency technologies. The Division examines the marketability of renewable energy system technologies in those sectors using methods of analysis recognized and accepted by decision makers in each sector. The Division is the focus of expertise relating to the engineering, economic, and policy issues involved in marketing renewable energy technologies in each of these sectors. The Division also characterizes and forecasts the demand for energy services in industry.

Methodology

The Utilities and Industry Division includes three branches and one group: Systems Development Branch, Utility Applications and Policy Branch, Industrial Applications and Policy Branch, and Agricultural and Transportation Group. These organizations are responsible for design and analysis of systems using renewable resources matched to specific applications in prospective utility, industrial, agricultural and transportation markets. As required, these efforts are applied to the international market sector to support the International Division, as well as the domestic markets. Field tests of prototype systems are conducted in cooperation with appropriate Divisions in the R&D Directorate. The agricultural sector is unique among these potential markets in that it represents not only a market for the application of renewable energy systems but also a source of supply for fuels from biomass. The Agricultural and Transportation Group is responsible for activities involving the production, gathering, and processing of biomass materials into transportable fuels.

Detailed application analysis is conducted to identify key markets. The Division also identifies organizations which play a key role in influencing decisions to manufacture or use solar systems which increase the use of renewable energy and allow increases in energy efficiency in industry and utilities, examines the factors which influence their role in these decisions, and identifies policy opportunities for encouraging the widespread adoption of renewable energy technology systems.

Goals and Objectives

Goals for FY81-86 include the development of expertise in the following major areas:

- Systems engineering design and testing;
- Systems cost characterization, including engineering and manufacturing cost estimation;
- Utility and industry applications analysis;

- Utility and industry policy analysis;
- Utility and industry market development.

Specific organizational goals are described in the related branch statements.

SYSTEMS DEVELOPMENT BRANCH

Mission Statement

It is the overall mission of the Systems Development Branch (SDB) to foster and stimulate the development of a renewable energy system supply industry which can effectively meet the demands for renewable energy systems in the Industry, Utility, Agriculture, and Transportation sector, both domestically and internationally. This thus complements efforts within the Applications and Policy Branches, including the Agriculture and Transportation Group, to stimulate demand for such systems.

The branch, which will be analytical and strongly hardware-oriented, will be the focal point in the division, and in SERI as a whole, for systems engineering activities for industrial, utility, agricultural and transportation applications. SDB will be responsible for the analysis, design, construction and testing of application-oriented systems. Using requirements defined by the Applications and Policy Branches, SDB will configure and analyze various renewable energy systems, including hybrid systems, which meet the energy needs of the end use. Both technical performance and engineering-oriented cost performance will be assessed. Effects of various policy-options, tax incentives, and financing assumptions on system "value" to the end use, however, will be the responsibility of the Applications and Policy Branches.

SDB will be responsible for the fabrication and test of promising systems for application testing, with support from the Applications and Policy Branches, the Research Divisions, and external organizations (e.g. RSECs, other national labs). This is an iterative process using advances in research as well as experiences from previous generation systems.

SDB will also develop the necessary engineering-oriented design, installation, operation and maintenance tools handbooks needed by the various user sections.

Approach

The general strategy of the SDB for accomplishing its mission is to focus on systems integration and engineering to yield technically feasible and economically attractive candidate systems for the various applications. Work within SDB will be focused in the areas of: Systems Analysis, System Design/Test; and Systems Cost Characterization. All three areas are interrelated, with outputs of the individual areas acting as inputs to other areas within the branch as well as to other branches. Activities within the three areas are defined below:

Systems Analysis

- Generation of system configurations, considering all solar technologies and hybrids, which meet application requirements.

- Definition and analysis of system behavior (engineering and cost) considering application requirements. Ranking of systems based on that analysis.
- Definition of subsystem and component cost-performance goals for R&D Division focus.
- Development of appropriate analysis tools, and engineering handbooks for various user sectors, based on requirements developed by the Application and Policy Branches.
- Validation of simulation/design methodologies.
- Design and fabrication of promising systems for application testing.

System Design/Test

- System design and fabrication
- Development and validation of appropriate design methods.
- Prototype system application testing, to optimize configurations/performance. (Prototype system testing not in the context of an application is the responsibility of Research Divisions).
- Application field testing to verify engineering and cost behavior.
- Analysis of system test results.
- Establishment of reliability, operation/maintenance requirements from field tests.

System Cost Characterization

- Development and maintenance of detailed cost data bank, characterizing technology costs.
- Development of methodology(ies) for assessing system costs.
- Determination of cost estimating relationships, capacity factors, and modular factors for solar systems.
- Determination of the optimum manufacturing methods of solar hardware to minimize costs.
- Objective assessments of system cost projections.

SDB acts as the major interface between the Research Divisions and the Applications and Policy Branches within the Utilities and Industry Division. Application requirements will be defined for SDB by the Application and Policy Branches. As a result of systems analysis and testing, SDB will define R&D requirements for the Research Divisions to focus on. SDB will look to the Research Divisions for both state-of-the-art technology information and advanced components/subsystems developed in response to SDB identified R&D needs. SDB supports the International Division by providing systems applications engineering expertise in the areas of analysis, design, and test. Interaction with the Information Systems Division will occur in the following ways: computer support to SDB tasks will come from ISD, and SDB will work with ISD who will assist in disseminating the various information products developed within the branch. Externally SDB will integrate its efforts with those of the DOE and regional energy centers. In addition, a close working relationship will be sought and maintained with the solar supply industry, to

ensure proper transfer of user-application technical needs, as well as the results of work performed by SDB.

Plans

Long term (FY81-86) objectives of SDB can be stated as:

- Definition and analysis of renewable energy systems, including hybrids, which offer the best potential for industrial, utility, agricultural, international and transportation applications.
- Design, fabrication, test, and evaluation of applications-oriented systems to verify and optimize system engineering and economic performance within the context of the application.
- Establishment and maintenance of a detailed cost data bank for systems.
- Development of necessary engineering-oriented simulation/design tools and handbooks for various user commodities.
- Specification of technology requirements in terms of component/subsystem cost/performance goals to the R&D Divisions for their emphasis/focus.

Short range (FY80/81) objectives within the areas of concentration are:

System Analysis

- Generic system study to define "standardized" solar system for low temperature IPH application.
- Analysis of use of stratified solar ponds for IPH applications.
- Development of standard analysis methodologies/assumptions for IPH/utility application.
- Analysis and ranking of total energy system for specific industrial applications.

System Design/Test

- Analysis of IPH field experiments for operation/maintenance (O/M) characteristics, with initial quantification of O/M costs [in cooperation with the Solar Thermal Engineering Development (STED) Branch].
- Corrective action and subsequent analysis of selected malfunctioning IPH systems (in cooperation with the STED Branch).
- Fabrication and testing of Stirling total energy system.
- Design, fabrication, and test of a methanol/hydrogen automobile.
- Analysis of performance of utility-connected wind system experiments.
- Assessment of FPUP (photovoltaic) systems field performance.
- Fabrication/test of SERI Electric Auto Charging Station.
- Completion of hybrid systems lab and Alternative Energy Village.

System Cost Characterization

- Review of MOD-2 manufacturing and field installation costs.
- Evaluation of engineering cost methodologies.
- Completion of small wind manufacturing study to identify ways to reduce wind machine costs.
- Implement the RCA "PRICE" computer system as a tool to analyze costs on a component level.
- Update of existing cost data bank.
- Analyze the impact on cost of the manufacturing techniques used for Barstow with respect to the G.E. Heliostat Study.

UTILITY APPLICATIONS AND POLICY BRANCH

Mission Statement

In the process of supplying energy to consumers in the United States, electric and gas utilities consume nearly one-half of the total nonrenewable energy resources consumed annually by the United States. It is the mission of this Branch to accelerate the displacement of this energy consumption by accelerating the application of renewable energy systems including wind, solar thermal, photovoltaic, biomass and hydro systems. The applications to be considered include not only utility-owned central and distributed systems but also consumer-owned dispersed systems which connect directly to the utility's distribution system. Extensive work in the areas of application engineering, market definition, policy analysis, economic evaluation and market communication is required to achieve this acceleration. This work will be performed by the Utility Applications and Policy Branch.

This Branch will work closely with several other SERI branches and groups. The Branch will obtain from the Division's Systems Development Branch descriptions of engineered solar systems including cost and performance information so that application analyses of those systems may be performed. The Branch will also give that Systems Development Branch a definition of the systems' requirements for the various applications. The Branch will also cooperate with the Buildings Division to obtain information about changes in the loads that buildings present to the utilities and to give information about the utilities and about utility-connected solar energy systems such as dispersed wind and photovoltaic systems connected to electric utility systems.

The Branch will be the focal point for utility-related communications to audiences outside of SERI. These audiences will include: utilities and regulatory agencies; state, local, and regional energy offices; potential owners of dispersed, utility-connected solar energy systems; industry groups; other laboratories and contractors, and the public at large. The Information Outreach Branch will be asked to assist in these communication efforts by providing services to improve communications and strengthen the "focal point" concept.

