PROCEEDINGS SUPPLEMENT

MASTER

sol:r 79
NORTHWEST

AUGUST 10-12, 1979

DISCLAIMER

FOREWORD

Three days of sunny skies and perfect 85° weather welcomed over 1300 registrants to the Seattle Center for SOLAR '79 NORTHWEST. The large attendance at the technical sessions was surpassed in even greater numbers by those attending the concurrent free programs of formal presentations and informal seminars. The variety of events scheduled during the weekend brought solar education in many forms to the curious and attentive public, truly offering "something for everyone."

Because a very important part of the 1979 conference was its public programs, this Supplement was compiled to describe the highlights of these many activities. Summaries of plenary session speeches and several technical session papers, missing from the main Proceedings volume, are also included. A listing of names, addresses, and solar interest codes of conference registrants appears in the hope that continuing dialogue and coalition building between neighborhood solar supporters might be encouraged.

Coordination of the Supplement has been handled by Sally King, editor of the Conference Proceedings. She is to be thanked for much of the text. Other contributing authors are as follows: Cassandra Adams (Solar Olympics); Evan Brown (PNWSEA annual meeting); Ann Coville (Exhibits); Allen Jones (Government and Organizing Panels); Jay Luboff (SEA Planning Meeting); Shannon McCormick (Public Seminars); and Annie Stewart (Women and Solar).

SOLAR '79 NORTHWEST was sponsored by the U.S. Dept. of Energy, Bonneville Power Administration, the City of Seattle, the state energy offices of Washington and Oregon, and the Washington Energy Extension Service. It was coordinated by the Pacific Northwest Solar Energy Association and its local chapters. PNWSEA's Seattle chapter, the Western Washington Solar Energy Association, served as conference host.

More than 70 volunteers were on hand during the weekend to assist with registration, badge checking, information handling, projection work, site monitoring, and booth tending. Over 150 speakers and moderators brought the substance that gave purpose to the organizing and volunteer labor. To each of these many people the success of the conference--and the solar enthusiasm it inspired--is truly indebted.

Since the production of the Proceedings volume, more volunteer angels have appeared to which thanks are due: Russ Cameron, KREM-TV, Spokane (public service announcement production); Shannon Greene (restaurant listing); Lynn Johanson Smith (bus map preparation); and Roy Leischman, Marvl Productions, Edmonds (session taping).

Our deepest tribute goes to the very special efforts of the following people: Jeanie Taylor, volunteer coordinator; Shannon McCormick, public seminar coordinator; John Shaw, registration coordinator; Ann Coville, exhibits coordinator; and Perry Lovelace, president of the host association and indispensable in his adoption of general responsibility. The long hours before, during, and after each day's sessions that these persons spent in conference organizing made it possible for the remaining participants to enjoy a conference atmosphere unmarred by major disturbances. Such unsung heroism deserves no less than an halleluia chorus of praise.

The symphony that would bring the greatest smiles to all our faces, however, is the sound of solar structures under construction throughout the land. We hope that the information shared at SOLAR '79 NORTHWEST will enable both those in attendance and those reading these proceedings to contribute to that dynamic melody.

Jill Goodnight, Coordinator September 1, 1979
SOLAR '79 NORTHWEST

To obtain a copy of the two volumes of these proceedings, write to:

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Seattle, WA 98112
(206)322-3753

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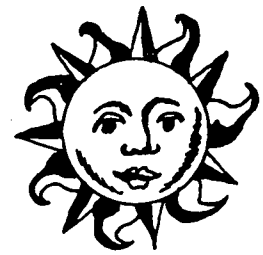
Supplement to Proceedings of Solar '79 NW

SALLY KING, EDITOR

MASTER



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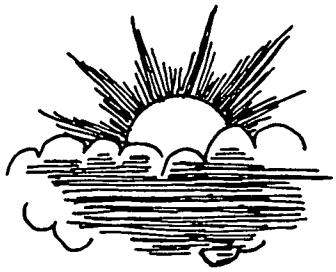

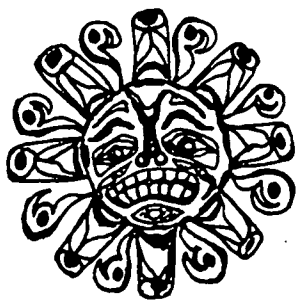

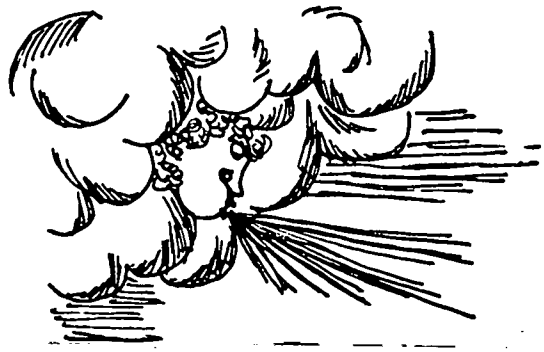

LIST OF PAPERS

PROGRAM SCHEDULE

sol:r 79 NORTHWEST

ALL LISTINGS PREFIXED WITH A "P" ARE OPEN TO THE PUBLIC AT NO CHARGE

THURSDAY EVENING, AUGUST 9

7:00 Registration, Conference Center lobby, Center House balcony

7:30 Planning session, board members of PNWSEA and local Solar Energy Assocations, Conference Center meeting room A

FRIDAY MORNING, AUGUST 10

8:00 Registration, Exhibition Hall lobby

8:45 Introductory Remarks - Douglas Boleyn, Pacific Northwest Solar Energy Association — EXHIBITION HALL
Perry Lovelace, Western Washington Solar Energy Association

8:55 Welcome - Deputy Mayor Bob Royer, City of Seattle — EXHIBITION HALL

9:15 Susannah Lawrence, lobbyist, Solar Lobby, Washington D.C. — EXHIBITION HALL
Keynote address on solar legislation at federal level and need for grassroots involvement

9:45 Donald Aitken, chairperson, Passive Division, ISES-AS and director, Western SUN — EXHIBITION HALL
Plenary session on natural energy design and overview of solar heating and cooling systems; update on Western SUN programs.

10:45 BREAK

11:15 I-A PASSIVE SOLAR RESIDENCES — RAINIER ROOM

John Hogan, moderator	University of Oregon, Eugene, OR
David Edrington	Wholeness in Environmental Design
H. Laird Parry et al	A Passively Heated Residence Designed for the Median Pacific Northwest Market
Christopher Mattock et al	Design, Construction and Initial Operating Experience with a Passively Solar Heated Townhouse

11:15 I-B WIND ENERGY RESOURCE ASSESSMENT — OLYMPIC ROOM

Ed Kennel, moderator	Clean Energy Products, Seattle, WA
D. L. Elliot W. R. Barchet	Northwest Regional Wind Energy Assessment
Scott D. Veenhuizen Jung-Tai Lin	Wind Resource Assessment in the Olympic Peninsula and the North Cascades
Norman Sanesi	Wind Power at Boardman, OR and Break-Even Economics

11:15 I-C ACTIVE SOLAR BUILDINGS — BLAKELY-FIDALGO

Mimi Sheridan, moderator	Seattle City Light, Seattle, WA
Charles Bliege	The Solar Way Building: A Commercial Solar Demonstration Project Which Uses Phase Change Material for Thermal Storage
William Wilson	Experience With an Inexpensive Space Heating Device in the Pacific Northwest

11:15 I-D PHOTOVOLTAICS — SHAW ROOM

Jon Burgett, moderator	Energy Production Systems, Everett, WA
Craig Mortensen	Regional Survey of Photovoltaic Development and Utilization
Grant W. Vincent	The Luminescent Solar Concentrator (LSC) (A Diffuse Sunlight Concentrator for Solar Cells)

12:45 LUNCH

FRIDAY AFTERNOON, AUGUST 10

1:45 Steve Selkowitz, group leader, Energy Efficient Windows and Lighting Program, Lawrence Berkeley Laboratory — EXHIBITION HALL

Plenary session on programs in daylighting design techniques and practices

3:00 I-F SOLAR DESIGN GUIDELINES — RAINIER ROOM

A.B. LaVigne, moderator — University of Washington, Seattle, WA

Dean Heerwagen et al — A Review of the BES/TR Efforts to Develop Passive Solar Design Guidelines for the State of Washington

Marietta S. Millet — Daylighting Design Guidelines for Pacific Northwest Buildings

3:00 I-G WIND ENERGY SYSTEM PROGRAMS — OLYMPIC ROOM

Glenn Andrews, moderator — Inter-Tech, LaGrande, OR

D. Philbrick and A. Kiphut — Wind Anemometer Loan Program

Tom Hiester — Siting Manual/Short Course for Small Wind Energy Conversion Systems

3:00 I-H GOVERNMENT PROGRAMS IN SOLAR ENERGY DEVELOPMENT — BLAKELY-FIDALGO

Mary Anderson, moderator — Washington State Energy Office, Olympia, WA

J. C. Emery and B. W. Cone — A Summary of the Analysis of Federal Incentives Used to Stimulate Energy Production

David Philbrick et al — Alternate Energy Incentives in Oregon

Paul Sansone — Solar Utilization for Economic Development and Employment in Low Income Communities (SUEDE)

3:00 I-I ISSUES IN WIDESPREAD SOLAR COMMERCIALIZATION — SHAW ROOM

George Hinman, moderator — Washington State University, Pullman, WA

John Ely — An Energy Philosophy and Two Solar Alternatives

Thomas Kayser — Using Solar Energy to Offset Peak Heating Demand

P 3:00 Fred Tuso — IRU Umbra Cone Workshop (plywood shell structure) — FLAG PLAZA

4:00 BREAK

P 4:10 I-H GOVERNMENT PROGRAMS IN SOLAR ENERGY DEVELOPMENT: PANEL DISCUSSION

Mary Anderson, moderator — Washington State Energy Office, Olympia — BLAKELY-FIDALGO

Donald Aitken — Director, Western SUN
Nancie Fadeley — Representative, Oregon State Legislature
Joel Pritchard — Representative, U.S. Congress
Alan Yamagiwa — Engineering Department, Seattle City Light

4:30 I-F SOLAR DESIGN GUIDELINES (continued) — RAINIER ROOM

Omer L. Mithun — Solar Design for Puget Sound

G. Z. Brown and B. J. Novitski — A Method for Analyzing Climate in Terms of Architectural Responses

Davis Straub — Design Prediction of Performance of Passive Solar Home Types in Western Washington: Analysis Using a Computer Model

4:30 I-G WIND ENERGY SYSTEM PROGRAMS (continued) — OLYMPIC ROOM

Jeff Aldred — The Field Evaluation Program for Small Wind Energy Conversion Systems

Ed Kennel — Experience with Small WECS in Western Washington

Kenneth J. Brondyke — The Role of Aluminum in the Development of Modern Vertical Axis Wind Turbines

4:30 I-I ISSUES IN WIDESPREAD SOLAR COMMERCIALIZATION (continued) — SHAW ROOM

David Baylon — The Impact of Direct Solar Heating and Conservation on Energy Use in Washington

David Baylon and Howard Reichmuth — Assuring an Equitable Energy Future by Delinking the Residential From the Industrial Energy Demand

FRIDAY EVENING, AUGUST 10

P 5:00 EXHIBITS Open for Public Viewing — EXHIBITION HALL AND FLAG PLAZA

P 7:00 GASOHOL TODAY AND TOMORROW: A SOLAR RESOURCE FOR OUR MOST PRESSING ENERGY PROBLEM — OLYMPIC ROOM

Lee Johnson, moderator — U. S. Department of Energy, Region X

Some Perspective: Why Is This All Happening Now?

Steve Rubin — Solar Energy Research Institute, Golden, CO

The Most Commonly Asked Questions About Gasohol

Lloyd Costley — U. S. Department of Energy, Washington, D. C.

U. S. DOE Action on Gasohol and Alcohol Fuels

Keith Sherman — Washington State General Services Administration, Olympia, WA

Gasohol: It's Here Now in Washington State

Nancie Fadeley — Representative, Oregon State Legislature, Eugene, OR

Recently Enacted Oregon State Gasohol Legislation

Janet Gillaspie — Oregon State Legislative Aide

Survey of Oregon State Gasohol Projects

7:30 INFORMAL SOCIAL FUNCTION at Bush School's solar greenhouse. Limited capacity. Admission by ticket only (available at registration). Film showing of "RADIANCE."

SATURDAY MORNING, AUGUST 11

8:00 Registration, Exhibition Hall lobby

8:45 Anna Fay Friedlander, editor, Solar Engineering Magazine — EXHIBITION HALL

Plenary session on directions taken by the solar energy industry to develop a solar market

9:45 BREAK

10:15 II-A PASSIVE SOLAR BUILDINGS — RAINIER ROOM

Christopher Mattock, moderator — Solar Applications and Research, Vancouver, B.C.