Approach

The activities of the Branch divide logically into three general areas: (1) application analysis, (2) policy analysis, and (3) market communications. A sample list of typical activities in each of those areas follow:

Application Analysis

- Identify key markets for utility-owned solar energy systems.
- Identify key markets for dispersed, utility-connected solar energy systems.
- Define the impact upon utilities of dispersed, nongrid-connected solar energy systems.
- Perform value analyses for key markets.
- Perform market analyses for key markets.
- Define application requirements of solar energy systems to Systems Development Branch.
- Perform strategy analyses (such as the Repowering Strategy Analysis) and recommend program plans for DOE.
- Rank utility-connected and also utility-owned solar energy systems.
- Perform technical integration studies.
- Develop and/or acquire the methodology and tools to perform the analyses.
- Develop and maintain knowledge of competing technologies and systems.
- Participate in the Branch's Market Communication efforts.

Policy Analysis

- Analyze utility rate structures and formulate policy recommendations.
- Analyze utility financial, accounting, and tax policies and formulate policy recommendations.
- Review proposed legislation and make recommendations.
- Design policies to increase the attractiveness of solar energy systems to the utility-related markets.
- Participate in the Branch's Market Communication efforts.
- Define impact of utility financing upon dispersed solar and conservation program.

Market Communications*

- Coordinate the planning for SERI information materials to be disseminated by SERI to utility-related target audiences.**
- Coordinate the preparation of SERI information materials to be disseminated by SERI to utility-related target audiences.
- Involve other DOE lead laboratories and DOE in the planning for and the providing of information materials to be disseminated by SERI to utility-related target audiences.
- Maintain feedback channels between SERI and the utility-related target audiences to provide input for improving SERI's utility-related communications.
- Coordinate conferences, meetings, workshops, and presentations to the utility-related target audiences using the staff of this Branch and the Systems Development Branch.
- Coordinate schedules and meetings for those visitors to SERI visiting on utility-related matters.

Plans for FY80/81

- Identify key markets for utility-owned and consumer-owned, utility-connected solar energy systems.
- Determine the information needs and policies which will help accelerate the utility-related application of solar energy systems.
- Commence activities to accelerate the applications to the markets identified as near term.

FY81-86

- Continue plans identified above for FY80/81 but expand activities to accelerate applications to markets identified as longer term.

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*The Market Communications activities should be performed in cooperation with the Information Outreach Branch such that the services available from that Branch will improve communications and strengthen the concept that the Utility Applications and Policy Branch serves as the focal point for utility-related target audiences.

**Utility-related target audiences are intended to include: Utilities (public and private); regulatory agencies; state, local, and regional energy offices; potential owners of dispersed, utility-connected solar energy systems; industry groups; architect engineering firms and consultants, and other laboratories and contractors.

INDUSTRIAL APPLICATIONS AND POLICY BRANCH

Mission Statement

The industrial sector of the economy is made up of many manufacturing, mining, processing, and construction activities which utilize energy, raw materials and labor to produce products for our economy. The sector will both be a significant end-user of solar energy to meet its own needs and the producer of solar-based fuels and solar systems. The ability of the sector to provide solar fuels and systems for the whole economy and to use solar to satisfy its own energy requirements is heavily dependent on the actions of others. The support of decision makers on the demand side, (plant managers, owners, etc.), the supply side, (equipment, manufacturers, plant designers, etc.), and institutional support side, (financial companies, regulators, etc.) is crucial to assure the maximum penetration of solar technologies into appropriate industrial markets.

Necessary energy forms that can be met by solar include hot water, space conditioning, process steam, and electricity. They can be provided by single-purpose technologies or by co-generation techniques for purely onsite industrial uses or, additionally, for companies, utilities, or communities. The wide variety of conservation and solar technologies that can help meet these requirements include solar thermal, direct combustion and gasification of biomass, wind, and distributed photovoltaics. Each of these technologies will necessitate the development of firms capable of designing, building, installing, and servicing the solar system. In one particular case, biomass, there will be additional requirements in some applications for industries established to convert a waste, residue, or energy crop into a more suitable bio-fuel form (e.g., pellets, gas, liquid fuels).

The mission of the Industrial Applications and Policy Branch is to help shorten the time to reach maximum use of viable solar-based technologies in the industrial sector, and to help ensure the development of a thriving industrial base producing solar systems and fuels. The Branch will take advantage of an industry-wide perspective of applicable policies, technologies, and generic energy needs to help accomplish this mission.

The Branch will contribute by concentrating in areas that taken advantage of SERI's vantage point. Analysis of technical and policy issues will support the development of information necessary for national policies to be formulated, ratified, and implemented. In a similar vein, other work will be directed toward moving decision makers more quickly to commitments to use, or support the use of, viable solar technologies for specific applications.

The Branch will rely on inputs from the Utility Branch, the Agriculture Group, Quality Assurance and Standards, and the International Division. The Systems Development Branch will provide descriptions of engineered solar systems including cost and performance data, and the Information Dissemination Branch will assist in the preparation and dissemination of material for specific target audiences. Since the branch will be the primary outside contact with the supply and demand decision-makers, a significant result of the industrial branch work will be to provide feedback to other SERI programs in research, analysis, and applications.

Finally, to be successful in achieving the Branch mission, Branch activities must be comprehensive enough to address audiences outside of SERI. These audiences include industrial owners, plant managers, engineers, and key actors on the supply and support side such as solar equipment manufacturers, financial institutions, regulatory bodies, equipment suppliers/distributors, engineering consulting and design firms whose support is

needed to assure an adequate delivery of near-term solar technologies. SERI work will complement the activities of other entities involved in the analyses and implementation of solar applications in the industrial market (RSEC's, EES, trade associations, state energy offices, business development agencies, etc.).

Approach

To accomplish the mission, the Branch must develop credibility with solar manufacturers, industry, government, and support elements that will sustain future work. To do this the Branch will collect and analyze information on how industry uses energy, how conservative techniques can reduce their energy requirements, and how solar applications can meet their needs. Additionally, the branch will analyze major constraints to the more rapid use of available solar systems in industry and find ways to overcome those constraints, and to assist in the transfer of technology and information to key decision-makers where solar is an appropriate option. While the Branch will orient many of its activities towards identifying and encouraging near-term solar applications (e.g., combustion of wood), the Branch also will analyze the suitability and market potential of solar technologies which may be more widely applied in the longer term but are not presently technically or economically viable. The Branch will also analyze policy options and identify those with the greatest potential for increasing the use of solar, where appropriate. This approach will necessitate the creation of a branch, with a variety of skills, including engineering, policy analysis, and marketing, which can jointly assess the problems and implement the solutions. The approach can be categorized into the following example activities:

Technical Analysis

- Analyze the engineering and economics of industrial energy use.
- Analyze how solar technologies can be matched to industrial energy processes.
- Develop and maintain knowledge of conservation techniques, and competing technologies and systems (both renewable and nonrenewable).
- Provide engineering support to assist specific industries in analyzing and implementing solar technologies.

Policy Analysis

- Develop and validate industrial energy demand projections.
- Perform market analyses for near-term markets.
- Design, evaluate, and recommend policies which could make solar more attractive in industrial applications.
- Analyze financial, regulatory, and institutional channels that are needed for widest possible implementation of solar in industry.

Market Development

- Assist proto-typical industries in actually implementing solar systems in their applications by providing assistance, information, workshops, and direct technical assistance.

- Assist government agencies in developing and implementing regulatory policies affecting industrial solar applications.
- Work to assist industries involved in providing solar systems and fuel conversion facilities.
- Assist private-sector groups such as banks, A/E firms, etc., to become more informed of and supportive in their activities in industrial solar applications.

Plans for FY80

In the FY80 period, this branch is to proceed with the tasks defined by the approved AOP and the internally approved subtask work plans. Therefore, the following activities will be performed:

- continued development and documentation of applications analysis software, such as PROSYS/ECONMAT.
- development of financial/economic analysis software for industrial applications.
- study of the feasibility of the application of solar technologies in industrial parks.
- market analysis and development for solar thermal IPH.
- energy use forecasting and assessment for the industrial sector.
- case studies will continue to be performed for industries which are considering the use of solar.
- identification of decision criteria for potential users.
- handbooks for plant managers will be developed for biomass.
- provide lower cost and/or higher performance materials to solar manufacturers for testing.
- various seminars for industry covering near-term solar options will be conducted.
- preliminary market analysis identifying key markets for further use of biomass will be issued.
- assessment of the role of industrial solar energy in utility load management.

FY81-85

The major thrusts for this period will include an increased effort in direct technical assistance and expansion of market development activities as the near-term economic market grows. In order to help key industries implement solar energy, technical and economic evaluations (including a limited amount of on-site assistance) will be provided to specific users, and general assistance provided through detailed design manuals, personal contacts and promotional workshops. Efforts should not be technology-specific or resource-specific, but should include all solar options available to any industry. In addition, the branch will concentrate on the identification, analysis, and development of unique and innovative areas of industrial application, including the integration of new processes with solar and the use of solar in new plant designs or under new planning arrangements such as industrial parks.

Specific activities will include:

- Development of a solar design handbook for industrial applications (perhaps extensive enough to cover industry in general or possibly narrowed to certain specific industries such as the food industry).
- Continued development of an optimization routine for determining the optimal mix of conservation, solar, and conventional fuels in large single plants or in groups of plants as in industrial parks.
- Study of industrial energy delivery infrastructure, focusing particularly on the role of A/E firms in implementing new technology.
- Work with the solar industry to analyze and recommend cost reduction opportunities through improved materials and production methods.
- Continued case studies through trade association contacts.
- Analysis of the potential effects on industry of current (i.e., PIFUA) and pending policies and regulations, and recommend new or revised policies.
- Expanded communications program through, and in cooperation with, industrial trade associations.
- Land availability inventory for solar installations.
- Establishment of several SERI/Industry task forces to implement certain projects by developing the projects by developing the project risk capital—e.g., solar ponds in Utah constructed with mine tailings, industrial park system in Phoenix, Arizona.
- Expanded materials commercialization activities with solar manufacturers to help develop higher performance and/or lower cost solar systems.
- Study of the role of financial actors in implementation of solar technology.
- Analysis of the effect of solar energy systems on conservation measures through industrial case studies.
- Perform market research studies to identify the near-term, and long-term market opportunities for solar technologies in the industrial sector.

AGRICULTURE AND TRANSPORTATION GROUP

Mission Statement

The agriculture and transporation sectors of the economy offer significant opportunities for solar energy. These sectors are major consumers of energy—particularly petroleum products—and both have energy needs that may be supplied by various solar energy technologies. The agriculture sector also contains a solar resource, biomass, that has wide potential for energy and feedstock substitution uses. In this sense, the agriculture sector is unique in that it represents not only a market for application of renewable energy systems but also represents a source of supply for fuels from biomass. The Agriculture and Transportation (A&T) Group will therefore be responsible for activities including the evaluation of production, collection and processing biomass feedstocks into transporation fuels.

The objectives of the agriculture section of the A&T Group are two-fold: (1) conduct analysis and market development activities which will increase the uses of biomass-derived energy throughout the economy in a manner compatible with societal needs for food and fiber; and (2) assist the agriculture industry in developing renewable energy technologies within the industry. Activities in the transportation area will focus on identifying and assessing sources of fuels for the transportation sector based on biomass and other solar technologies.

The scope of activites of the A&T Group includes:

- Analysis of potential supplies of biomass energy feedstocks from agriculture. Analysis will investigate how such uses will affect the present use of land for food and fiber production;
- Assessment of techniques to produce, collect, transport, and transform wastes, residues, and energy crops into fuel forms for on-farm applications and uses in other sectors;
- Analysis of on-farm energy needs for heat, electricity, fuel, and techniques to satisfy them with renewable energy systems;
- Analysis of transportation sector energy use and methods to reduce this use, and assessment of renewable energy systems for application in the transportation sector;
- Assistance to International Division for agriculture and transportation applications in developing and industrial countries;
- Market development activities to ensure that results of R&D findings are available to appropriate audiences and obtain input from commercial sector to ensure that responsive research programs are developed.

The Group fits most appropriately in the Utilities and Industry Division since those sectors represent a major end-use application of biomass. The Group will be responsible for analysis of the fuels from biomass up to the point it enters the industry or utility. From that point, the Industrial and Utility Policy and Applications Branch will be responsible. In those cases where a biomass-derived fuel is produced as a waste or residue at an industrial facility, and the energy content is consumed on-site, the Group will provide assistance as necessary to the Utilities and Industry Branches.

To illustrate internal and external information flows, the analysis of one feedstock (corn stover) for direct combustion may involve the following units at SERI:

Activity	Lead SERI Unit	Support Unit
Combustion properties	Biotechnology	Systems Development A&T Materials Research
Systems Analysis (Harvesting)	A&T	Systems Development
Systems Analysis (Combustion)	Systems Development	A&T
On-Farm Uses	A&T	Systems Development
Utility Applications	Utility Policy and Applications	A&T Systems Development
Industrial Applications	Industrial Policy and Applications	A&T Systems Development

Approach

The general approach of the Agriculture and Transporation Group can be categorized into three areas: economic and policy analysis, technical assessments and systems analysis; and market research and development. Specific examples of activities that will be undertaken in these three categories include:

Economic and Policy Analysis

- Quantify the economic and social potential of conserving energy in agriculture and transportation, and applying solar technologies for on-farm and transportation uses.
- Analyze the potential of producing biomass energy from food, food crop residues, animal wastes, and crops specifically grown as biomass feedstocks, and the economic and environmental constraints on producing energy crops on marginal land. Examine the compatibility of solar technologies in-sector application and supply of biomass with current structure of agriculture.
- Analyze the economic potential of producing biomass energy from forest products, wastes and short rotation species.
- Assess the economic desirability of alternative biomass conversion technologies with respect to likely feedstocks.
- Conduct analysis of the impacts and effectiveness of existing and proposed government policies and programs affecting the production of biomass fuels and application of solar energy technologies in the agriculture and transportation sectors. Assess the impacts of various measures designed to affect the use of conservation and solar technologies (e.g., regulation, taxes, subsidies) on the agriculture and transportation industries. Analyze the relationship between energy policy objective and those of traditional agriculture policy (farm income, nutrition needs, export earnings, etc.).

Technical Assessment and Systems Analysis*

- Perform technical assessments (based on performance, safety and cost criteria) of alternative solar applications in the agriculture and transportation.
- Assess system performance for small-scale energy conversion facilities, including equipment designed for cooperative uses.
- Conduct technical assessments and systems analysis of equipment to harvest, collect, and convert biomass feedstocks.
- Undertake systems studies to optimize matching between renewable energy supply systems and current uses of energy in the agriculture and transportation sectors.

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*Major responsibility for hardware-oriented systems research will be assessed by the Systems Development Branch.

Market Research and Development

- Assess the market opportunities for biomass feedstocks used as fuel and petrochemical feedstocks.
- Conduct studies of the market potential for nonenergy by-products of biomass conversion processes.
- Analyze the capabilities of the agriculture and transportation industries to supply renewable energy technologies.
- Organize, support, and conduct a wide variety of market development activities that will: (a) encourage private and public decision makers to consider biomass fuels as a viable option and assist in creating a market environment amenable to commercial success of these fuels; (b) ensure that the results of technical and economic assessments and R&D findings are available to appropriate audiences; (c) provide practical information to potential users of solar technologies in the agriculture and transportation sectors; and (d) obtain input from the commercial sector and other relevant organizations and groups to assist in developing research programs responsive to the needs of those involved in commercializing solar energy. Specific target audiences of these market development activities include potential end-users of the technologies (e.g., farmers, cooperatives), potential suppliers of the production and conversion systems, organizations and individuals who can play significant roles in the introduction of solar technologies (e.g., Cooperative Extension, legislators, financiers), and those involved in conducting research and development.

Plans

During FY80, the following activities will be completed:

Economic and Policy Analysis

- Analysis of agriculture sector impacts of producing ethanol from corn grain.
- Farm-level analysis of residue use, including soil fertility and soil loss constraints on crop residue removal for energy production, crop residue collection costs, and crop residue combustion costs.
- Nutritional study of ethanol manufacturing joint products.
- Feed market studies (protein and oil markets from biomass refining joint products).

Technical Assessments and Systems Analysis

- Survey of ways in which renewable fuels can be applied to meeting U.S. transportation needs. The study will examine trends in transportation demand and technology and will suggest research programs to increase the applicability of renewable energy forms.
- Systems analysis of alcohol-gasoline blends, to rank various blends of methanol, ethanol and gasoline in terms of potential supply, distribution, cost and end-use.

- Development of system model of ocean kelp farm and use of this model to assess ocean farm concept.

Market Research and Development

- Conduct market study of potential for using biomass feedstocks as substitutes for petrochemicals.
- Complete biomass market development project for anaerobic digestion.


SERI

SECTION 4.0

FISCAL YEAR 1980 TASKS

SYSTEMS DEVELOPMENT BRANCH

3142.00 New Concepts/Thermoelectric Energy Conversion

The principal objective is to develop thermoelectric energy conversion systems for efficient and economical production of electric power from low-grade heat resources such as ocean thermal gradients, solar ponds, etc. Support objectives include: fostering the development of new, superior thermoelectric materials in the industry; identifying new, superior thermoelectric materials through exploratory research at SERI; developing more economical conversion device designs and fabrication techniques; identifying the most promising potential applications for thermoelectric energy conversion; characterizing systems performance requirements; and demonstrating new materials, devices, and systems on a laboratory scale.

Criteria for determining success of subtask: Demonstration of thermoelectric systems on a laboratory scale.

3320.70, 3532.45, 5624.00, 5624.10, 5624.20 Technology Characterization

Wind, Biomass, Solar Thermal, and AHAC:

These subtasks are a portion of the Technology Characterization effort (which supersedes the former Solar Cost Data Bank work) and will be directed in FY80 for solar technologies. Five significant items to be identified are:

- A determination of the most realistic costs of the technology in a consistent manner on a life cycle cost basis.
- An identification of the technology configurations which are competitive with existing energy alternatives with respect to cost and schedules.
- Collection of conventional cost data.
- Establishing a range of confidence for the technology cost.
- Performing economic analysis to determine delivered energy costs for various locations and applications.

These tasks will be part of a continuing activity to provide up-to-date and well documented information about the costs, performance, and certain other characteristics of specific solar energy systems. The information will be refined, and updated on a regular basis and the number of systems examined, enlarged, or reduced as needed. The data collected in this task will be analyzed and presented in a format consistent with the needs of the DOE-wide technology characterization effort.