Charless W. Fowlkes — Measured Performance of a Passive Solar Residence in Bozeman, MT

J. Norman MacLeod — An Energy Saving Albertan House

Perry Lovelace and Joseph M. Weinstein — Solar Remodel of a Seattle House

Dennis N. Young — Three Passive Solar Heat Systems and Energy Conscious Design for a Community Center in the City of Spokane, WA

M. Steven Baker — HUD Passive Design Competition Winners from the University of Oregon

10:15 II-B MARKETING OF SOLAR HEAT — OLYMPIC ROOM

Tom Scott, moderator — TransWestern Investors - Solar Division, Eugene, OR

G.F. Deannie Williams — Clark County P.U.D. Solar Home Award Program

George Reynoldson — A Collector on Every Roof and a Rock in Every Garage

Gordon McCutcheon — Securing an 80% Cost of Construction Bank Loan for a Passively-Heated Solar Home with No Back-up Heating System: Solar Without Subsidies

J. M. Hill et al — The Potential for Residential Solar Energy Applications in British Columbia

Terry Esvelt and Mark Roberts — Pacific Northwest Residential Energy Survey

10:15 II-C HOT WATER SYSTEM PERFORMANCE — BLAKELY-FIDALGO

Bill Miller, moderator	Miller and Sun Enterprises, Portland, OR
M. Steven Baker and Robert M. Lorenzen	Lane County Solar Water Heater Demonstration Program
Ken Eklund, Ed Siegel	Heat Tape as Freeze Resistance in a Thermosiphon Solar Water Preheater
James S. Englund	Solar Water Heaters in Pullman
Timothy M. Hayes	The Synergistic Effect of a Solar-Assisted Heat Pump System and Swimming Pool
Jon Burgett	Solar Heating for an Olympic-Sized Pool in Western Washington

10:15 II-D NEIGHBORHOOD-SCALE SOLAR PROJECTS AND SOLAR ACCESS ISSUES — LOPEZ ROOM

Jay Luboff, moderator	Western SUN, Seattle, WA
Lucy Gorham	The Neighborhood Technology Program
Rodner Winget et al	American Indian Projects in Solar Energy: Community Involvement
Dale Goble	Solar Access: Evaluation of Present Statutes and Proposed Legislation
Sally King	Solar Access Protection in Washington
Alan Kiphut et al	Solar Access Legislation in Oregon
William A. Randall	Legal Issues Involved in the Adoption of a Solar Zoning Ordinance

(Sally King, Alan Kiphut et al, William A. Randall: PANEL)

10:15 II-E RESEARCH IN RADIATION MEASUREMENT — MEETING ROOM H - CENTER HOUSE

John Hay, moderator	University of British Columbia, Vancouver, B.C.
John Hay, Stephen J. Lamble	The Vancouver U.B.C. Slope Radiation Measurement and Modelling Programme
John E. Hay, Robert Tooms	The Mesoscale Variability of Solar Radiation in Vancouver, B.C.
L.J. Fritschen, J. Hsia	Estimation of Hourly Direct Beam and Diffuse Solar Radiation from Global Solar Radiation Measurements
Carl M. Berkowitz, Nels S. Laulainen	The Use of Standard Surface Weather Observations to Evaluate Solar Insolation in the Pacific Northwest
Bill Wadsworth, Larry Palmiter	A Radiation Shield for Air Temperature Measurement

12:45 LUNCH

P 9:00 Ken Cooper, Vancouver, B.C. Solar Greenhouse — SHAW ROOM

P 10:00 EXHIBITS Open for Public Viewing till 6:00 — FLAG PLAZA & EXHIBITION HALL

P 10:00 Mary Smith, Seattle, WA Home Energy Conservation — SHAW ROOM

P 10:00 Bjorn Lunde, Micro Environment Research Group; Pat Robertson, Seattle City Light — CHILDREN'S SOLAR ACTIVITY CENTER till 5:00 — EXHIBITION HALL COURTYARD

P 10:00 Fred Tuso IRU Umbra Cone Workshop (plywood shell structure) — FLAG PLAZA

P 11:00 Bill Miller, Portland, OR Active Solar Space Heat and Domestic Hot Water Systems — SHAW ROOM

P 12:00 Laird Parry, Richland, WA Trombe Wall House — SHAW ROOM

SATURDAY AFTERNOON, AUGUST 11

P 1:00 Portland Sun Demonstration of assembly of solar hot water collector through 5 pm — EXHIBITION HALL COURTYARD

1:45 Wayne Nichols (developer) and Susan Nichols (designer and builder), solar subdivision specialists, from Santa Fe. — EXHIBITION HALL
Plenary session on developing, financing, designing and marketing the solar subdivision

3:00 II-F PASSIVE SOLAR SYSTEM COMPONENTS — RAINIER ROOM

Laird Parry, moderator	Battelle-Northwest, Richland, WA
G.A. Tsongas et al	An Experimental Study of Solar Heating Effects on Wall Insulation Performance
G.A. Tsongas et al	A Field Study of Moisture Damage in Walls Insulated Without a Vapor Barrier

3:00 II-G SOLAR SITE PLANNING AND ENERGY CODES — OLYMPIC ROOM

Donald Heil, moderator	Washington State University, Pullman, WA
Roger Bryenton et al	Community and Site Planning for Solar Developments
Sharon Davidoff	St. Johns Development: Proposed Passive Conservation Guidelines

3:00 II-H ACTIVE SOLAR BUILDINGS — BLAKELY-FIDALGO

Bill Kingrey, moderator — Gerard and Associates, Spokane, WA

Peter Morrison, Aileen Jeffries — An Analysis of the Performance and Economics of a Low Cost Retrofit Solar Heating System in North Central Washington

Douglas Boleyn — Operating Results of Eleven Solar Installations in Northwest Oregon

P 3:00 II-I OPEN DISCUSSION ON SOLAR ORGANIZING EFFORTS — LOPEZ ROOM

Evan Brown, moderator — Pacific Northwest Solar Energy Association, Seattle, WA

Susannah Lawrence — Solar Lobby

Cris Salsbury — Washington State Model Solar Projects

Paco Maribona — Oregon Solar Lobby

Joined by Principals of Solar Energy Associations throughout the Northwest

3:00 II-J SOLAR DATA COLLECTION PROGRAMS — CONFERENCE ROOM H - CENTER HOUSE

Dave McDaniels, moderator — University of Oregon, Eugene, OR

Charless Fowlkes — Montana Solar Radiation Measuring Network

Randy Nichols — Solar Data Collection System

P 2:00 FILM SHOWINGS — ROOM A, CENTER HOUSE

2:00 "Energy from the Day Star"
2:30 "The Great Adventure"
3:00 "Backyard Alternatives"
3:30 "Build Your Own Greenhouse - Solar Style"
4:00 "The Hottest Show on Earth"
4:30 "The New Western Energy Show"

P 2:00 Tom Lenchek, Seattle, WA — Passive Solar Home Design — SHAW ROOM

P 3:00 Bob Hull, Seattle, WA — Earth Sheltered Housing — SHAW ROOM

P 4:00 Ken Eklund, Seattle, WA — Residential Wood Heat — SHAW ROOM

4:00 BREAK (Technical Session Programming)

4:30 II-F PASSIVE SOLAR SYSTEM COMPONENTS (continued) — RAINIER ROOM

John D. Aspnes, John P. Zarling — Solar Heat Gain Through Windows at High Latitudes

A.B. LaVigne — Insulated Window Covers for a Temperate Climate

Michael Corke, James Bruvold — An Analysis of a Thermosiphon Floor Heating System

4:30 II-G SOLAR SITE PLANNING AND ENERGY CODES (continued) — OLYMPIC ROOM

Morton O. Awes, Daniel J. Smith — The Model Energy Code Impact on Building and Solar Communities

Heather E. McCartney, James L. Binkley — The Impact of the 1980 Energy Performance Standards for New Buildings on Active and Passive Solar Strategies

Larry Palmiter, Davis Straub — Window Performance and the Seattle Energy Code

4:30 II-H ACTIVE SOLAR BUILDINGS (continued) — BLAKELY-FIDALGO

Terry Bratvold — Everything You Wanted to Know About Solar in Seattle but Were Afraid to Ask!

Artemio Paz Jr. — St. Paul Center, United Methodist Church: A Solar Heated Sanctuary

M.P. Scofield et al — The Boise Cascade-INEL Factory-Built Solar Home

SATURDAY EVENING, AUGUST 11

P 7:00 Annual Meeting of the Pacific Northwest Solar Energy Association — OLYMPIC ROOM

Special guests Don Aitken, chairman, Passive Division, and Lee Salmon, chapter coordinator, ISES-AS

P 7:00 FILM SHOWINGS --see listing above (Saturday, 2:00 p.m.) — CONFERENCE ROOM A, CENTER HOUSE

SUNDAY MORNING, AUGUST 12

8:45 Richard Hill, professor, Department of Industrial Cooperation, University of Maine — EXHIBITION HALL

Plenary session on solar/wood heating system, design, performance, and implications for large-scale applications

9:45 BREAK

10:15 III-A WOOD ENERGY IN THE NORTHWEST — RAINIER ROOM

Thomas R. Miles	Biomass in the Northwest - Available Inventory
Thomas R. Miles	Biomass Fueled Industrial Installations
Robert Escalante	40-MW Woodwaste Electric Generating Station

10:15 III-B ECONOMICS OF SOLAR HEAT — OLYMPIC ROOM

Gil Stuart, moderator	Beaverton Banking Company, Beaverton, OR
Craig McDonald	Conservation and Solar Economics in Conventional House Designs
Don Parker	Capital Budgeting Investment Decision for Active Solar Systems
David Baylon Bruce O'Halloran	Comparative Solar Economics - Real Cost Comparison
Cristina Kirschner et al.	Passive Solar Economics in 15 Northwest Locations
Henry H. Knapp III	The Economics of Energy Conservation With Application to Passive Solar Home Design

10:15 III-C LONG-TERM EDUCATION PROGRAMS — BLAKELY-FIDALGO

Cynthia Weston, moderator	OMSI Energy Center, Portland, OR
Shaun Taylor	An Innovative Solar Energy Program for Schools
Terry Egnor Richard Armstrong	Solar Greenhouse Construction: A Model for Energy Education
Tom Eckman	Seattle/OIC's Training and Curriculum Development Program
Elaine D. Miller	Energy Management Technician Training Program
Ken Eklund Evan Brown	Training a CETA Weatherization Crew for Deployment of Low-Cost Solar Technology Via the SUEDE Program

10:15 III-D AGRICULTURE, AQUACULTURE — SHAW ROOM

Glenn Kranzler	Drying Hops With a Solar Assist
Davis Straub et al	Performance (Thermal, Agricultural and Aquacultural) of a Passive Solar Greenhouse in Western Washington
William Head	Greenhouse Aquaculture
Greg Higgins et al	Solar Greenhouse Produce Marketing in the Pacific Northwest

10:15 III-E INDUSTRIAL APPLICATIONS AND THERMAL ELECTRIC GENERATION — LOPEZ ROOM

Chuck Clark, moderator	Rocket Research Corporation, Redmond, WA
James I. Mills	Solar Enhanced Oil Recovery
William D. Beverly	Solar Energy for Thermal Electric Power Generation: Review of Concepts
William D. Beverly	Solar Energy for Process Heat: Review of Concepts
Kirk Drumheller	Manufacturing Costs - Heliostats for Solar Thermal Systems
Ralph Schlichtig	Engine Cycles Tailored for Solar Power

P 10:00	Women in Solar	Open Forum led by Elizabeth Coppinger and Annie Stewart	CONF. RM. C
P 10:00	Stan Nealey	A $200 Solar Swimming Pool Heater	CONF. RM. H
P 10:00	Ed & Mary Jacobs	Evolution of a Solar Home-How-To, From the Experience of an Owner-Builder	CONF. RM. G
P 10:00	Lisa Kennan et al	Display of Solar Greenhouse Designs by Juanita High School Students (through 1:00 p.m.)	CONF. CNTR. LOBBY
P 10:30	James Peterson	How to Determine the Potential Savings for a Solar System	CONF. RM. H
P 10:30	Bob Evans	A New Greenhouse for an Old Home and a Solar Heated Hot Tub Too	CONF. RM. G
P 11:00	Rob Lerner	Adding a Heat & Food Producing Greenhouse to an Existing Home	CONF. RM. H
P 11:00	Mel Wilson	A System to Use Waste Clothes Dryer Heat to Supplement a Forced Air Heating System	CONF. RM. G
P 11:00	Terry Nelson	Self-Sufficient Floating Home - A Solar Enthusiasts Plans (through 2 pm)	CONF. RM. B
P 11:00	Steve Cruzen	Talk with a Solar Designer; Look at his Plans	CONF. RM. F
P 11:30	David Dunnette	A Solar Homeowner-Builder's Hybrid Trombe Wall House	CONF. RM. H
P 11:30	Mark Smith	Solar Heat for Public Bldgs. - an Energy-Saving Passive School Design	CONF. RM. G
P 12:00	John & Goldie Caughlin	Solar Greenhouse Owners Discuss Advantages & Disadvantages	CONF. RM. H
P 12:00	David Foland	Solar Heat to Increase Greenhouse Production	CONF. RM. G
P 12:30	Jo Yount	A Solar Homeowner Discusses Low-Cost Heat Saving Techniques	CONF. RM. H
P 12:30	Noel Nedved	The Vapor Bubble Pump - More Flexibility for Thermosiphon Solar Water Heaters	CONF. RM. G
P 1:00	Larry Smith	Solar Condominiums	CONF. ROOM H

SUNDAY AFTERNOON, AUGUST 12

P 12:00 - 2:00 SOLAR OLYMPICS — FLAG PLAZA

P 1:00 THE ENERGY SHOW, a musical review performed by the Footlites of Tolt Jr.-Sr. High School, Carnation, WA — FLAG PLAZA STAGE

P 1:45 John Reynolds, professor of architecture, Solar Energy Center, University of Oregon — EXHIBITION HALL
Plenary session on Northwest solar architecture and the influence of university solar design programs.