3455.00 Systems Evaluation and Ranking

The objective of the Systems Evaluation and Ranking task to describe and comparatively rank small generic thermal power systems for process heat application on a common economic basis according to their potential for commercial deployment in the mid-1980s and mid-1990s. Systems in the capacity range of 5 to 30 MW_{th} will be considered.

The comparative ranking will permit DOE to establish a program to promote those technologies which demonstrate the highest potential for commercial process heat and to allocate resources accordingly.

3473.30 Cost Analysis of Industrial Process Heat Systems

Information on costs of solar thermal industrial process heat systems has often been sketchy, incomplete and inconsistent. The lack of an analysis of the information available and a plan for obtaining better data has hampered decision-making in this area. The purpose of this subtask is to provide consistent and realistic cost information on solar IPH systems from which to support cost modeling, systems analysis, and applications studies. The major objectives are: (1) to determine the most realistic costs of IPH systems in a consistent manner, (2) to compare IPH system costs for various field engineering tests and designs and note areas of similarity and divergence in order to devise cost relationships, (3) to establish a range of confidence for each system cost, (4) to develop reliable cost models for IPH systems, and (5) to recommend design modifications or principles to reduce installed system costs.

3473.50 Analysis of Generic Solar Industrial Process Heat Systems

This subtask consists primarily of a subcontract to analyze the potential effectiveness of generic, or standard modularized, IPH systems for the supply of low-temperature industrial process water. The objective is not to identify a single, intricately designed standard system, but rather to determine (1) the viability of such a concept both technically and economically and (2) the critical considerations and required steps in generating such a generic system design.

3510.00 Systems Analysis Research

This subtask has the following primary objectives:

- Demonstrate an automobile system consisting of an onboard methanol dissociation reactor and lean burn, high compression engine.
- Rank various biomass alcohol systems for automotive gasoline/alcohol blends considering potential supply, competing markets, harvest, collection, processing, distribution, and utilization.
- Construct a model of an ocean farm system for growing giant kelp for energy supplies and use this model to evaluate current approaches and suggest alternatives.

- Complete an evaluation of current research in safe, highly efficient, low emissions residential wood stoves, and suggest new design approaches.
- Perform a systems analysis of multifueled 1-2 kW free piston Stirling engine total energy system for developing countries and residential application and suggest a conceptual design.

3528.20 Value of Thermal Storage in IPH Systems

The objective of this task is to determine the value of thermal storage in solar IPH systems. This information will be used by the solar thermal storage program manager to establish cost goals. The value of thermal storage in IPH systems will be determined first by selecting representative solar IPH systems for analysis. It is expected that a maximum of three systems will be chosen. The performance of these systems, with and without thermal storage, will be determined with either a system simulation computer code or published data. The increased value of the solar IPH system due only to thermal storage will be calculated. A report documenting the approach and results of this study will be written and the value data generated will be used to recommend cost goals for thermal storage.

3525.12 District Heating with Solar Ponds

In FY80, the objectives of the solar pond work are to analyze applications of ponds to district heating and to perform experimental studies on pond salts and configurations. The expected result of the work is to further the understanding and accelerate the commercialization of solar ponds for neighborhood scale application through analytical and experimental studies.

3820.20 Cost Characterization

This subtask is a portion of the Technology Characterization effort (which supersedes the former Solar Cost Data Bank work) and will be directed by the Systems Development Branch in FY80 for solar technologies. Five significant items have been identified:

- A determination of the most realistic costs of photovoltaics in a consistent manner on a life cycle cost basis.
- An identification of the biomass configurations which are competitive with existing energy alternatives with respect to cost and schedules.
- Collection of conventional cost data.
- Establishing a range of confidence for photovoltaic cost.
- Performing economic analysis to determine delivered energy costs for various locations and applications.

This task will be a part of a continuing activity designed to provide up-to-date and well documented information about the costs, performance, and certain other characteristics of specific solar energy systems. The information will be refined, and updated on a regular basis and the number of systems examined, enlarged or reduced as needed. The data collected in this task will be analyzed and presented in a format consistent with the needs of the DOE-wide technology characterization effort.

3825.70 Systems Design

The objectives of this subtask are to: (1) develop and utilize a capability to design and optimize photovoltaic systems with specific emphasis on international applications; (2) design and fabricate a small systems engineering application lab to test and optimize advanced, developmental PV subsystems/systems. The purpose of the lab is to provide a state-of-the-art test bed where new components/subsystems can be tested and compared to the existing state-of-the-art.

This subtask addresses the need to: (1) provide technology assessment of advanced subsystems and guidance to R&D programs, and (2) to support SERI's lead role in international applications.

5636.20 Mass Producibility of a Small Horizontal Axis Wind Turbine System

The objective of this study is to identify the cost of a small wind turbine configuration (8-10 kW) which can be mass produced for applications in the rural area, residential, commercial, and industrial sectors. The wind machine is to have a minimum 30-year field life. Determination of the manufactured product will be made by a firm that has experience in manufacturing rotating products with severe shock loading in all types of field conditions.

9126.00 UN Pakistan Mission

The objective of this task is to support a United Nations project to harness locally available renewable energy sources such as solar and wind energy and the energy obtainable from biomass products like animal and agricultural wastes in rural energy centers in Pakistan. During the mission, the team of three consultants, which includes Mr. John Thornton, SERI, Prof. James Gaddy of the Univ. of Missouri and Mr. William E. Heronemus of the Univ. of Massachusetts, will: survey potential sites selected by the Pakistani Government for installation of solar energy devices and prepare a detailed work plan and project document. The major coordination and study integration will be performed by the Solar Energy Research Institute.

UTILITY APPLICATIONS AND POLICY BRANCH

5625.10, 5625.20, 5625.30 5625.40 Regional Assessments Studies

The regional assessment studies identify near-term market opportunities that could lead to large-scale use of solar electric systems (both central and dispersed) on a regional basis in the United States. The studies divide the United States into six regions. Each region identifies market opportunities for the various solar energy options, determines a schedule for deployment given existing barriers and facilitating factors, and identifies government actions to accelerate market penetration. Each study interfaces with potential commercial and private users of future solar energy options and uses this input as a key component of the planning process. SERI is responsible for managing the North Central, South Central, and Northwest studies. The other studies are completed and available in draft form at DOE.

6722.16 Wind Energy TID Project

This project's objective is to make the results of the federal Wind R&D Program available to wider audiences to enhance the commercialization of WECS. This task involves planning and coordination of information activities with the DOE labs and other national and regional groups. The major thrust is development of information materials tailored to key audiences.

6722.15 TID Project Ocean Systems

The TID Ocean Systems subtask objectives are to increase public awareness of ocean energy through appropriate audiovisual and printed materials and to coordinate the efforts of ocean research prime contractors in effective information dissemination.

Cataloging and analysis of information products will enable the TID staff to evaluate ongoing activities for the four target audiences with cooperation of the prime DOE contractors.

6721.80 Regulatory Support - ERA

This subtask's objective is to analyze several alternatives for utility involvement in residential solar development. A proposal submitted to ERA will include an implementation strategy for encouraging utility involvement via the most favorable alternative. The costs to the rate payer and the adopting utility will be assessed.

5640.10 Utility Financing and Regulation

This subtask's FY80 objectives are (1) to provide input to the SERI subtask on capacity planning under uncertainty (charge #5627.30) and (2) to explore the modeling capability needed to analyze a variety of policy options that could be adopted to achieve a more optimal allocation of resources from society's viewpoint.

The SERI subtask on capacity planning under uncertainty is to develop a computer model that allows utilities and public service commissions to assess which investments in solar, conservation, or conventional generating equipment would be least costly to the utility and end users. In addition, its objective is to develop a framework for evaluating investment decisions under uncertainty. This subtask will provide input to the capacity planning subtask by specifying the current tax policies applicable to the utility industry, and the major utility regulatory policies, including rate base determination under AFUDC and CWIP policies and accounting and financing policies.

This task will also explore the modeling capability needed to analyze which policy options could be adopted to achieve a socially desirable allocation of resources.

5627.10 Value Analysis of Grid-Connected Solar Electric

This project continues SERI FY79 task 5228 which reviewed the methods used to assess solar electric technologies in both utility and end-user applications. The draft report

(completed in FY79) identifies the factors that must be considered in economic assessments of solar electric technologies; assesses the techniques used to analyze their interactions; and discusses the data problems, deficiencies in existing techniques, and unresolved issues common to all methods of assessment. This report provides background material requested by DOE staff that will be useful to utilities and regulatory officials requesting this information. The report indentifies several approaches that could be used to meet DOE planning needs.

The objectives of FY80 activities in this area are to circulate this draft report for comment by external reviewers and revise it accordingly, and to monitor a subcontract commited in FY79 to Lawrence Berkeley Laboratory to develop analytical methods for solar electric power system reliability evaluation.

5627.30 Utility Expansion Model

This task's objective is to develop an expansion model for the purpose of electric utility planning. The model will incorporate the uncertainties inherent in the forecast of demand, costs, and reliability into the planning process. The model will handle solar technologies in a manner comparable to conventional resources.

The criteria of success would be the ability of the model to choose solar technologies under suitable assumptions and acceptance of the model by regulatory agencies and utilities.