P 4:00 Presentation of Solar Olympics awards — RAINIER ROOM

3:00 III-F WOOD ENERGY RESOURCE AND BIOCONVERSION — RAINIER ROOM

Constance Harrington et al	An Experiment in Biomass Production: Results from Three Consecutive Harvests of Cottonwood and Alder
Linda Sutliff Dolan Chadwick Oliver	Cultural Treatment of Selected Species for Woody Biomass Fuel Production
Larry Winiarski	Gasifiers Enable Existing Equipment to Use Waste Material as Clean Fuel
Elizabeth Coppinger	Anaerobic Digestion Systems for Dairy Farms: Experience and Implications for Wider Use

3:00 III-G SIMULATION — OLYMPIC ROOM

Davis Straub, moderator	Ecotope Group, Seattle, WA
Ashley Emery et al	An Evaluation of a Passive Solar House Using a Thermal Simulation Program
Alan Kiphut et al	Estimating Passive Solar Performance and Economics
John L. Ellis	A Passive Solar Simulation Program for a Small Micro-Computer
William M. Kingrey	Modelling Passive Solar Buildings With a Small Computer
Ben Levy et al	Solar-Assisted Heat Pump Performance and Computer Simulation
Christopher C. Morgan	The Micro-Computer as a Design Tool for Economic Optimization of Passive Solar Techniques in the Pacific Northwest
Davis Straub	Demystifying the Computer: How to Use a Computer Model as a Passive Solar Design Tool

3:00 III-H INFORMATION/EDUCATION SHORT-TERM PROGRAMS — BLAKELY-FIDALGO

Kevin O'Connor, moderator	Solar Energy Research Institute, Golden, CO
Belinda Boulter	Ecotope Group's Energy Resource Center
Cassandra Adams	An Alternative Technology Workshop for Junior High School Students

3:00 III-I SOLAR SYSTEM/COMPONENT RESEARCH — LOPEZ ROOM

Bruce Bolme, moderator	Consulting engineer, Ridgefield, WA
Robert B. Allen Gary Goldsberry	Controlled Experiments Using Passive Solar Techniques
Donald R. Heil	Scale Models Used to Simulate Passive Solar Home Performance
N. R. Gordon G. L. Tingey	Plastics Honeycomb Solar Coverplate

PROGRAMS BELOW ARE IN THE CENTER HOUSE

P 1:30	Bob Lamson	A Heat Pump Heating System Designed for Northwest Homes	CONF. ROOM H
P 1:30	Connie Krautter	Energy Organizing: How Citizens Can Influence Local Energy Policy	CONF. ROOM G
P 2:00	Cameron Hyde	A Hybrid Solar Home Design With Radiant, Air-Heated Floors	CONF. ROOM H
P 2:00	Mike Bonoff	Your Solar Project and the Building Department; Your Sun Rights vs. Your Neighbor's Trees	CONF. ROOM G
P 2:30	Paul Bogen	Money-Saving Passive Solar Heat for a 20-Year Old Home	CONF. ROOM H
P 2:30	By & Marie McIntyre	Distilling With Solar and Wood Heat at Home: Legal Methanol (Alcohol) from Vegetation	CONF. ROOM G
P 3:00	W. Baden	An Inexpensive Home-Built Solar Water Heater	CONF. ROOM H
P 3:00	Perry Lovelace	Solar and Conservation Measures: Making the Best Choice for the Existing Home	CONF. ROOM G
P 3:30	Terry Egnor	Construction Details of the Bush School Greenhouse	CONF. ROOM H
P 3:30	Heather McCartney	Review of National Energy Performance Standards for New Buildings	CONF. ROOM G
P 3:30	Dundas	Northwest Design and Code Modifications for a Double-Shelled Home	CONF. ROOM F
P 4:00	Dean Martin	How Wind Energy Systems Might Work for You	CONF. ROOM G
P 4:00	Bruce O'Halloran	Solar Tax Credits	CONF. ROOM H

Plenary Sessions

Bob Royer, Deputy Mayor, City of Seattle
Welcome address

Bob Royer welcomed conference participants by praising those people who are getting involved in solar businesses today, while government continues to "wait until next year." The Deputy Mayor described the growing solar interest as a social movement whose essance is quality: quality motivates the people, and people motivate politicians and government. People are aware of the economic and safety problems associated with large central electric generation. They are seeking decentralized alternative over which they can have some control. Royer stressed the significance of SJR 120, the November ballot measure which if passed will allow public utilities such as City Light to finance customer investment in energy conserving equipment. He mentioned other City of Seattle projects involving solar energy,including the Odessa Brown Children's Clinic and a planned health and housing project on Sand Point Way. Momentum has begun with individuals who believe in solar. New leadership such as at City Light, TVA, and BPA is responding slowly with positive change.

Susannah Lawrence, Lobbyist, Solar Lobby, Washington D.C.
Keynote address on federal solar legislation and grassroots involvement

Solar Lobby was created in August 1978 at the First National Solar Congress. (The Second National Congress is being held August 16-19, 1979 in Boulder, Colorado.) The organization has 25,000 members nationwide and three full-time lobbyists based in Washington, D.C. Solar Lobby serves its members by disseminating information on relevant federal legislation. Efforts are also made to track political activities among grassroots organizations which are part of Solar Lobby's national information network. These organizations and individual members constitute a strong power base of which the national organization can draw. In addition to lobbying, Solar Lobby monitors other federal activity such as the writing of a model solar code funded by the U.S. Department of Energy.

Solar Lobby is involved with the rulemaking process to assure that existing legislation is implemented effectively. Input has been made to draft and final regulations for the small business solar loan program, the federal income tax credit for solar, and sections of the National Energy Act which deal with the residential utility conservation service and the schools and hospitals conservation program. Efforts focus on assuring that regulations are consistent with the original intent of the law, and that solar provisions are strengthened or added where possible.

Key pieces of new legislation for which Solar Lobby is working are passive tax credits (since it is unlikely that IRS regulations will change which exclude most passive elements from the existing credit); a solar bank to make low interest loans; and the Energy Management Partnership Act which would provide money to state and local governments for energy planning and implementation of existing programs such as those required by the NEA. Some effort in the coming year will focus on the 1980 elections to assure that the recent rhetoric of the Carter administration is translated into meaningful conservation and solar action.

Donald Aitken, Chairperson, Passive Division, ISES-AS and Director, Western SUN
Plenary Session on natural energy design, overview of solar heating and cooling, and introduction of WSUN.

Donald Aitken described numerous examples from the nature of energy and resource conservation, as well as a variety of passive space heating and cooling techniques. (The technical portion of his talk is described in "Natural Energy Design by Intuitive Wisdom", a paper presented at the 3rd National Passive Solar Conference, January 11-13, 1979, vol 3., which is included at the end of the plenary sessions.) Aitken then described the four regional solar commercialization centers established under contract to the U.S. Department of Energy. The Western Solar Utilization Network (Western SUN) serves the 13 western states and is headquartered in Portland. The 14 person staff will be expanded to 34 in December when WSUN moves into a passively heated office building.

Don described the WSUN staff as individuals who have been actively involved in a variety of aspects of solar development, such as passive architecture and wind electric generation. The organization wants to serve people in the Northwest, and welcomes suggestions for programs in 1980. (Submit your ideas and priorities to: Al Kiphut, WSUN Program Planning Division, 921 S.W. Washington St., Suite 160, Portland, OR 97205.) Because WSUN's mission is to commercialize solar technologies in the Northwest, Don said that once this goal has been achieved, the office can disband and its staff can go back into the field.

Richard Hill, Professor, Department of Industrial Cooperation, University of Maine
Plenary session on wood heating system design and performance

Professor Hill's talk is described in a paper "Stick Wood Furnace Research at the University of Maine at Orono", which is included at the end of the plenary sessions. Copies of the design manual for the furnace are available from Professor Hill, 109 Boardman Hall, University of Maine, Orono, Maine, 04473.

John Reynolds, Professor of Architecture, Solar Energy Center, University of Oregon
Plenary session on Northwest solar applications

Professor Reynold's talk is described in a paper included at the end of the plenary sessions entitled "Northwest Solar Architecture and the Influence of University Solar Design Programs".

Steve Selkowitz, Groupleader, Energy Efficient Windows and Lighting Program, Lawrence Berkeley Laboratory

Plenary session on programs in daylighting design, techniques, and practices

Efficient lighting in buildings can be achieved by: use of efficient systems and components; better design; better operation and maintenance; and use of natural lighting to complement the first three factors. Use of daylighting saves energy and therefore dollars, and improves the quality of light. However, there are technical and institutional barriers to use of daylighting. For example, the illuminating industry has opposed daylighting as it threatens to diminish use of lighting equipment. However, increased use of controls required for effective daylighting systems means that more jobs will be created in development and manufacturing of control hardware. Lack of professional education programs on daylighting is seen as a key barrier. Impact on electric utilities can be interpreted in several ways. Decreased energy use leads to decreased revenues, yet reduced peak demands are a benefit to the utility. The Lawrence Berkeley Labs are working with Pacific Gas and Electric to study impacts on the utility from daylighting, and alternative rate structures which could encourage use of daylighting in perimeter offices.

Selkowitz' focus is on commercial buildings in which daylighting is often the largest component of energy consumption. Sources of daylighting include direct sunlight, and light reflected from the ground, cloud cover, and structures. A variety of design techniques such as skylights, clerestories, and reflectors, as well as vertical glass, enable light to enter a working space. Numerous quantitative approaches have been developed to determine daylighting levels for commercial buildings. The Lawrence Berkeley labs are currently studying a method to convert solar radiation data into illumination data.

Two major tools for calculating daylighting levels are: 1) the daylight factor method and 2) the lumin method. According to the daylight factor method, ratios are developed of light at certain points in the room to light received outside. Levels of daylighting (from the sky, external obstructions, and reflections from surfaces in the room) can be determined for any window or room configuration, and shading devices can be considered. The technique treats cloudy conditions more effectively than clear skies, although work is being done to improve this. The lumin method is based on empirical models which include both clear and cloudy skies, but only a limited number of standard window and room configurations. The technique is the most widely used today, and is available from Libby-Owens-Ford distributors for a small charge. According to the lumin method, illumination is a function of daylight available at a window (from the sky and ground), transmission through the window, and a coefficient of utilization (given on tables) which varies with season and window orientation. A strength of the technique is that it is simple and straightforward.

About 60 approaches, many computerized, exist for calculating daylighting levels in buildings. Variations in the techniques and the assumptions on which they are based can lead to radical differences in calculated values of daylighting in a particular room. Once daylighting is calculated, a critical step is integrating natural lighting levels with artificial lighting through a control system. Tradeoffs exist between dimmable and on/off systems, and manual and automatic controls.

Energy savings of 50 - 80% can be achieved through daylighting in perimeter rooms. In addition to energy impacts, the quality or visual comfort of natural lighting should be considered. However, daylighting cannot be analysed in isolation, as windows and building configurations will affect other components of energy use such as space heat. The Lawrence Berkeley Labs publish a periodical, "Windows for Energy Efficient Buildings", which includes state-of-the-art research, products, etc. Send a self addressed stamped envelope for copies to: Steve Selkowitz, Lawrence Berkeley Lab, 1 Cyclotron Rd., Berkeley, CA 94720.

Anna Fay Friedlander, Editor, Solar Engineering Magazine

Plenary session on directions taken by the solar energy industry to develop a solar market

According to Friedlander's introductory comments covering a range of solar statistics, approximately 7.5 million square feet of domestic hot water collectors and 7 million square feet of swimming pool heating collectors have been installed. Such figures do not include passive systems and therefore significantly underestimate solar market penetration to date. $35 million have been issued in solar tax credits on the federal income tax according to preliminary data. Census Bureau statistics indicate that 1% of all new buildings are solar. Domestic water heating collector manufacturers comprise the largest segment of about 4,500 firms currently in solar collector manufacturing.