3531.15 WECS Market Characterization

This subtask's objectives are to investigate in depth all salient variables that impact the development of the wind energy conversion systems market as a technically viable and economically attractive concept for widespread commercial application; secondly, to determine short- and long-term market potential in selected markets; and finally, to develop a comprehensive marketing plan for attaining the cost competitive commercialization of this concept as one of the most feasible alternatives in realizing efficient operations while reducing the continued dependence upon the diminishing supply of conventional fossil fuels.

This task will be the primary source of market related data for the decision data base that will support FY81 Wind Program commitment decisions. As additional data on manufacturer costs and pricing strategies is obtained, the economic and noneconomic factors that control the purchase decision; the cost added due to interconnection of SWECS with utilities; WECS applications, wind resources, and possible commercialization initiatives; and the market characterization data produced by this task will allow for the forecasting of sales activity.

3532.15 WECS Utility Analytical Modeling

This subtask's objectives include:

- Maintaining the computer programs obtained and developed in FY79 for this subtask;

- Preparing useful reports and user's manuals for the completed work;
- Extending the analysis capability to include the random nature of the wind resource;
- Increasing the credibility of WECS value determination to the electric utility industry;
- Extending the analysis capability to innovative WECS designs;
- Providing the analysis tools necessary for the performance of other WECS analysis subtasks;
- Providing the foundation for the capability to analyze the value of other solar-electric technologies to electric utilities; and
- Making available to interested parties the analysis tools and procedures developed.

Success of this subtask will be determined by the usefulness of the computer package and accompanying documentation.

3532.20 Selected Utilities' Value Analysis

This task is to determine the value of WECS at specific sites in relationship to the system mix of selected utilities. This study should give significant insights into the relationship of a variety of resources and WECS and the effects of this relationship on the value of WECS. A secondary objective is to provide a validation for SERI's in-house modeling endeavor. The purpose of this endeavor is to model solar resources effects in a system mix. The WECS study will validate the model for the wind energy aspect of the resource.

3532.25 Economics of WECS Owned by the End User

This subtask's objectives are to:

- Develop a computer program to calculate the economic value of consumer-owned WECS given consumer loads, wind characteristics, electric utility rate structures and rates and metering methods, WECS size and performance characteristics, consumer economic factors and consumer storage and/or load shift capabilities;
- Develop nomographs that permit the objective to be accomplished by those without computer capability;
- Use the above tools, analyze utility rate structures and their impact upon WECS economic value, and make recommendations concerning rate structures;
- Accomplish an analysis of the economic impact of dispersed wind turbine generators on the operations of a generating electric utility considering WECS ownership both by individual consumers and by the utility; and
- Continue previous "WECS for RECS (Rural Electric Co-ops)" work into newly exposed areas: (a) examine various complementary consumer load combinations that might increase WECS value; i.e., Rural Residential Electric Heating plus Rural Irrigation loads; (b) correlation studies affecting WECS value; and (c) develop an expanded Guide for WECS Application to RECS.

3532.30 Economics of WECS Tied to Utilities

This task's objective is to determine capital cost goals for the two most promising regions of the United States. The tools developed for the utility analytical modeling task will be used in this task.

Wind data for the two most promising regions in the United States will be used along with the EPRI synthetic utility data for these regions. The value of WECS will be determined for various penetration levels, machine designs, and load growth and fuel escalation scenarios.

The results of this study will be presented in a report to include:

- analysis of methodology,
- complete description of assumptions,
- description of EPRI Synthetic Utilities,
- all results,
- analysis of results—including parametrics, and
- recommended cost goals.

6720.70 WECS Commercialization

This subtask's objectives are to:

- Identify barriers to the diffusion of wind systems into the utility and develop ways to overcome the barriers,
- Define the decision criteria for utilities to buy WECS,
- Complete a generic Environmental Impact Statement (EIS) for WECS systems,
- Contact utilities and related associations and establishments, and
- Draft a market development plan for accelerated commercialization of WECS in the utility sector.

INDUSTRIAL APPLICATIONS AND POLICY BRANCH

3473.10 Industrial Process Heat Performance Models

The computer codes PROSYS/ECONMAT developed by SERI to evaluate solar IPH applications have been used extensively in applications, parametric sensitivity and case studies. It is anticipated that the software will be heavily used in the case studies and industrial park analysis. Because of the continued use of the software and its significant role in diverse studies, it is important to achieve and maintain a high level of accuracy in the model. The model should be reviewed and improved where possible and the data bases expanded where appropriate. In order to allow extended use of the software, documentation in the form of a user's manual will be prepared. Regional centers have

expressed an interest in the PROSYS/ECONMAT software for use in applications analysis of local industries. A package containing user manual, codes, and data bases will be made available to Regional Centers and other potential users.

3473.20 Industrial Process Heat Industrial Case Studies

The objectives of this subtask are to perform case studies of selected industrial plants to determine the near-term feasibility of industrial solarization and to provide inputs to SERI's effort in end-use matching, research, and commercialization. The selected industry is asked to provide specific data on energy use, plant operations, etc. After initial analysis, a plant visit is arranged to obtain additional information and clarify details. Opportunities for energy conservation are identified, and using existing codes, a suitable solar system is designed and costed. A report will then be submitted to the industry for review and approval.

3473.40 Solar Systems for Industrial Parks

This subtask will include a survey of the locations of industrial parks across the United States and an assessment of possible future trends in development. Industrial park energy use will be determined, leading to the characterization of typical demand profiles and appropriate solar design possibilities. Solar energy will be viewed from the perspective of an integrated solution to future energy use problems; i.e., the utilization of solar IPH, solar cogeneration, solar electric power or solar space heating systems will be analyzed and compared in order to select the most appropriate configuration. Process redesign and conservation will be incorporated. The entire menu of solar technologies will be considered in order to select the most appropriate use of the solar resource. While the preanalysis will focus on general issues, two specific industrial parks will be selected for a detailed and practical analysis of the concepts described above. These actual cases, as in the IPH Case Study project, provide a necessary test of general hypotheses and contribute to our credibility with the industrial user.

3474.10 IPH Market Characterization

The objectives of this subtask are to identify the criteria, tradeoffs and economic methodology employed by industrial decision makers in the course of evaluating energy supply alternatives and secondly the establishment of cost and performance goals which are necessary to successfully commercialize solar energy within the industrial market sector.

Relative to task activities and program goals successful attainment of the above objectives will provide background information from industrial decision makers which will be used to determine system design requirements and costs that must be met if solar energy is to be competitive with other alternative industrial energy sources. It is widely known that industry will not accept costing schemes that differ from conventional industrial accounting practices, i.e., life cycle costing. Information obtained during the course of this subtask will address the above questions and the geographical location of industry on an industry specific basis. Success of the subtask can be measured in terms of the degree of cooperation received from industry along with the quality and applicability of the information obtained during the course of the site visits.

3474.20 Market Development

The objectives of this subtask are to:

- Determine the more feasible near-term applications in solar IPH through a market suitability analysis and mapping.
- Summarize the current relevant marketing information in solar IPH and to draw conclusions regarding the implications for market development activities.
- Prepare a plan for a workshop series designed to stimulate interest in solar IPH in the industrial sector.

3531.25 Small User Decision Analysis

The basic objective of this subtask is to develop a quantitative description of the small electrical user (less than a few hundred kW) decision process with regard to the decision of whether or not to purchase a small wind system. The subtask results will feed into the Market Characterization Study. The relevance is that any valid market characterization must not only identify potential buyers but must also discover what criteria affect the purchase decision and evaluate their interaction. The key criteria for accomplishing task goals are the development of attributes and criteria that adequately describe user decision processes, and performing a set of field interviews to obtain decision maker preferences.

5634.30 Market Penetration Studies

Formal market penetration models based on cost are used frequently in DOE R&D and commercialization planning. This subtask will test the value of a different approach to the market penetration problem. It will take a broader view of the factors which influence market penetration than cost-based penetration models, which rely on comparative cost analysis to project future market penetration. This subtask will employ the findings, methodologies, and conceptual approaches of diffusion research to analyze proposed government programs to increase the rate of market penetration in the case of a single solar technology: industrial process heat. The project will complement other SERI efforts to increase the accuracy of market penetration forecasts and the validity of policy analyses of alternative government programs to increase the rate of penetration.

5638.10 Industrial Energy Service Characterization

The objectives of this subtask are: (1) to examine the current energy demand, its end uses, and costs in order to characterize "typical" energy applications and resulting services in the industrial sector;* (2) to develop trends of future uses of energy and prices in the industrial sector from 1980 to 1985.

*Although industry includes (1) agriculture, (2) mining, (3) construction, and (4) manufacturing, this subtask will concentrate only on the manufacturing sector.

5639.10 Behavioral Decision Criteria Among Potential IPH Adopters

The objective of this subtask is: to identify a set of behavioral decision criteria which potential solar IPH adopters might apply when selecting new energy sources. These behavioral decision criteria are meant to complement the standard economic analyses of proposed IPH systems for selected industries (e.g., food processing). The completed research, when juxtaposed with other SERI IPH technology and market research, will provide a more complete picture of what mix of government programs would be most efficacious in accelerating the diffusion of solar IPH technologies.

The subtask standards will be an interim briefing and a final report.

6221.10 Market Analysis

The objective of this subtask is to identify the actual industries that have the best potential for further development of biomass in the industrial and agricultural sectors. Particular attention will be paid to the forest products firms such as brick and textile industries, and dairy and poultry farms in the agricultural sector.