Can the industry meet the challenge of Carter's 20% solar goal by the year 2000? Currently the industry has excess capacity; products are proliferating and installation time has decreased. However, a consumer market has not developed on a large scale. A major question as the industry develops is to what degree will large firms be involved. Solar heating and cooling and related technologies such as controls, are ideally suited for small business. Whether or not the market ever becomes dominated by large firms, there will always be a need for local and regional firms. Advantages of larger firm involvement include their ability to mass produce and bring prices down; sufficient resources to carry out research and development; and their interest in long term investment rather than short term profit. While Exxon, GE, and Westinghouse are considering involvement in the solar field, such firms as Alcoa and PPG have left the industry in part because they do not see a role for a national industry.

Many small firms are entering the market now as both manufacturers and installers. As the market expands it is likely that more specialization will occur. For example, we are beginning to see trained installers, some trained through manufacturers and some through federally-funded community college programs.

The large firms with an interest in the solar market have made diverse predictions about where the market will be and what kinds of products will succeed. For example, Grumman describes the solar consumer of the future as an emotional consumer, interested in a reliable energy source at any price. Such firms as Westinghouse and Lennox predict that the heating, ventilating and air conditioning (HVAC) industry will be the major supplier of solar technology. The HVAC industry has the resources, plant, and dealers, and they predict that consumers will not want to deal with more than one individual or firm for all of their heating and cooling needs. Exxon is pushing for utility leasing of solar equipment, while GE is considering using its established distribution network to market evacuated tube collectors. Fafco, a medium sized firm, is the dominant producer of low temperature collectors, primarily for pool heating. They are also studying a low cost space heat system using a solar assisted heat pump. Other firms are focusing on the international market, which is especially appropriate for photovoltaic electric generation in remote areas. Firms exploring this option include such oil giants as Shell, Mobil, Exxon, and Atlantic Richfield.

A number of institutional barriers remain to widespread use of solar systems. Problems associated with availablility of capital may be alleviated by such federal actions as passage of the solar bill, and the currently available SBA loans to solar businesses. Questions related to resale values, aesthetics, and sun rights have been raised, although they seem solvable. Banks need more information on solar products. WSUN could play a useful role in this critical area of public education. Compliance with standards and provision of warrantees mean added costs, although they attempt to assure quality products and consumer protection. There is industry concern that each state will require product testing and labeling which would add significantly to costs of products sold in more than one state.

Wayne Nichols, developer and Susan Nichols, designer/builder, Sante Fe solar subdivision specialists
Plenary session on designing, developing, and marketing the passive solar subdivision

In Sante Fe, New Mexico 15 -20% of all new custom housing starts are passive solar, a trend which Wayne Nichols predicts will occur throughout the country. Wayne and Susan's small company, Communico, includes engineers, designers, builders, and their own construction crew. The interdisciplinary team makes passive subdivision building considerably easier. The Nichols' first subdivision (First Village) included eight active and passive solar heated homes. The passive houses cost one half what the active houses did, and they required no maintenance compared to frequent call backs on the active systems. Los Alamos Labs monitored the homes and performance was superior in the passive designs. The team decided to stick with passive.

Passive solar homes are a real estate product. Marketing solar homes can give a competitive advantage over conventional homes. However, a solar designer or builder must understand real estate development practices, financing, location, and sales taxing. Wayne Nichols strongly recommends that interested builders and developers establish their reputations in solar early on while the technology is still in the innovative stages, but is nearing a time of significant growth. Opportunities for success are in the local market.

A profile of buyers by family size, income, and taste is useful. Profiles done by the Nichols , SERI, and Franklin Institute indicate that solar buyers are generally young (30-45 years old) with few children or 55 years or older, active retired. These persons are generally higher income, self-employed or professional, well educated, and concerned with environmental quality. Components of marketing the passive solar home include selling the image (of something new and socially desirable); comfort (of a high quality radiant heat system); and energy performance (the solar consumer is generally interested in engineering detail).

Site planning is as important as building design in the passive subdivision. Another subdivision in Sante Fe on which Communico is working is a 19 unit planned unit development. This more flexible siting approach has been used to form cluster housing and large open spaces with indigenous vegetation left intact. Four model passive homes range in price from $75,000 to $125,000, and provide 76-90% solar heating. It was discovered in marketing the houses that the buyers generally like to be involved in designing at least some parts of the house. Because the Nichols' employ their own construction crew, the crew is very aware of the importance of tight energy conserving construction for passive solar success. Some detail on passive designs and construction techniques was given.

Wayne recommends that the solar developer involve the community as much as possible. The Los Alamos Labs and the local private utility have been monitoring the Nichols' homes, and the utility has provided some financing. The passive systems benefit the utility by decreasing peak electric loads. Financing is one of the most difficult aspects of solar developing. The first sale is to the appraiser who must be educated about passive solar with thorough cost and performance data. The lender should be matched to project size. While the local savings and loan company is sufficient for one or two houses, the Federal National Mortgage Association (Fannie Mae) should be considered for projects of five or more units.

NATURAL ENERGY DESIGN BY INTUITIVE WISDOM

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ABSTRACT

The thesis is advanced that the source of passive solar design wisdom spans all human history and crosses all life forms, allowing us to find a spectacularly efficient basis for our current solar home design work in our human heritage from centuries ago and a common foundation for our design solutions in the efforts of both human and nonhuman life. To the extent that "evidence" is appropriate to an inherently esoteric thesis, examples are given of remarkable natural energy design by ants, termites, bees, birds and Native Americans, with extrapolations to underscore parallels with contemporary solar home designers. Human intelligence does not seem to be as great a factor as "intuitive wisdom", by which human intuition and animal instinct merge indistinguishable. The contemporary solar architect is discussed in light of this analysis.

PREFACE

The following material was presented to the Third National Passive Solar Conference to set the stage for a state-of-the-art progress statement by Jeffrey Cook, a historical perspective by John Yellott, and the theory of the application of "passive" solar design techniques by Doug Taff, John Hayes, David Wright and Scott Matthews. This session, entitled "Passive Realization", was concluded by an inspirational example of the joy of occasionally allowing creativity in passive solar design to have an entirely free reign, as Scott Morris described his passively-heated solar balloons.

This combined effort, which constituted the morning public (plenary) session for the last day of the conference, was based almost entirely on beautiful visual representations by each speaker. Consequently, the primary thesis of this particular paper was also developed as much on the basis of visual evidence as it was on verbal reasoning. Since almost all of this visual support was drawn from copyrighted material, no attempt has been made to reproduce it here. References are provided to lead the reader to each of the original sources for the slides shown, so that this material may again be assembled in its total form by others, while providing the reader with the opportunity to delve further into this marvelous subject.

1. THE THESIS

My own increasing experience in natural energy (= "passive solar") design, along with my expanding contacts (and friendships) with others creatively at work in this field, causes me to assert that the primary ingredient in this kind of design process apparently arises from what I choose to call "intuitive wisdom". While the conscientious designer will first take into account the local microclimate and seek to meet specific needs as directed by the client or the intended use of the structure, the synthesis of the product still appears to emerge almost whole in the mind.

It sometimes appears that the mind, after assessing the particulars of the task, reaches into a pool of available solutions and draws out the most nearly appropriate one. Subsequent design work clarifies first indications that were dim, and even alters some of the first design ideas, but remaining basically unaltered is the primary whole concept as the mind first offers it up, the intuitive solution which guides, rather than follows, mathematical analysis. And yet the individuality of the results in passive solar architecture appears to bear to the consistency of a common underlying design wisdom as does the striking individuality of snowflakes bear to the consistency of the snow-covered field.

The thesis of this paper is that the source of passive solar design wisdom appears to span all history and to cross all life forms, allowing us to find a spectacularly efficient basis for our current solar home design work in our human heritage from centuries ago and a common foundation for our design solutions in the efforts of both human and nonhuman life. I shall therefore argue that natural energy design as understood, for example, by contemporary passive solar architects, by Native Americans and by termites arises from a genetically shared solar wisdom, revealed to humans by what we call intuition and to nonhumans by what we (but probably not they) call instinct.

2. THE EVIDENCE

2.1 Early Lessons From Two Wrights

I first experienced most of the best elements of natural energy architecture in my teen years, as I courted Elizabeth, my wife-to-be, in the beautiful Frank Lloyd Wright home in Middleton, Wisconsin, built by Herbert and Katherine Jacobs (1). I knew then that Mr. Wright designed according to what he called the principles of "organic architecture", but it was only later that I learned that that particular house, designed for the southern Wisconsin climate in the winter of 1943-44, had been named by its genius architect the "Solar Hemicycle."

The Jacobs home functioned with remarkable effect to provide heat in the winter and coolness in the summer and to ward off cold winter winds while introducing cooling summer breezes. It featured some of the best contemporary passive solar design principles, such as solar gain directly irradiating thermal floor mass. In addition, the home features considerable thermal mass energy storage well coupled to the interior spaces, earth-berming to temper the home's climate, client and natural beauty developed not according to the expansive principles of nature's organic lessons.

I first understood what I had earlier experienced as I later began to study and appreciate the work of modern solar architects and as I began to develop my own design and teaching capabilities and experience. David Wright, for example, who shares a last name but no relationship with my earlier inspiration, began creating solar home designs in New Mexico, utilizing purely passive climate control techniques, thirty years after Frank Lloyd Wright's pioneering solar design on the Wisconsin prairie. While both employ many of the same fundamental design principles, David Wright's creations obviously reflect his own artistic individuality. The common bond between the two Wrights is not revealed in enormously different stylistic approaches, but rather in a design process that invokes nature's lessons.

When David Wright does give credit for his architectural inspiration, it is to the cliff-dwelling Anasazi Indians of the American Southwest (2). I knew Frank Lloyd Wright, and I know David Wright, but I could only "know" the Anasazi through my own pilgrimage to the crumbling evidence of their design wisdom (3). As I stood amid those ruins, and again as I later reflected upon that experience while studying the archaeological interpretations of the remarkable natural energy functions designed into those dwellings (4), a new awareness emerged with full conviction: the Anasazi, Frank Lloyd Wright and David Wright all shared the same knowledge, although they had come upon it in different ways and over a thousand-year span of time.

I then began to wonder if the basis for that knowledge might also be as independent of human experience as it is of time. In this view, a hierarchal placement of "intelligence" as applied to natural energy design loses all meaning, and it ceases to be distinguishable whether one looks "forward" or "backward" for the wisdom to design for today's needs.

2.2 Natural Energy Design in Nature

It may seem redundant to refer to "Natural energy design in nature", for anything accomplished in nature without human intervention or assistance is, by definition, "natural." But what we often call "passive solar" design is actually understood by its practitioners to encompass all aspects of natural energy design. Without such a broad definition any comparisons of natural cooling and humidifying or dehumidifying techniques that could further strengthen the similarity of human and nonhuman architectural approaches to achieving habitat comfort would be precluded. This would be as limited as a design that seeks only to provide solar heating in the pretense of yielding year-round dwelling comfort. "Natural energy design in nature" will simply allow us to discuss nonhuman approaches to our total design task.

In the paper entitled "Introduction to Passive Solar Design: Nature's Lessons", W. Douglas Davis admired the diversity and sophistication of nature's approaches to the efficient collection and utilization of solar energy in support of the primary processes of life (5). He also extrapolated the affinity of some creatures for seeking warmed "thermal mass" to the clever use of the "thermal mass within the insulated envelope" concept by native peoples building in harsh climates. But it is in a reference common to both Davis' paper and this one that one finds an outstanding specific focus on animal architecture as a means for providing habitat comfort and function. In his book on "Animal Architecture" (6), Karl von Frisch notes:

> "The most usual purpose of building activities in animals is to make a home that will give protection. Such a home may be constructed for the building animal itself, for its progeny, for the family as a whole, or, by social cooperation, for large colonies as, for instance, in the case of social insects. The enormous morphological differtiation of animals and the great differences in their needs and faculties are reflected in the great variety of homes they build. (7)...
>
> Insects are by no means 'low forms of life', though this is a description often given to flies and wasps...In certain respects their performances are even superior to our own. It will, therefore, come as no surprise to learn that some of their structures are highly original, that they frequently differ in their materials and manner of construction from those erected by vertebrates, and that they may reach very high levels of perfection." (8)

Frisch proceeds to describe the construction of ant hills as "passive solar collectors", with additional heat provided when necessary by ant bodies warmed in the sun (9); he describes massive termite mounds above the ground, precisely oriented with flat sides facing east and west and narrow sides facing north and south, to promote almost uniform daily solar heat gain, apparently spaced so that shadows from these passive "collectors" do not fall upon others, and with careful cyclic redistribution of building materials to promote dehumidification and the prevention of the growth of mold (10); he describes the construction of well-insulated bee combs with a geometry designed to minimize total resource (and hence embodied energy) consumption while maximizing volume and function, supported by dwelling for mold prevention, and boosted when necessary by bees fanning their wings to promote proper air circulation and drying (11); and he notes that wasps will stretch and contract their abdomens in vigorous muscular exercise to generate additional heat as needed in breeding combs, or will provide evaporative cooling of the cells by moistening them when the temperature is too high. The result is a constant temperature (86°F) with a precision appropriate to the incubation needs of the larvae. (12)

Frisch further describes the actions of some remarkable birds in building nests which are first internally heated by the decay of carefully constructed compost heaps into which the eggs are laid, and then by the meticulous control of heat flow, both outward from the compost decay and inward from solar heat gain, through the constant varying of internal nest ventilation and the thickness of an internal insulating layer of sand (13). As both compost action and solar heat gain diminish during this strenuous eleven-month activity by male and female, the surface area of the sand is proportionately increased by spreading it on the ground during high-sun hours to maintain the solar energy stored in the sand thermal mass at a sufficient level. The result is that the temperature at the egg level varies by no more than one degree Centigrade.

Throughout these expositions Frisch continues to marvel at the precision by which these results are achieved and, whenever possible, to note similar solutions by widely varying forms of life (e.g. thermal control of the nest by both crocodiles and brush turkeys) or differing solutions by morphologically identical species (e.g. termites) living in different microclimates (14).

Perhaps the "ultimate" in precise thermal and moisture content control, though, is achieved by dwellings which automatically vary their own geometry in response to external temperature and radiation. The action of the California poppy in this regard, and hence chosen as the symbol for the Third National Passive Solar Conference, is a good example of minimizing collection in the thermal mass of the blossom during solar availability while simultaneously reflecting solar energy into the important inner portions of the bloom. The careful storage of heat thus obtained and moisture is accomplished by the complete enfolding of the flower by its own petals within a few minutes after the cessation of sufficient solar gain. Mosquitos on the North Slope of Alaska are often seen taking personal advantage of this kind of internal reflection within tracking, concentrating flower "collectors" by sitting at the flower's focal point.

> "Scientists take it for granted that these structures perform a vital function in the lives of their owners--only what is of proven biological value will develop and survive over long periods. The fact that they appear at

the same time as objects of perfect beauty is something I gratefully accept as a gift of nature..." (15)

2.3 Natural Energy Design in the American Southwest

The history of native architecture in the Southwestern United States is one of differing period during an estimated 12,000 to 14,000 years of occupancy. In the southern Colorado region of Mesa Verde the resident natives apparently dwelt in the now-famous cliff-dwellings until 1,200 years ago, when they moved for a time out onto the mesa. About 1,000 years ago they moved back into the cliff dwellings, and perfected their architectural art. The most successful of the cliff dwellings are those (e.g. Longhouse Pueblo) that face south, and the evidence is that, when living on the mesa, the regional inhabitants grouped their houses in rows with a crescent shape that opened toward the south.

Merely facing a dwelling toward the south, though, is not sufficient evidence to suggest that members of Homo Sapiens also carried in their genetic fabric the capability for realizing the finely tuned, sophisticated solar architectural art achieved by many nonhuman forms of life. An argument for this might be better if, without the aid of University classes, conferences and computers, the Native Americans accomplished a deliberate control of energy flows in the promotion of year-round dwelling comfort that would challenge the best of today's "advanced" technology and minds in an effort to approximate those results. Such was the case.

The outstanding energy study of southwestern native regional architecture, presented by Ralph Knowles and his students (4), dwelt on three major structures: the Longhouse Pueblo (a true cliff dwelling); the Acoma Pueblo, located on top of a mesa and still occupied after about one thousand years of sensitive climate control; and Pueblo Bonito, the remarkable example in Chaco Canyon of a total multifamily design consisting of 800 rooms for perhaps 1,200 inhabitants (3). Each of these design approaches solved the passive climate control problems differently, with evidence of an evolving degree of sophistication.

Each of these design approaches additionally respected completely the "solar rights" of all inhabitants in gaining thermal comfort, access to interior illumination and to cooling breezes, and in the uninterrupted illumination of work areas, apparently without the benefit of solar rights "legislation". Today's mandating of protection for one another from one another seems to have been accomplished back then by a policy of voluntary cooperation and total design in the interest of the community.

In all cases studied by Knowles and his students the dwellings were designed in such a way as to increase solar gain in the winter as compared to summer and to equalize the interior energy profiles (stabilize the interior climates) during the day and across changing seasons. This was attained in the "new" Bonito construction to such a remarkable extent that the same structure transmits an absolutely constant amount of thermalized solar energy to the building interior from 8:00 AM to 4:00 PM during winter months, while diminishing both total heat gain in the summer afternoon relative to the summer morning, the latter to compensate for higher afternoon air temperatures. This is all accomplished with fixed architectural components--no daily or seasonal moving parts. It represents absolute perfection in functional natural energy design (16).

The thermal performance of these remarkable dwellings is accomplished in part by orientation, in part by spatial design, and in part by a careful selection of materials. For example, today's computer analysis suggests that a minimum-energy orientation on a year-round basis for simple, exposed dwellings in this region would be with a long axis in a generally east-west direction and a short axis oriented about 25^{o} east of south. The thousand-year-old Acoma Pueblo orients its rows of houses slightly east of south, and the even more ancient "old" Bonito construction orients its radial axis about 30^{o} east of south. The Bonito orientation was converted to due south in the later construction stages of the "new" portions, with the heights in the buildings on the rear and end portions of the structure providing controlled heat gain through illumination and shadow patterns, substituting more intricate design controls for mere spatial orientation.

Construction materials were chosen by the Indians to provide both maximum heat retention and transmission for winter heating, and minimum heat retention and transmission for summer-illuminated portions. In addition, the function of the interior spaces was matched to the interior microclimate (17).

All of this is perhaps as remarkable as the accomplishments of the termites on the Australian steppe, for the similarities of approach and results are striking. The termites, too, utilized orientation and materials to control heat gain and transmission, and carefully selected the interior function to match interior microclimate. To the best of our knowledge, though, neither the Australian termites nor the North American Indians knew of the other's activities or results. The evidence, nevertheless, is that indeed both "knew".

2.4 Contemporary Natural Energy Design as a Continued Expression of a Living Heritage

Richard Stein, in his fine book on "Architecture and Energy", (18) begins his chapter on "A History of Comfort With Low Technology" with the observation

> "If we turn our attention...back in time, we will note that virtually all vernacular buildings--those that developed identifiable regional or local characteristics --were solar buildings, that is, buildings whose basic form and material were carefully refined to introduce solar heat when it was advantageous, to keep out the hot sun when it was undesirable, to defer solar heat's impact, or to store the sun's heat until it was more essential to the occupants. Our building history is a history of solar architecture." (19)

That theme is expanded in this essay to suggest that not just our human history, but our living history, is a history of solar architecture. This being the case, we might find suggestions that our modern passive solar architects are still drawing upon the architectural lessons of life as well as culture.

For example, let us imagine a home designed to utilize the principle of oriented thermal mass for the capture of solar radiation, in the manner of the termites; let this capture be controlled with insulation and ventilation that we can vary at will, such as the Thermometer Bird or the poppy; and let us include the bees' approach toward grouping geometric units to maximize internal space with minimum use of external resources. We have just derived Steve Baer's 1971 house (20).

Or, let us take a closer look at the physics wisdom of the mound-building termites. One actual solution to the provision of fresh air and to the exhaustion of humidity from African mounds housing perhaps two million active termites is to provide a network of passages riddling the material close to the surface. The flow of air through the mound and the passages is promoted both by heat given off by the termite bodies and by heat generated in small fermenting compost heaps prepared by the termites deep inside their mounds. The gravity power necessary to circulate the air is provided by the cooling of this warmed air in the near-surface passages during the process of oxygen and water exchange to the outside (21). We have just generated architect Lee Porter Butler's "envelope" approach to wintertime climate tempering of the interior of his passive home designs, only with the substitution of solar heat gain for the termites' compost-derived heat (22).

An alternative solution by morphologically identical termites living in a different African country is to replace the dwelling skin air passages and closed-loop air circulation with an open system. Starting with the introduction of air from the outside into porous regions directly beneath the nest, the humid, carbon-dioxide-laden air is ultimately exhausted from a port at the top of the mound. This process is again energized by the heating of the dwelling from its base level, through composting, while the gravity power to drive it arises in the displacement of the less dense warm interior air by the more dense cool exterior air (21). Here we have just derived Lee Butler's "envelope" approach to the summertime climate tempering of the interior of his passive home designs (22), again only substituting the heating of the sun for the termites' compost-derived heating.

The differing solutions derived by the same species of termite living in two different areas of Africa are completely parallel to the different solutions derived by a contemporary passive solar architect for two modes of operation of the same dwelling to match seasonal requirements. A further comparison is in Lee Butler's use of the inner and outer surfaces of his passive dwellings to provide a resource for the transmission of humidity from the interior to the exterior. This is already parallel to methods employed by humans in ancient times, as well as a complete parallel to one of the termite solutions.

One can always point to such similarities as happenstance. Certainly neither Steve Baer nor Lee Butler sat down to design a passive solar dwelling and first asked himself, "Now how do the ants, termites, bees and birds do it?" The thesis here, again, is that they didn't have to: They knew. The creative process of design provided the conditions for tapping this well of universal wisdom.

If some kind of direct evidence is needed to support such an esoteric thesis, perhaps it lies in Lee Butler's steadfast defense of his novel thermal design approach in the face of early criticisms by those who drew on their "knowledge" of physics to suggest that it couldn't (or wouldn't) work. Lee knew it would, and didn't need the observations in various winter climates that have subsequently proven that his predictions were, if anything, conservative.

If blind termites can know across the boundaries of space and time that each is contributing to a perfectly designed and oriented passive solar collector which is on a scale to them as would a mile-high building be to us and placed in non-conflicting juxtaposition with those being built by other termite colonies, then are we to suppose that humans are so inferior that we, too, cannot "know" across space and time that our design approaches are correct and appropriately engineered to a worldly balance of life, resources and energy?

2.5 A Possible Unifying Element

Both Karl von Frisch (6) and Ralph Knowles (4) considered the evidence for the apparently precise execution of a design "plan" without any apparent means for "planning", von Frisch concerned, of course, with forms of life which presumably don't possess such reasoning powers, and Knowles with early Americans who didn't have access to our wonderfully complex modern planning techniques. They arrived at different views.

Regarding Longhouse, Knowles admitted

> "It is difficult to believe that they worked from a plan. The arrangement is too complex and the buildings too specialized in their siting. On the other hand, it is reasonable to belive that they...did not hold to some general notion of the advantages to be gained from a southern exposure." (23)

In analyzing the more sophisticated design solutions revealed in the Acoma Pueblo, Knowles observed.

> "As with Longhouse, the study raises a question of the Acomas' purpose, their conscious intentions. Were they aware of what they did? Did they build a purposeful system, a machine for equalizing seasonal extremes?
>
> The nature of the house would suggest that they were aware and did act purposefully." (24)

Finally, while still marveling at the unbelievable accuracy of the design of Pueblo Bonito, Knowles considered

> "It is difficult to attribute such particular relationships to chance...The quanitification of such visual phenomena in energy terms strongly suggests that the Bonitians were aware of the relationship between the form of their constructions and the dynamics of earth and sun; in fact, they must have worked from a fairly distinct mental image or even from a two or three-dimensional physical model of form.
>
> The evidence is convincing that they had a plan of action...What the Mesa Verde Indians accomplished with cave dwellings and the Acomas attained through the use of a highly developed generative increment, the Bonitians realized through the systematic generation of total form...The full realization of purpose had come with the completion of the form. They were powerless to reach beyond this level." (25)

Frisch's analysis allowed for a freer interpretation of what might have been as the marvelous Indian structures were being constructed:

> "When human beings start to build, they first make a plan and try to find the best solution for each individual case. Animals do not need all that. They follow innate drives. Even the greatest architects among them work correctly by instinct. (26)
>
> ...And yet their finished structures seem evidence of a master plan which controls the activities of the builders and is based on the requirements of the community. How this can come to pass within the enormous complex of millions of blind workers is something we do not know. One can try circumlocution with learned words, but I think it is better to say, quite simply, we do not understand. Here, as so often in the science of life, the investigating human spirit must bow before the unknown." (27)

I do not see any difficulty at this juncture with the adoption of a little species humility. We are often told that one thing that sets humans apart from animals is that "they" go on instinct. while "we" operate on reason. Is it not possible that residual instinctive lessons might still be available to us, in helpful guidance whenever we choose to let our efforts conform to natural law and to the requirements of a living world? Would not a perfectly-functioning passive solar home derived in part from instinctive wisdom and consistent with natural beauty measure up to our highest engineering and artistic achievements? Frisch observes

> "We humans are proud of our inventions. But can we discern greater merit in our capabilities than in those of the master builders who unconciously follow their instincts? The evolutionary roots of human behavior reach far back into the behavior patterns of animals." (28)

If there is a unifying element in all of this, perhaps it lies in a larger interpretation of the nature of the plan by which we act. We may never know from what reaches in space and time this "plan" is derived, nor how it is transmitted to us in ways that can influence our actions or steer our creativity. Is it possible that Native Americans a thousand years ago did not work from a plan in the normal, mechanical sense or, alternatively, must it trouble us to conclude that their actual creative techniques may forever elude out intellectual inquisitions,

just as today's creativity still cannot be explained by a computer? What is the process by which intuition serves us? What are the limits of intuitive knowledge?