In addition, case studies will be developed illustrating a wide variety of near-term promising applications for biomass in industrial, utility, and agricultural operations. These will help document successes and barriers encountered in innovative biomass projects.

6221.20 Infrastructure Support

The objective of this subtask is to help identify and reduce institutional barriers that may unduly slow industry's decisions to use wood as a fuel. Specific objectives include:

- Identify, monitor, and report on energy on governmental incentives in the NEA and other legislation that seeks to stimulate use of wood for industrial fuels.
- To identify the financial community and potential users to develop and use innovative financing techniques to speed use of biomass.
- To assure that an adequate supply system for wood is being established and analyze new techniques in this area.

6221.30 National Program Support and Coordination

The objective of this subtask is to provide the DOE Wood Resource Manager with continuous technical and management support for planning, implementing and coordinating the National Wood Commercialization program as called for in the National Wood Plan.

These activities may include updating of the national wood plan and program support with other federal agencies and RSEC programs.

6221.40 Market Development and Training

The objective of this subtask is to help promote the use of wastes and residues (primarily wood) as an industrial and residential fuel. Particular emphasis will be placed on

encouraging conversions where users have a ready access to a waste supply. Specific objectives include:

- Assist small to medium size forest products, secondary wood manufacturers and food processing companies to move towards actual use of available wastes and residues for process heat, cogeneration, and space conditioning.
- Assure that potential users of wood for residential applications are adequately informed on information pertaining to safety, installation of systems, and other important issues relating to heating with wood.

These subtask objectives relate to overall task objectives because the use of wood in industrial and residential applications represents two of the most promising near-term applications for biomass.

6720.11 Industrial Sector Planning

The objective of the subtask is to provide a focused, coordinated set of tasks for FY81. The subtask will involve the development of a market development framework which can be used by the three groups in the industrial applications and policy branch to interrelate their programs. To the extent practical, the market development framework will address the activities of SERI and other contractors in the DOE Division of Solar Thermal Energy Systems, Market Development Branch.

6720.60 Coordination Management Strategy Dev.

The objectives of this task are: (1) ensure a coordinated commercialization program at SERI across all presently market ready technology applications and precommercial technologies; (2) ensure timely submittal of the Program Plans for the Commercialization and Passive Programs and other tasks that TCW leads within other programs (such as QATS and Biomass Commercialization); and (3) ensure responsible financial management of the budgets for those programs.

6721.00 Infrastructure Development

The objectives of this subtask are: (1) to influence builders and developers to be more receptive to passive and solar domestic water heating systems in new homes; (2) to establish a strong working relationship between SERI, RSEC's, NAHB (National Association of Home Builders), State Energy Officers and local Builders Organization; (3) to evaluate the effectiveness of pilot education seminars in stimulating conventional HVAC contractors to become involved in solar marketing, sales, and installation; (4) to provide an information booklet to help states select and design solar commercialization incentives; (5) to begin a program of dialog and education with solar contractors through the National Association of Solar Contractors (NASC) to assist the installation segment of the solar industry in supplying high quality solar installations to consumers.

6721.10 Financing

The financing subtask at SERI for FY80 is directed primarily at influencing the availability of financing for the solar energy industry, both manufacturers and users. The specific objects of the subtask are to:

- Assist the small to medium size solar producer and user in understanding what financial resources are available to them, and how to best approach those sources of funds. This will be accomplished through the development of a handbook for solar borrowers.
- Determine the effect that the availability of U.S. Government loan guarantees would have on the availability of private capital for construction financing and long term financing for large solar projects ($1 million and larger) in A/IPH, Wind, Biomass, Low Head Hydro, OTEC and Solar Thermal technologies. The ultimate purpose of the study will be to influence DOE and Congress to consider a reasonable solar loan guarantee program.
- Provide consultant expertise to groups of lenders, borrowers, and other solar groups, on the financing of solar energy through more thorough understanding of the problems of financing.

6722.11 Technical Information Dissemination Program Management

The objective of this subtask is to plan, direct and coordinate the Technical Information Dissemination (TID) Program in accordance with the approved plan. The TID Program has five other subtasks that correspond to the solar technology information projects described in the plan. The successful accomplishment of these projects (photovoltaics, solar thermal, biomass, ocean systems, and wind) is dependent upon the management and coordination delivered by this TID management subtask.

6722.12 TID Project/Photovoltaic Systems

The objective of this subtask is to coordinate information dissemination activities for the DOE Photovoltaic Systems Program Office and disseminate useful information to carefully defined target audience groups so as to help enhance the fastest possible commercialization of photovoltaic systems.

The criteria for determining the success of the subtask would involve comparing the results of this year's activities with the FY80 subtask plan; i.e., how many products have been turned out, how they have been disseminated, how they have been received.

6722.13 TID Project/Solar Thermal

The objective of the subtask is to increase awareness and technical knowledge of four target audiences; to support the Technology Transfer initiatives at DOE, national labs, and contractor institutions; to speed up and facilitate technical information dissemination among researchers; and to develop a national center communication network in solar thermal technology.

6722.14 TID Project/Biomass

The objective of this subtask is to plan and coordinate information dissemination activities for the DOE Biomass Energy Systems Branch. A further objective is to accelerate commercialization of biomass technology by producing and disseminating appropriate

information materials. These products are designed to lead from providing information to the curious, to developing awareness and finally to providing practical information for potential users.

AGRICULTURE AND TRANSPORTATION GROUP

3346.10/50 Alcohol Crops and Biomass Policy Analysis

The objectives of these subtasks are:

- Identification and assessment of environmental constraints on energy crop production in arid lands.
- Assessment of the economics of land substitution possibilities at the farm level.
- Assessment of the feasibility of intensive cultivation of innovative sugar crops in the major agricultural regions.
- Identification and assessment of existing and proposed federal policies and state policies affecting the use of biomass fuels and chemicals.
- Identification of direct and indirect substitution paths for biomass fuels and chemicals and an assessment of the economic feasibility of the proposed substitutions.

3346.40 New Markets for Biomass Feedstocks

The objectives of this subtask are:

- Identification of major markets for petrochemicals;
- Determination of technically and economically feasible biomass substitution possibilities;
- Identification of key near-term markets for biomass-derived petrochemical substitutes.

3346.60 Grain Drying/Residues

The objectives of this subtask are to:

- Estimate the costs of collecting agricultural residues;
- Estimate the costs of using agricultural residues in several direct combustion applications;
- Analyze the farm-level economic feasibility of collecting residues and using them in several types of applications.

5622.50 Solar Energy in Transportation

The objective of this subtask has been modified; this subtask's major focus is now to prepare the Transportation Sector report of the Sawhill Project. As such, it will assess historical trends in transportation, identify promising conservation/renewable energy sources for transportation applications, and recommend policies for the transportation sector.

SECTION 5.0

PUBLICATIONS

MR-13-068	Wind Energy Innovative Systems Summary.	Vas
MR-13-104	Wind Energy Innovative Systems Semiannual Progress Report for Period 4/1/8 - 9/30/78.	Vas
MR-13-125	Wind Energy Innovative Systems, Technical Status Report. November 1978	Vas
MR-13-143	Wind Energy Systems Program Summary, Program Development Plan.	Vas
MR-13-258	Program Development Plan. August 1978	Vas
MR-13-259	Wind Energy Innovative Systems, Technical Status Report. January 1979	Vas, Mitchell
MR-35-136	Feasibility Reprot: A Rural Energy Center.	Bishop
MR-35-136	Solar Thermal Test Facilities Users Assn. Management Plan.	Bishop
MR-35-222	Systems Analysis and Testing Program Management Plan.	Bishop
MR-51-106	Turning Laws into Incentives.	Roessner, Weis, Saltonstoll, Green, Ashworth, deKieffer
MR-62-414	Solar Energy Commercialization Planning. (Technical Report - 40 pages)	Feasby
MR-351-384	Analysis and Design Method Development for Solar Heating and Cooling - A National Plan.	Murphy
MR-351-405	Annual Report: WES System Studies.	Perkins
MR-351-498	Wind Energy Systems Program Summary Program Development Plan 1980.	Vas
MR-351-522	WEIS Technical Status Report. September	Mitchell
MR-434-414	Solar Energy Commercialization Planning.	Parker, Kettle
PR-13-054	Wind Energy Innovative Systems, Technical Status Report. July 1978.	Vas

PR-13-101	Storage Systems Analysis, FY78 Progress Report.	Copeland
PR-13-154	Solar Thermal Test Facilities Users Assn.	Bishop
PR-35-228	Technology Crosscuts for BES, Critical Research Needs for Solar Technology Development.	Jayadev
PR-35-291	Wind Energy Systems Quarterly Review 1/1/79 - 3/30/79.	Vas
PR-53-073	Labor, Manpower and Training Requirements Technical Progress Report.	Mason
PR-351-566	Wind Energy Systems Quarterly Review October 79 - December 79.	Strong, Vas, Mitchell
PR-353-212	Market Characterization of Solar Industrial Process Heat Application Progress Report - Second Quarter 78-79.	Ketels, Reeve
PR-722-411	Market Characterization of Solar Industrial Process Heat Applications: Progress Report - Third Quarter 78-79.	Ketels, Reeve
RR-51-292	A Preliminary Report on the Agricultural Sector Impacts of Ethanol From Grain.	Hertzmark
RR-51-357	The Market for Ethanol Feed Joint Products.	Hertzmark
RR-52-173	Solar Cost Reduction Through Technical Improvements: The Concepts of Learning and Experience.	Krawiec, Flaim
RR-52-311	Economic Measurement of Environmental Damages.	Krawiec
RR-53-045	Direct Labor Requirements for Select Solar Technologies: A Review and Synthesis.	Mason, Armington
RR-53-109	Preliminary Tabulation of Solar Energy Traning and Education Programs. November 1978	Barker, Mason
RR-53-128	The Role of Education and Training Programs in the Commercialization and Diffusion of Solar Energy Technologies. January 1979	Burns, Mason
RR-53-396	Assessment of California CETA Solar Training Programs. December 1979 (Draft)	Burns, Mason

RR-351-347	A Simple Design Tool for Sizing Solar Ponds.	Edesess, Henderson, Jayadev
RR-351-364	Preliminary Requirements for Thermal Storage Subsystems in Solar Thermal Applications.	Copeland
RR-351-377	Statistical Problems in Design Technique Validation.	Cohen
RR-53-396	Assessment of the Labor Market Experiences of CETA-Trained Solar Workers.	Burns, Mason, Mikasa
RR-351-404	Validation Approaches for Solar Heating and Cooling Models.	Morrison
RR-351-413	A Comparison of Six Generic Solar Domestic Hot Water Systems.	Noreen
RR-353-474	Solar Cost Reductions Through Technical Improvements: The Concepts of Learning and Experience.	Krawiec, Flaim
RR-354-395	Beyond the Body Count: The Qualitative Aspects of Solar Energy Employment. October 1979 (Interim Progress Report)	Burns, Mason, et al.
RR-732-644	A Methodology for Quickly Estimating the Competitiveness of Solar Technologies in Electric Utilities.	Taylor
SP-33-593	Photovoltaic Technology: Teachers' Background Section and Suggested Classroom.	Carroll
SP-35-232	Analysis Methods for Solar Heating and Cooling Applications.	SAT Program
SP-62-401	HVAC Contractors Solar Energy Guide.	DeAngelis (editor)
SP-69-242	Biomass: Solar Energy from Farms and Forests. (Brochure)	Grace
SP-69-268	Photovoltaic Power Systems. (Brochure)	Carroll, Wilkens
SP-69-290	Wind Energy Information Directory.	Weis, Mooney
SP-69-327	History of the Federal Solar Program.	Cotton
SP-69-337	Wind: An Energy Alternative. Aug. 1979	Weis, Evans

SP-69-337R	Wind: An Energy Alternative. Jan. 1980	Weis, Evans
SP-69-379	Biomass: Solar Energy from Forests, Farms, and Waterways. (Pamphlet)	Grace
SP-69-424	Biomass: Solar Energy from Farms and Forests.	Grace, Farley
SP-433-437	The DOE Wind Energy Program. October 1979	Weis, Smathers
SP-433-445	Solar Thermal Test Facilities.	Cotton
SP-433-487	Photovoltaics: Solar Electric Power Systems. (Booklet)	Carroll, Wilkens
SP-433-491	DOE National Photovoltaic Program System Field Tests. (Poster)	Carroll, Wilkens
SP-433-526	DOE Solar Thermal Power Systems Program.	Cotton, Braun
SP-433-527	Photovoltaics . . . .at SERI. (Brochure)	Carroll, Wilkens
SP-433-528	Technical Information Dissemination Plan for Solar Thermal Technology.	Cotton
SP-434-454	Market Development Directory for Solar Industrial Process Heat.	DeAngelis (editor)
SP-434-470	State Solar Energy Incentives Primer: A Guide to Selection and Design.	DeAngelis, Parker, Green, Ashworth, Roessner
TP-34-187	Development Programs in Solar Desiccant Cooling for Residential Applications.	Shelpuk, Hooker
TP-34-236	An Applications Analysis for the Solar Industrial Process Heat Market. 10th Annual Pittsburgh Modeling and Simulation Conference, April 1979.	Stadjuhar
TP-34-202	Overview of Desiccant Cooling Systems and Their Storage Requirements.	Shelpuk, Hooker
TP-35-056	Complementarity of Solar and Wind Resources for Hybrid Systems Application.	Bingham
TP-35-057	Solar Repowering Workshop. August 2-3, 1978	Nordman
TP-35-077	Technology Development Needs for High Temperature Process Heat, Technical Report.	Copeland

TP-35-086	An Overview Assessment of Potential Small Electric Utility Applications of Wind Energy Systems.	Jayadev, Perkins, Percival
TP-35-096	Industrial Applications of Solar Wind Hybrid Systems.	Jayadev
TP-35-208	Solar Pond Concepts: Old and New.	Edesess, Jayadev, Henderson
TP-35-213	Economic and Performance Comparisons of Salty and Saltless Solar Ponds.	Jayadev, Benson, Edesess, Henderson
TP-35-229	A Review of the Wind Program at SERI.	Vas
TP-35-253	Analysis of a Heat Exchanger-Thermoelectric Generator System. Presented at the 14th Intersociety Energy Conversion Engineering Conference.	Henderson
TP-35-279	Rough Cost Estimates of Solar Thermal/Coal or Biomass Derived Fuels. Presented at the AIAA Terrestrial Energy System Conference, Orlando, FL; June 4-6, 1979.	Copeland
TP-35-300	Solar Energy Perspectives for Public Power. Presented to American Public Power Assn. 1979 National Conference, Seattle, WA; June 19, 1979.	Woodley
TP-35-375	Integration of Intermittent Sources into Baleriaux - Booth Production Cost Models.	Fegan, Percival
TP-49-065	Matching Solar Systems to Industrial Process Needs.	Brown
TP-51-158	Status of Information for Consumers of Small Wind Energy Conversion Systems.	Weis
TP-51-188	Public Attitudes and Solar Policy.	Weis
TP-53-123	Solar Energy Commercialization and the Labor Market. Presented at the Solar Energy and Conservation Symposium-Workshop, University of Miami, 11 December 1978.	Mason, Ferris, Burns
TP-62-299	Biomass Energy Conversion Workshop for Industrial Executives.	Farley
TP-69-221	Proceedings: Solar Thermal Power User Review Panel Meeting - March 1-2, 1979.	Cotton

TP-69-276	Proceedings: Photovoltaics User Review Panel. (Report)	Carroll, Wilkens
TP-333-427	Two Case Studies of the Application of Solar Energy for Industrial Process Heat.	Hooker, West
TP-333-538	Feasibility Evaluation for Solar Industrial Process Heat Applications. Proceedings Second Annual Systems Simulation and Economics Conference	Stadjuhar
TP-351-112	Feasibility Report: A Rural Energy Center.	Bishop
TP-351-390	Small Solar Thermal Electric Power Plants: A Comparative Ranking.	Thornton, et al.
TP-351-460	Solar Ponds for Industrial Process Heat.	Brown, Edesess, Jayadev
TP-351-469	A Review of the Wind Energy Innovative Systems Program.	Vas, Mitchell
TP-351-508	Prospects for Investment in Solar Energy.	Edesess
TP-351-529	Goals: Objects and Measures of Progress.	Brown
TP-351-545	Planning for Electric Utility Solar Applications, the Effects on Reliability and Production Cost, Estimates of the Variability in Demand.	Fegan, Percival
TP-351-546	Problems in the Integration of Intermittent Sources into Utility Production Costing Models.	Fegan, Percival
TP-351-587	Solar Ponds.	Jayadev, Edesess
TP-351-598	Solar Electric Technologies.	Jayadev
TP-353-467	Industrial Applications Analysis: Market Characterization and System Definition for Several Industries. Proceedings 1979 Industrial Process Heat Conference. October 1979	Brown, Ketels, Stadjuhar
TP-354-589	Training for Solar Jobs: A Followup of California CETA Programs and Their Graduates.	Burns, Mason, Mikasa
TP-354-589	Training for Solar Jobs: A Followup of California CETA Programs and Their Graduates. (Draft)	Burns, Mason, Mikasa

TP-631-618	National Desiccant Cooling Program.	Hooker, Arnold
TP-632-665	Reducing Fuel Usage Through Applications of Conservation and Solar Energy.	May, Hooker
TP-731-626	The Use of Solar Energy to Produce Process Heat for Industry.	Brown
TP-733-617	Solar Ponds and Their Applications.	Jayadev, Edesess
TR-34-090	Simulations and Economic Analyses of Desiccant Cooling	Shelpuk, Hooker, Jorgensen, Bingham
TR-34-091	End-Use Matching for Solar Industrial Process Heat.	Brown, Stadjuhar, Hooker, Rabl, West
TR-35-047	Technology Development Needs for High Temperature Process Heat, Technical Report.	Copeland
TR-35-078	Conversion Systems Overview.	Henderson
TR-35-225	Summary of Currently Used Wind Turbine Performance Prediction Computer Codes.	Perkins
TR-35-233	Program Plan for Systems Analysis and Testing (SAT).	Bishop
TR-35-234	Generalized System Reliability and Safety Methodology for Wind Energy Conversion Systems.	Edesess, McConnell
TR-35-238	Comparative Ranking of 1-10 MW_e Solar Thermal Electric Power Systems, An Executive Overview.	Thornton, Brown, Edgecombe, Finegold, Herlevich, Kriz
TR-35-358	Basic Research Needs and Priorities in Solar Energy; Technology Crosscuts for DOE.	Jayadev, et al.
TR-51-059	Solar Incentives Planning and Development. August 1978	Schiffel, Posner, Hillhouse, Doane, Weis
TR-51-194	Application of Diffusion Research to Solar Energy Policy Issues.	Roessner, Posner, Shoemaker, Shama
TR-51-332	A Proposition of Energy Analysis and Economic Efficiency.	Hertzmark
TR-52-041	Federal Income Taxation of the Petroleum Industry and the Depletion of Domestic Reserves. September 1978	Flaim