In admitting, as did Frisch, that "we do not know", we may open ourselves to full knowledge without obstruction from objective, "reasoned" notions as to how and why living things, including humans, act. Indeed, as suggested earlier in this essay, "plan" might be metaphor for "life":

> "When we stand before great churches, temples, pyramids and other works of architecture built hundreds, if not thousands, of years ago, our minds are filled with awe and admiration. Yet there have been architects millions of years before that. Their work, it is true, owes its existence not to the inspired genius of great artists, but to the unconscious, unremitting activity of the force of life itself..." (29)

3. THE LESSON: ON BEING A HUMAN SOLAR ARCHITECT

If the thesis of this essay has been made with any conviction, that is, that our purest solar home designs may originate in a resource of intuitive widsom which we share with all other forms of life, and if my urging for a little humility in view of the awe-inspiring solutions by nonhuman and pre-technological human architects is taken seriously, then we may wonder whether we, today, really have anything at all special to add in a contemporary human architectural expression of repetitious, inferior emulations of prior or natural perfections? Only if we choose to be.

Perhaps worse, we may choose inferior architectural forms which no longer serve the natural principles by which they were conceived. An example of this is the recent Navajo technical simplification of Hogan roofs to use asphalt shingles over wooden deck roofs, with a resultant loss of energy efficiency and comfort in both winter and summer (30). Contemporary western home and building designs in general appear to epitomize the worst realization of such a divorce of function from form. It is a tragic cultural denial of our better capabilities.

"Intelligence", in the tustomarily accepted sense, does not appear to be the key in accomplishing the design of dwellings with astounding comfort control by natural means. Human solutions may be fully as clever, but apparently not more clever, than those of termites, or bees, or birds. Furthermore, even termite architecture varies from simple to complex without any apparent concomitant difference in the number of nerve cells--normally taken as a sign of relative species "development" --between the different termite builders. And the sophistication and relative scale the building results of bees, wasps and ants, even though the latter not only possess a greater number of nerve cells than the termites but also possess the association-forming "mushroom body" (only a poorly developed feature in termites) which is thought to promote social (i.e. cooperative) behavior (31). We cannot turn to our favorite anthropocentric observation about the "superior" intelligence of human beings or the complexity of our nervous systems to gain any inherent species advantage in our capactiy to design buildings and to use natural energies.

We might then argue that our high degree of cerebral development allows us and only us to introduce creative variants into our designs, and to have an aesthetic appreciation along with a functional perception. But we also see both in nature. The bower bird, for example, designs a spectacularly beautiful bower in which to woo and seduce his mate, but which is not used as a nest. He carefully places colored berries and objects in patterns around the entryway, paints with berry juices, regularly steps back to study the effect and varies the design as he goes along until he is pleased with the result (32).

The fallacy of an attempt toward defining what we might reserve as intrinsically "special" for contemprary human architects is in seeking something that we may point to as being our unique creative realm in the living world. I doubt that there is any. What we must really do is seek ways in which we allow ourselves to be fully human, to realize to the fullest the total creative potential that we have and to synthesize our experience in ways which may not be unique or superior behavioral variants, but which nevertheless define the special nature of the individual. As snowflakes represent solutions to a common design task with such rich permutations that the results are unique to each flake without the loss of perfect beauty, so can we draw upon natural law and experience to arrive at architectural solutions which are not only perfectly functional examples of natural energy design, but which are also beautiful expressions of the uniqueness of the individual designer.

A trend toward creative individuality in association with cerebral development was noted by Frisch:

> "...among certain highly developed birds and mammals, the factor of individual achievement is added, and an animal's own experience may lead to exceptional individual solutions." (33)

Our very high level of cerebral development, then may well provide a gift of a spectrum of opportunities for creative, individual architectural solutions that is very much greater than the number of individual variants available to "lower" mentalities (but apparently not as compared with snowflakes).

Our "uniqueness" as human architects is then perhaps seen in our almost limitless spectrum of the physical fact of each result. If this is indeed the case, then we must wonder all the more at the architectural perversion that causes us to design monotonous boxes and faceless towers, all unimaginable proportions.

In no way is the opportunity for creativity in individual architectural solutions diminished by constrianing our dwelling designs to yield overall comfort through natural means. Even the bower bird in us is beginning to emerge in the manner of bringing soft illumination through roofs or walls in stained glass windows inserted, for example, into the roof of Steve Baer's drumwall passive solar home (20), or into the wall of David Wright's passive solar home at Sea Ranch, California, or into Ron Shore's trombe walls in his Colorado houses (34). Ron Shore also allows his bower bird self to extend to colors for his solar absorbing surfaces, preferring a slight loss in system efficiency in favor of the artistic totality and individuality of the result.

The fundamental relationship between all of nature's builder's is the application of common principles to individually-varying circumstances. It is this that links termite to human, and past to present. Toward this end, Stein wrote

> "In previous times there was an inseparable interrelationship between the purposes of buildings and forms. These forms expressed and were the result of principles that still apply. By indoctrinating ourselves with the principles rather than the forms, we can learn from the past.
>
> ...the buildings of tomorrow will look different because they will be different, just as the occupant of one will be different from the occupant of the next." (35)

4. THE THESIS REVISITED

If, as a species, we are collectively to realize a measure of our "higher" intelligence, it will certainly require that we accept into our scope of intellectual resources the wisdom offered by our companion forms of life.

"Intuitive wisdom" provides human access to that composite resource. The manner in which that wisdom is drawn upon and expressed identifies the uniqueness of the individual. It would appear that passive solar architecture--"natural energy design"--might be a new pathway to this nobler realization of our universal creative selves.

5. ACKNOWLEDGEMENT

I wish to express my special gratitude to Herbert and Katherine Jacobs for introducing me to solar architecture and to their daughter Elizabeth, for both continue to inspire me in gentle and warming ways.

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(13) Ibid, pp. 177-183 (Thermometer Bird brood illustration p. 180).
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(27) Ibid, p. 150.
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(32) Ibid, pp. 236-247 (colored photograph on p. 236).
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STICK WOOD FURNACE RESEARCH AT THE UNIVERSITY OF MAINE AT ORONO

Professor Richard C. Hill

THE PROBLEM OF BURNING WOOD

A series of very complex time-and-temperature-dependent chemical reactions accompany the burning of wood. To supply the correct amount of air is difficult; to control the output to match a particular heating load is impossible. This difficulty in carburetion and control is compounded by difficulties in ignition. The pyrolysis gases generated from heating wood have an ignition temperature between 725°F (methanol) and 1128°F (carbon monoxide). Since stove surface temperatures do not operate in this range, much of the gas distilled from wood is vented to the chimney with three unhappy consequences:

1. the loss of energy
2. the pollution of the atmosphere
3. chimney condensation with subsequent fire hazard

As a stick of wood is burned heat is transferred from the surface to the interior with a counter flow of pyrolysis material. The kinetics of the reaction depend upon

1. surface to volume ratio of the stick
2. surface temperature
   a. radiant field
   b. convection field
3. wood moisture
4. specie
5. rate of air supply
6. rate of ash removed from the burning surface

Given this complexity the only design approach is to cut and try. The only design rule is to keep the combustion zone hot and turbulent for a sufficient time to complete the reaction.

At the start of the present work we tried several arrangements of all refractory combustion chambers without real success. Regardless of how we introduced the air or stacked the wood the radiative capacity of the refractory would force carburetion problems that would sometime result in explosions strong enough to lift a 20 pound cast refractory charging door.

The present design uses a water-jacketed combustion chamber with a refractory base. The combustion air is introduced at several inches of water static pressure. The resulting high velocity impingment on the burning wood tends to blow away the ash formation on the surface, expose unburned material at a fairly constant rate, and promote a constant rate of heat release.

The flame leaves the refractory base through a refractory tunnel 7 1/2" wide, 3 1/2" high and 14" long (the unit will burn about 25 lb of 20% moisture wood per hour). The length of the tunnel is important:

1. the incandescent tunnel walls are necessary to provide ignition for the small drops of tar and carbon that are driven from the wood.
2. the heat exchanger must "see" the flame for radiant heat transfer, but the flame must not be quenched by the walls of the heat exchanger or carbon deposits will result.

The present configuration does not pay a penalty for carbon deposits which means that the heat exchanger may not absorb as much radiant energy as would be possible with a shorter tunnel.

The ideal design would allow the flame to reach the heat transfer section for good radiant transfer, but without impinging on the surfaces to force the loss of ignition.

PERFORMANCE

During the firing cycle excess air will range between 30% and 50%; the stack temperature between 350 and 400°F. If the wood has 20% moisture on a wet basis the efficiency will be about 80%. This is based on an "input" of 8,600 Btu per bone dry pound and losses based on the enthalpy of the stack gas at the heat exchanger exit. The fraction of useful energy that enters the water jacket is uncertain as we have not yet insulated the heat exchanger or storage tank. But each pound of wood burned will force a one degree F temperature rise in the total system which is about the equivalent of 600 gal of water. This rise will be higher once insulation is installed. A 20 ft section of 6 inch smoke pipe between the heat exchanger and chimney drops the temperature 150°F resulting in a four point improvement in efficiency. As additional heat transfer surface is added a point will be reached when the increasing pressure drop and decreasing stack bouyancy will require an emergency battery operated ID fan to keep smoke from entering the building in the event of a power failure.

There are no problems with carbon or tar deposits on the heat exchanger in spite of some hostile testing procedures. City water at 60°F was introduced into the heat exchanger and discharged at 120°F. Most of the surface is therefore below the dew point of the water vapor in the stack gas. After a thousand pounds of wood were burned the unit was disassembled. The surfaces were only dust covered, and a cloth could expose the parent metals. The combustion chamber interior, however, is coated with tar deposits which build up and flake off.

The upper portion operates under the fuel-rich, air-lean condition experienced by traditional wood burning equipment. Several gallons of condensate were removed from the stack by a condensing heat exchanger that cooled the gas to about 60°F. The condensate was over 99% water and the pH ranged from 7 to 8. A sample of the condensate was evaporated at room temperature. The residual was 0.3 percent of the original sample. The start-up performance with cold heat exchangers and cold refractory will cause several minutes of smoky operation, but once the refractory is hot the smoke disappears.

OPERATION & SAFETY

The induced draft fan means easy start up: some paper, kindling, a match and a fire will be established in a few minutes. Forty pounds of stick wood can be loaded almost at once. Stack temperature and heat release rate will stay almost constant for the two-hour burn. Additional wood can be added at any time without changing the steady-

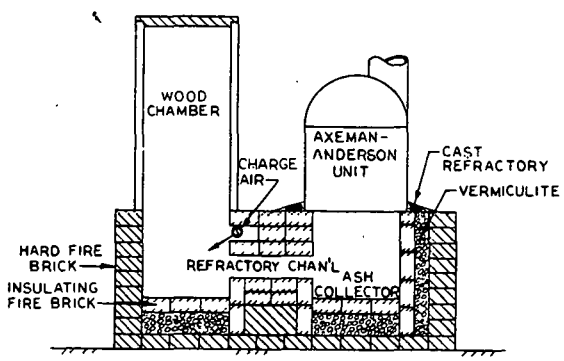
state output. If the forced draft fan is shut off the induced draft fan will pull building air in the open charging door and no smoke will enter the building. The performance is only slightly sensitive to the size of sticks fired. A bundle of 2 inch diameter branches or a single unsplit log will both burn satisfactorily. The small sticks may require a reduced air flow to prevent fuel-rich, air-lean mixtures from "bumping" (a euphemism for small explosions within the combustion chamber that drive smoke out around the charging door). The single log will burn only if introduced into an already red hot refractory base; a small penalty is paid, however, for excess air. No high limit control is needed as the 500 gal storage tank will absorb a full wood charge without overheating. The expansion tank is open to the atmosphere; so no over-pressure is possible. The complete combustion will not permit chimney deposits -- chimney fires are impossible. A thermostat in the stack will shut off the forced and induced draft fan when the stack temperature falls to 250°F. At this point only coals are left in the combustion chamber. Again stack draft will keep odors from the building.

The 500 gal tank will store 500,000 Btu which will protect a building for several hours or several days (depending on the building and the weather) against building freeze up. If building thermostat set-back is used the recovery rate can exceed the capacity of the burner because the tank temperature can be reduced at the same time the unit is being fired. No circulator pump is needed for safety as piping is sized for gravity circulation. With R20 insulation a 500 gal tank will lose only 500 Btu/hr with a 100°F temperature difference tank to ambient; so heat loss from storage is not critical. After the tank is heated and the wood fire is out the air flow through the combustion zone is close to zero. There is no stand-by penalty such as that paid by an oil or gas furnace.