TR-52-055	Economic Feasibility and Market Readiness of Solar Technologies. December 1978	Flaim, et al.
TR-52-324	Soil Fertility and Soil Loss Constraints on Crop Residue Removal for Energy Production. July 1979	Flaim
TR-52-353	Agricultural Crop Residue Collection Costs. December 1979	Dauve, Flaim
TR-52-369	The Costs of Using Crop Residues in Direct Combustion Applications.	Flaim, Urban
TR-53-100	A Review of Regional Economic Models with Special Reference to Labor Impact Assessment. May 1979	Ferris, Mason
TR-53-155	Public Opinion About Energy.	Farhar, Weis, Unseld, Burns
TR-53-321	Macroenomic Impacts of Solar Energy. May 1979	Groncki, et al.
TR-62-069	Solar Energy Legal Bibliography.	Seeley, Euser, Joyce, Morgan, Laitos
TR-62-148	Organized Labor and Solar Energy.	Livingston
TR-62-255	Regulated Utilities and Solar Energy.	Laitos, Feuerstein
TR-333-323	West/Industrial Process Heat Case Studies.	Hooker
TR-333-468	Analysis of Industries with Potential for Solar Industrial Process Heat.	Brown, et al.
TR-351-224	Survey of Currently Used Photovoltaic Simulation Methods.	Watkins
TR-351-233	Program Plan for System Analysis and Testing (SAT).	Bishop
TR-351-402	Standard Assumptions and Methods for Solar Heating and Cooling Systems Analysis.	Murphy, Leboeuf
TR-351-426	Economics of Wind Energy Conversion Systems Owned by End User.	Edesess
TR-351-461	Comparative Evaluation of 0.1 to 10 MW_e Solar Thermal Electric Power Systems. (In Review)	Thornton, et al.

TR-351-481	Applications and Systems Studies for Solar Industrial Process Heat.	Brown
TR-351-557	A Comprehensive Guide to WECS Connected With Electric Utilities.	Taylor
TR-351-562	Solar Energy and the Oil Refining Industry.	May
TR-351-604	Electric Utility Value Determination - Wind.	Percival, Harper, Fegan
TR-352-340	A Government Role in Solar Thermal Repowering.	Doane, Horgan, Taylor
TR-352-392	Solar Technology Applications to Enhanced Oil Recovery.	deLeon, Brown, Nasr, Margolis
TR-352-434	Federal and State Restraints to Central Receiver Electric Generating Systems.	Easterling, Gresham
TR-352-579	Implementation of State Solar Information Outreach Programs in Selected States.	Perwin, Roessner
TR-352-583	Making Solar Laws Work: A Study of State Solar Energy Incentives.	Ashworth, deKieffer, Roessner, Green, Piernot, Neuendorffer
TR-353-311	Economic Measurement of Environmental Damages.	Krawiec
TR-353-459	An Investigation of Learning and Experience Curves.	Krawiec, Thornton, Edesess
TR-353-474	Economic Assessments of Intermittent Grid-Connected, Solar Electric Technologies: A Review of Methods.	Flaim, Considine, Witholder, Edesess
TR-400-560	Feasibility Report on the Establishment of Rural Energy Centers in Pakistan. (In Preparation)	Thornton
TR-431-580	Economics of Selected WECS Dispersed Application.	Krawiec
TR-434-603	The Accelerated Commercialization Program for Materials and Components - Solar Sheet Glass - An Example of Materials Commercialization.	Livingston
TR-733-323	Industrial Process Heat Case Studies.	Hooker, May, West

TR-733-603	The Accelerated Commercialization Program for Materials and Components.	Livingston, Butler
TR-8016-1	Solar Thermal Repowering Utility Value Analysis.	Taylor, et al.
TR-8043-1	Heliostat Manufacturing Cost Analysis. Prepared by Battelle Labs, October 1979 (Two Volumes)	Horgan
TR-8043-2	The Cost of Heliostats in Low Volume Production. Prepared by Battelle Labs, January 1980	Horgan
TR-8037-1	Solar Thermal Repowering Systems Integration.	Stearns-Roger, Inc. Project Managers: Hargan, Taylor
TR-8052-1	Heliostat Production Evaluation and Cost Analysis. Prepared by General Motors Corp. December 1979 (Executive Summary SERI/TR-8052-2)	Horgan
TR-8125-1	A Handbook for the Sale of Excess Energy by Industrial and Individual Power Producers Under PURPA.	Berger, Farley
TR-8234-1	Decisionmaker's Guide to Wood Fuel for Small Industrial Energy Users.	O'Grady, Farley
—	A Guide to Obtaining Financing for Biomass-Fueled Industrial Facilities.	Hodam, Farley, Parker
—	Biogas for the Farm. (Slide Show)	Grace
—	Electricity from the Sun. (Slide Show)	Carroll, Wilkens
Journal of Energy. March-April 1979	"Experiments with Heliostats for Central Receiver Power Plants."	Thornton, Waddington
—	Matching Solar Systems to Industrial Needs. First ASME Solar Energy Conf., March 1979	Brown, Stadjuhar
Journal of Solar Energy Engineering. ASME Transactions Feb. 1980	"Measurement of Heliostat Performance Characteristics."	Thornton, Waddington

—	Photovoltaics: Teacher's Guidebook and Classroom Activities. (Educational Package)	Carroll, Wilkens
—	Photovoltaics: An Energy Alternative. (16mm film) (Segment of DOE-ACTS)	Carroll, Wilkens
—	Solar Technologies - An Overview. (Handout)	Livingston
—	SERI Photovoltaic Program. (Exhibit)	Carroll, Wilkens
—	Solar Industrial Process Heat Overview. Prepared for National Program for Accelerated Commercialization, Feb. 1979	Stadjuhar
—	Solar Technology - Federal Government Involvement.	Livingston
	Working Photovoltaic Model. (Exhibit for Colorado State Fair)	Carroll, Firor
Lawrence Livermore UCRL-52814	Economic Analysis of Solar Industrial Process Heat Systems.	Brown, Dickinson
DDS-044	Options for Solar Thermal Conversion.	Kreith, Lamriro, Brown
ET6	Near Term Prospects for Solar Industrial Process Heat.	Brown
IECEC 799038	Comparative Ranking of 0.1 to 10 MW_e Solar Thermal Power Systems.	Thornton, Brown, Edgecombe, Finegold, Herlevich
SERI-11	Economic Parameter Assessments and Data Base Compilation. November 1978	Flaim
SERI-34	Economic Feasibility and Market Readiness of Eight Solar Technologies. 11 July 1978	Flaim, et al.
SERI-36	Small Power Systems Study, Quarterly Report No. 1. July 1, 1978	Thornton, Brown, Bishop, Edgecombe
SERI-39	Wind Energy Innovative Systems, Technical Status Report. June 1978	Vas
ASME 79-SOL-28	Matching Solar Systems to Industrial Needs.	Brown, Stadjuhar
ASME 79-HT-65	The Use of Power Series Solutions in Radiation Heat Transfer and Thermal Network Analysis.	Connolly (SERI) and McMordie (Martin Marietta)

AIAA 79-1006	Comparative Ranking of 0.1 to 10 MW_e Solar Thermal Power Systems.	Thornton, Brown, Edgecombe, Finegold, Herlevich
—	Prospects for Electric Utility Involvment in Residential Solar Development. (Draft)	Laitos, Brown, Feuerstein, Soma, Taylor
—	Report on Gas and Electric Utilities, A Report of the Utilities Task Force of the SERI/Solar Conservation Study. (Draft)	Mause, Flaim, Taylor, Hertzmark, et al.
—	SERI Solar/Conservation Study Utilities Task Force. (Draft)	Mause, Flaim, Taylor, et al.
—	Near-Term Prospect for Solar Industrial Process Heat.	Brown
—	SERI as a Solar Energy Information Resource. Presented at Systems Simulation and Economic Analysis for Solar Heating and Cooling Meeting, San Diego, CA; June 1979.	Morrison
—	Solar Energy Data Bank and Simulations. Presented to International Symposium on Simulation, Modelling, and Decision in Energy Systems, Montreal, Canada; June 1978.	Morrison
SPOIE	Options for Solar Thermal Conversion.	Kreith, Lameiro, Brown
—	Solar Technology Seminars for Congress, Wind Systems. June 8, 1979.	Vas, Lavender, Weis
—	Wind: An Energy Alternative. February 1980 (Film)	Weis, Evans
—	Wind Energy Theatre. February 1980 (Videotape)	Weis, Avery