SOME PROBLEMS

A conventional air-tight stove requires careful design and construction to prevent uncontrolled in-leakage. This problem is much more critical with the design described here. The induced draft fan produces a vacuum in sections of the system far greater than what natural draft can produce. We were forced to abandon an ash cleanout door for example; we could not keep it sufficiently leak tight.

The safety of the system depends upon the open expansion tank which means that adaptation to existing two story houses is difficult. We chose a 500 gal oil tank for storage. In an existing dwelling the tank would be constructed in place. We have made a 600 gal concrete block tank lined with extruded polystyrene and BLOCKBOND which is satisfactory, but the cover seal is difficult to construct and the pressure is limited to the level of water in the tank.



SECTION THROUGH WOOD CHAMBER, REFRACTORY CHANNEL, AND AXEMAN-ANDERSON HEAT EXCHANGER

NORTHWEST SOLAR ARCHITECTURE AND THE INFLUENCE OF UNIVERSITY SOLAR DESIGN PROGRAMS

John S. Reynolds, Professor of Architecture and Director, Solar Energy Center,
University of Oregon, Eugene.

In this talk, a series of slides depicts some developments in the use of solar energy for space and water heating in Oregon since 1973. The influence of the work of individual experimenters, such as Henry Mathew of Coos Bay, on university research efforts is clear[1]; of special importance is the continuing reflector-collector enhancement studies for winter space heating, first illustrated by Mathew in his 1968 solar home.

The influence of university programs on solar designers is less obvious; fully functioning solar research and architectural design studios at Pacific Northwest universities arebut a few years old. In this time period, however, several kinds of developments can be demonstrated. A few examples seem largely negative; the second known "decommissioned" Pacific Northwest solar house is one on the University of Oregon campus, which was an active solar retrofit, with attached greenhouse, designed, built and operated by students of Physics and Architecture. Its storage tank was surrounded all year by ground water, resulting in virtually no useful heat storage. After several years of declining student interest, the collectors were removed in June '79. The greenhouse remains, as does the storage tank beneath it.

Another "learn by others' mistakes" example involves the siting of solar homes; nearby vegetation is especially likely to cause problems if designers assume that all deciduous trees will drop their leaves before cold weather begins, or remain bare until the end of the heating season. A study of defoliation periods for typical Willamette Valley tree species was done some years ago at Oregon State University Extension's North Willamette Experiment Station. (2) A follow-up series of slides of exterior spaces on the University of Oregon campus will be shown, from January to July 1979. Further detailed work is in progress.

The use of reflector-collector geometry, deciduous vegetation, and student solar design investigation is combined in an example now on the drawing boards: a passively solar heated store in Cottage Grove, Oregon. The store will sell solar collection components, compost toilets, and hydraulic ram pumps. An architectural design class developed alternate schemes for this building late in 1978; the architects have since developed the design to the state shown in the talk. The project has been submitted for consideration in the U.S.D.O.E.'s Passive Solar Commercial Building Design and Demonstration.

Government funding has been received by several Pacific Northwest projects, including 1978 HUD Passive Solar Home Competition design and construction money awarded to University of Oregon architecture students and the contractors with whom they worked. These home designs, developed in a class taught by Steven Baker, are detailed in his paper which appears in the proceedings for this conference.

Another subject area of continuing solar development is that of thermal switches, which protect solar passive solar collectors from winter night heat loss, and summer heat gain. A passive solar home near Corvallis, designed by University of Oregon faculty members Michael and Glenda Utsey, has weathered a winter and two summers without the interior thermal shutters which were to be an integral part of the design. The owners are now installing, one by one, these important components. When construction funds run low, shutters or shades are an easier casualty than other passive system parts.

External shutters are a dominant feature of an eastern Oregon home, built to function without electricity in a remote area. The designer-owners include a University of Oregon graduate, Andy Laidlaw, who was on the team that designed and built the solar greenhouse at Noti, Oregon in 1976 under Professor Edward Mazria.(3)

The talk concludes with a look at water heating, beginning with a simple "breadbox" for a small Eugene restaurant (built by Larry Parker) installed in 1979. University-sponsored solar water heater workshops are shown, along with the results of a design-build class in 1978 at Malheur Field Station near Burns, Oregon. Illustrations from an excellent "how-to" booklet, sponsored by British Columbia Hydro,[4] conclude this presentation.

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(2) R.L. Ticknor, Landscape Tree Performance, Circular of Information 633, Revised May 1974, Agricultural Experiment Station, Oregon State University, Corvallis.

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Public Programs

Activities during the conference to which the general public was invited included seminars on how-to-do solar and conservation projects, films, a children's activity center, demonstration of construction of a water heater collector, and the musical review "The Energy Show."

HOW - TO SEMINARS

The free public programs far surpassed our expectations not only in terms of the numbers of persons attending, but also in the quality of the speakers and the enthusiastic response of the audiences. (A complete list of speakers and topics for the public seminars is given in the conference schedule at the beginning of the Proceedings Supplement.) Both the earth-sheltered housing and passive solar home design presentations filled the Shaw Room (250 seats) on Saturday. On Sunday solar greenhouses (retrofit) filled a 120 person capacity room. A presentation by a solar homeowner/builder and a talk/demonstration featuring a simple solar still used to make methanol (for fuel use) from salal berries each filled 45 seat rooms with nearly 70 persons. Total seminar attendance on Saturday was 1,150 and on Sunday 1,430.

Speakers emphasized how-to and how-does-it-work aspects of their subjects. Saturday's speakers were selected on a referral basis from previous public programs. Following the most popular formal presentations, such as passive and earth-sheltered housing, many persons from the audience met outside the room with the speakers to ask questions.

Sunday's half-hour informal programs offered a wide variety of topics and speaker styles. As many as three speakers were giving presentations in seperate rooms at the same time. Most persons attending the presentations appeared to have very specific subjects in which they were interested. Several Public Program participants preferred not to give a lecture but wished to discuss their projects more informally. They were assigned a room in which to pin up drawings and display models. Large numbers of people circulated through the room and had a chance to ask questions about solar home designs and a self-sufficient floating home.

Displays in the lobby of the Conference Center on Sunday included a 40 foot solar greenhouse design with models which was brought by Juanita High School students. A commercial greenhouse was also on display. The displays drew large numbers of viewers and were well-received.

Conclusions:

1) There is very strong support for free public programs. The programs drew considerable response from the public and drew them into the solar information network.
2) There is a large pool of speakers available for public programs. Many speakers received valuable information from audience participants as well.
3) Many persons who were registered for the technical sessions attended the public programs. They comprised 15-20% of the audience at several programs.
4) Practical, how-to information drew the best response. Many who attended stated that the information provided was valuable and would be helpful in making a decision to purchase products and services.
5) Many persons who attended will now undertake solar and conservation projects of their own with confidence, and will have contact with suppliers of products and services.

FILMS

The following films were shown on Saturday afternoon and again on Saturday evening. (The films were scheduled for Friday evening but equipment difficulties made it necessary to shift the showing to Saturday evening.)

"Energy from the Day Star" - by documentary filmmaker Bill Jersey, examines the pragmatic and philosophic implications of a quiet revolution occuring in this country: a rediscovery of the use of solar energy. The film was funded by Exxon Corporation and has received the 1979 CINE Golden Eagle award.

"The Great Adventure" - produced by the U.S. Department of Energy, examines a variety of grassroots solar projects throughout the country. One organization featured is the Seattle-based Micro Environment Research Group and their floating alternative energy research and education center, the barge "Heliark". Bjorn Lunde from MERG was at the afternoon film showing to discuss his project and to answer questions.

"Backyard Alternatives" - produced by former TV Commentator Kirby Bromfield, shows solar, wind, methane and other forms of energy generation in use in the Pacific Northwest and California. The film features an entertaining excursion around the region with Kirby's family.

"Build Your Own Greenhouse - Solar Style" - produced by Bill Yanda and his Solar Sustenance Team from New Mexico, features a greenhouse workshop put on by the New Mexico Solar Energy Association. The film is included as part of a U.S. DOE - funded greenhouse workshop training program.

"The Hottest Show on Earth" - produced by the National Film Board of Canada, outlines the energy situation and explains how insulation can ease the pressure on our dwindling fossil fuel resources. It is a highly entertaining film.

"The New Western Energy Show" - produced by the Alternative Energy Resources Organization, describes the group's entertaining road show on alternative energy. The show is described in detail by Shaun Taylor on page 309 of the Solar '79 Northwest Proceedings. The film was a good prelude to "The Energy Show" performed on Sunday by the Footlites of Tolt Junior-Senior High School.

While reels were changed between films, there was impromptu audience discussion and questions asked. The projectionist at the Saturday afternoon showing asked the audience for film ratings, which were given as follows:

FILM	EXCELLENT	GOOD	FAIR
"Energy From the Day Star"	17	24	2
"The Great Adventure"	12	42	5
"Backyard Alternatives"	12	18	8
"Build Your Own Greenhouse - Solar Style"	14	12	2
"The Hottest Show on Earth"	12	14	6
"The New Western Energy Show"	4	8	-

CHILDREN'S ACTIVITY CENTER

Bjorn Lunde from Micro Environment Research Group and Pat Robertson from Seattle City Light organized a variety of activities in which children could get involved on the plaza west of the Exhibition Hall. The most popular activity was a solar panel designed and built by MERG as part of a renewable energy education program for elementary schools which was funded by City Light. The panel has a solar cell to convert the sun's rays into electricity. Kids could

watch an ampmeter register current, or stop registering current if they covered the cell or turned it from the sun. A favorite activity was to charge a three inch electric sports car with the cell and watch it go! Kids quickly became adept at charging batteries, running propellers, and telling fumbling parents how to use the sun's energy correctly!

Other childrens' activities included Mr. Sunshine, a clown with bright yellow hair; face painting; poster making on various sun-related themes; solar tea making; roasting weiners in a parabolic solar cooker; and making solar prints by putting objects on photo sensitive paper placed in the sunlight. There was a small flat plate collector which kids could operate as a thermosiphon water heating system. As one child held a jug of cold water at the intake, another drew water off the top of the collector into a tube. Performance of the system was tested simply by sticking a finger into the cold and then solar-heated water.

Children at the activity center were mostly five to ten years old, some of whom stayed to play with the solar "toys" all day. A water heater panel built by junior high school students in Port Townsend was also on display. The panel drew considerable attention from adults surprised to see that children had built a solar collector, and convinced that they too should be able to do such a thing!

DEMONSTRATION OF COLLECTOR CONSTRUCTION

On Saturday afternoon Marnie McPhee and Lynn Youngbar of Portland Sun demonstrated to a frequently changing group of on lookers how to build a solar collector for a domestic hot water system. The panel was constructed from a kit available from Bill Miller (Miller and Sun Enterprises, 10451 SW 63rd Drive, Portland, OR 97219). Several onlookers at the workshop stayed to see the entire assembly, benefiting from the many questions that were asked of Marnie and Lynn. System diagrams were on display to aid in explanations of how the collectors are integrated into existing domestic hot water systems. The immediate usefulness of a solar system that can be built at home at low cost was one of the most impressionable results of the workshop. Improvising tools that were inadvertently left in Portland made the process a particularly relevant experience in "appropriate technology"!

THE FOOTLITES' ENERGY SHOW

A written description cannot do justice to the vitality, creativity, and humor that flowed out of each actor and actress in the Tolt Junior-Senior High School Energy Show. The cast of about fifteen students did a marvelous job producing and acting out a series of songs and skits on energy use today and tomorrow. (The show was written by the Alternative Energy Resources Organization from Montana which produced the original "New Western Energy Show.") A mistress of ceremonies narrated the musical review, providing continuity and explanations. Riddles, with lines like "what is crude though has no manners, slick but has no style", kept the audience on their toes. Players popped up from the audience, poked heads out of windows and doors in the stage set, and cavorted across the stage making this a very lively performance.

The show began with skits on fossil fuels. A wonderful green-nosed dinosaur sang about plants and animals buried long ago. And "Ole King Coal" concluded after a series of multiplications, that each American uses two and a half tons a year! But we are soon informed that these fossil fuels are running out: a TV set walks on stage and tunes in to "As The World Turns Off."

In another skit, we meet Fossil Fuel who is exhausted and irritated with Mr. Society, who has just arrived revving up his imaginary motor cycle. As they quarrel about just how long this excessive energy use can go on, Nuclear Power arrives setting their minds at ease with the promise of unlimited clean electricity. (Nuke stealthily turns to the audience and informs us that little do they know that by the year 2000 uranium will run out and HE DOESN'T CARE.) Then on bursts Sun and song breaks out for the new heroine: "Oh Sun, oh Sun we're glad we found you, we'll build our new world around you."

More skits tell us what we can do with the sun: from food driers and cookers, to water heaters, to the story of Louisa the wind generator. Louisa, like many old wind generators, served her farmer owners well until one day electric lines were built from a big plant faraway and she was left to rot. But, one day the power lines no longer work, and Louisa is put back to use, ultimately triumphant.

Finally, a skit about Fido and Mother Hubbard tells us how we can have enough money to buy food to fill our empty cupboards if only we insulate and conserve energy at home. Every skit was amusing and educational. It was inspirational to see that young people are working with such material and teaching others to share their views by putting on such a great Energy Show!

Panel Discussions

GOVERNMENT PROGRAMS IN SOLAR DEVELOPMENT

Friday August 10

Mary Anderson, moderator	Washington State Energy Office
Joel Pritchard	Representative, U.S. Congress
Donald Aitken	Director, Western SUN
Nancie Fadeley	Representative, Oregon State Legislature
Al Yamagiwa	Seattle City Light

At each level of government, some policies and programs promote and others thwart solar development. "The Arabs have done more to promote solar energy than any government policy," according to Washington's Congressman Joel Pritchard. Federal programs can help, but solar energy will prosper only when the average citizen finds it viable and when private companies are rewarded for good solar products by profits and growth.

The federal government has taken modest steps to make solar energy more viable. The federal tax credit for solar investments is the best example. U.S. Department of Energy funding for solar research and development grew rapidly for several years but actually decreased in real terms this year, if funding for low lead hydro is excluded. Congress is considering but has not passed a proposal for a Solar Bank to make available low interest loans for solar investments. The Cristian Science Monitor has characterized the President's solar policy as "Carter's Solar Nudge".

"We need more than a nudge," said Congressman Pritchard.

Don Aitken, the new director of Western SUN, lamented the meager size of his organization's budget -$4½ million for 13 states. According to Aitken, "There are too many people chasing too few dollars." He advised local groups to coordinate and cooperate to stretch these dollars. He also urged solar activists to become professionals, and to provide fee services. "Don't just depend on public money, " he cautioned.

Oregon's State Legislator Nancie Fadeley, commented on the success of solar legislation in Oregon this year. She attributed this success to many factors: a strong state energy office, a supportive governor in earlier years, an Energy Conservation Board, and strong citizen lobbying efforts by such groups as Solar Oregon Lobby. More can be done at the state level. Next year she will be working for a massive investment in solar energy through a state renewable energy bank.

Al Yamagiwa, of Seattle City Light, described numerous research and demonstration projects. A combination of federal and local funding is being used to construct and test a varity of systems in the Seattle area. While such projects may break the ice for solar, many local barriers to solar commercialization remain. Local planning departments must be educated and building codes must be changed to encourage solar development.

GASAHOL, TODAY AND TOMORROW

Friday August 10

Lee Johnson, moderator	U.S. Department of Energy, Region X
Steve Rubin	Solar Energy Research Institute
Lloyd Costley	U.S. Department of Energy
Keith Sherman	Washington State General Administration
Nancie Fadeley	Representative, Oregon State Legislature
Janet Gillaspie	Oregon State Legislative Aide

About one hundred thirty people attended the panel discussion on gasahol. Many questions were asked, and considerable interest shown by the audience. The general concept of gasahol (a mixture of methanol, ethanol, or other non-fossil fuel substitute with conventional fuels for use in motor vehicles), and a variety of production techniques were described. For example, gasahol can be produced by using a solar still for the fermentation process. Large firms and single individuals can and are producing gasahol. It was suggested that individuals who encounter difficulties in obtaining a license for their still from the federal Alcohol, Tobacco, and Fire Arms Administration, try applying for an experimental facility to speed up the process.

A fair amount of action to encourage gasahol use has been taken at the legislative level in the Northwest. During the last session of the Washington State Legislature a business and operations tax exemption for gasahol producers was passed, and a memorial written to urge Govenor Ray and President Carter to use gasahol wherever feasible. In Oregon two bills passed, one of which requires the state to use gasahol in the motor vehicle fleet to the extent that it is commercially feasible, and the second which exempts commercial ethanol and methanol plants from corporate income taxation. While bills were defeated in both states which would have partially exempted gasahol from gasoline taxes, the National Energy Act of 1978 does provide for a four cent exemption for gasahol from the federal gas tax.

The Washington State motor pool in Olympia is currently using gasahol in all of its cars. Alcohol is purchased from a Georgia-Pacific plant in the state which has been proudicing since the 1940's. Georgia-Pacific produces about five million gallons of alcohol a year from wood sulfer. Oregon, Nebraska, California, and Japan are among the buyers of the product. Additional gasahol plants are under consideration by the Port of Pasco and at Moses Lake in eastern Washington.

The Solar Energy Research Institute is publishing a pamphlet on questions commonly asked about gasahol. Copies will be available shortly from Steve Rubin, SERI, 1536 Cole Boulevard, Golden, CO, 80401. One of the panelists, Lloyd Costley from the U.S. Department of Energy, submitted a paper entitled "U.S. Department of Energy Action on Gasahol and Alcohol Fuels". The paper is included at the end of the panel discussions section.

LOCAL, STATE AND FEDERAL ORGANIZING

Saturday, August 11

Evan Brown, moderator	Pacific Northwest Solar Energy Association
Susannah Lawrence	Solar Lobby
Cris Salsbury	Washington State Model Solar Projects
Paco Maribona	Oregon Solar Lobby

"Times of growth are beset with difficulties," says the I Ching. "But these difficulties arise from the very profusion of all that is struggling to attain form." This certainly applies to the burgeoning solar energy movement. Many solar organizations grew out of the first national SUN DAY in 1978; others are even more recent. Representatives of several of these new groups joined the discussion on organizing.

The Solar Lobby is working for solar legislation at the federal level. Susannah Lawrence described their efforts to pass needed programs like the synfuels boondoggle. Solar Lobby is affiliated with the Center for Renewable Resources whose focus is more on public education and out-reach. CRR has begun a program to establish better contact with grass-roots organizations in each state. They are compiling a catalogue of model solar projects nationwide. In each state they are financing efforts to compile possible entries for the catalogue.

Cris Salsbury is coordinating Washington State's Model Solar Projects Program. A steering committee has been formed representing various interest groups in the state to compile program entries. The best two or three projects will be published in the national catalogue. In addition, descriptions of twenty or more projects will be compiled for publication in a Washington State Model Solar Programs Catalogue. The steering committee is the foundation for forming Citizens for Solar Washington, a statewide coalition of groups supporting solar development. The coalition will be established officially at a conference in Yakima on September 14-16, 1979.

Oregon's solar community is developing somewhat differently. Paco Maribona described how his organization, Solar Oregon Lobby, grew out of a SUN DAY coalition. S.O.L. focused first on state legislative issues and was quite successful in getting a variety of important bills passed during the 1979 session of the Oregon Legislature. Paco gave tips on local organizing such as: gear campaigns to the self interest of citizens that you want to involve, and minimize news-letters, as they are rarely read.

PNWSEA has added local chapters during the past year, has published "Sunstrokes", and has put on the Solar 79 Conference. However, PNWSEA still lacks permanent paid staff. (There is further discussion of this organization under the PNWSEA and Local Affiliates section of the supplement.)

These pioneering efforts, valuable as they are, only begin to meet the need for solar education and advocacy. During a discussion period panelists and members of the audience suggested many ways for solar activists to become more involved:

--Join in or cooperate with other political organizations (environmental or church groups, political parties, etc.)
--Form Legislative Committees of local PNWSEA chapters.
--Work on specific issues (Northwest Power Bill, SJR 120, and others).
--Establish coalitions with other groups.
--Learn about and educate your local utility.
--Develop and propose new building codes or state legislation.

The difficulty of organizing is not in finding projects and opportunities for involvement, but in choosing from an overwhelming array.

WOMEN AND SOLAR: OPEN DISCUSSION

Sunday August 12

Elizabeth Coppinger and Annie Stewart, moderators

About thirty women met for two hours and discussed their ideas and experiences with solar-related work. People introduced themselves, discussed current building activities, and described job and business plans. One idea set forth for continued development of awareness and communication among women interested in solar and alternative technology was preparation of a directory. The directory would list women working in solar and related businesses in the Northwest, with an emphasis on those with trade and professional skills. Some members of the group indicated that they would pursue this idea. (Contact Nancy Cosper, Cascadian Regional Library, P.O. Box 1492, Eugene, OR 97440 if you would like to work on such a directory.) Other topics discussed included: educational opportunities for women, especially in engineering; developing building skills; community hands-on workshops for women; and experiences with contractors for women building their own solar buildings. A lengthy general discussion was held on changes in consumer attitudes, cultural emphasis, and political activity which are necessary for a sound renewable energy society.

U.S. DEPARTMENT OF ENERGY ACTION ON GASOHOL AND ALCOHOL FUELS

Lloyd Costley
Department of Energy
Washington D.C. 20461

The development of a new[1] gasohol industry in the United States has resulted in several major actions by the Department of Energy to encourage its growth.

In January 1978, the DOE granted a stay of certain regulations to expedite the opening, in Illinois, of the first three retail gasohol outlets (other than test markets) on a continuing commercial basis in the United States. Also in January 1978, to show its support for Gasohol, the DOE sent a representative to the first official meeting of the National Gasohol Commission in Lincoln, Nebraska. In February 1978, the DOE granted further stays of the gasoline price regulations to additional gasohol marketers in Illinois, Iowa and Wisconsin.

In March 1978, DOE issued a proposed rulemaking and public hearing notice in the Federal Register regarding modifying the price regulations for all resellers and retailers interested in marketing gasohol. Hearings were held in Chicageo and Washington D.C. in April 1978 and the final amendments were adopted in May 1978. Also, in May 1978 the DOE amended its entitlements regulations to make gasohol eligible for subsidies under the entitlements program.

In July 1978, the Under Secretary of Energy formed an agency wide task force to evaluate the potential of gasohol and all alcohol fuels and to make recommendations regarding federal assistance. One of the options being considered by the task force, removal of the 4 cents per gallon federal excise tax for gasohol, was enacted into law in November 1978 as part of the National Energy Act.

After nearly a year's work, the DOE Alcohol Fuels Task Force in June 1979 published its report. The following is a brief summary of the findings and recommendations of the task force:

In letters to the Nation's govenors and members of Congress Energy Secretary James Schlesinger, reaffirming DOE's commitment to alcohol fuels, emphasized that "alcohol fuels represent important supplies based on the American agricultural system and on the potential of U,S. Coal." Adding that greater alcohol fuels development could help moderate current pressures on U.S. oil supplies, the Secretary also emphasized that the report describes a number of policy initiatives which constitute an aggressive program for developing an important energy source.

Those policy initiatives recommended by the task force to encourage the growth of gasohol and alcohol fuels are as follows:

- Presidential recommendation to make permanent the current gasohol exemption from the Federal gasoline tax of four cents per gallon.
- A ten percent additional investment tax credit for facilities that convert alternate substances or feedstocks (including coal and biomass) into synthetic liquid fuels.
- Federal assistance of $11 million in loans, grants and loan guarantees to help construct 100 small-scale plants to produce alcohol fuels (to be administered by the Economic Development Administration of the Department of Commerce, and the Community Services Administration.)
- Gasohol to be used in Federal vehicles where available.
- Legislation submitted by the Administration to simplify Treasury's application procedures and bonding requirements for alcohol fuel producers.

The report also contains positive findings on the major controversial issues involving the widespread use of gasohol and alcohol fuels, namely:

- Food versus fuel
- Net energy balance
- Gasohol economics
- Environmental impacts

Pursuant to the above announced DOE policy on gasohol, the DOE is currently developing several regulatory incentives for gasohol marketing:

- Price incentive rulemaking for refiners wishing to market gasohol.
- Further amendments to the entitlements program to make the gasohol and alcohol fuels subsidy automatic rather than on an application, case-by-case basis.
- A proposed rulemaking on the several gasohol allocation issues.

The following is a functional telephone list of government gasohol and alcohol fuels experts in DOE and other agencies who will provide assistance to interested parties (experts are DOE unless otherwise indicated, and area code for all is 202):

Policy issues - Ed Blum (252-6360) and Marilyn Herman (252-4487)
Regulatory issues - Lloyd Costley (254-8034)
Alcohol raw materials - Les Levine (376-9475)
Alcohol Production technology - Marvin Singer (633-9102)
Future uses of Alcohol fuels - Ken Friedman (376-4827)
Gasohol engineering issues - Gene Ecklund (376-4892)
Denaturing, bonding issues - (AFT) William Davis (566-7531)
EDA Financial assistance - Rachelle Levitt (377-5265)
IRS 4 cent exemption - (IRS) Bob Waltuch (566-3328)
USDA - Weldon Barton (447-2455)

[1] The use of alcohol fuels in motor vehicles, however, is not a new technology. There have been many war and peacetime applications. Alcohol fuels were used by both sides during WWII. Henry Ford designed the Model "T" to run on alcohol or gasoline. All Indianapolis "500" race cars run on 100% alcohol. The first automobile, the Otto Cycle, ran on alcohol. (See DOE Alcohol Fuels Policy Review Report, June 1979.) Nevertheless, until recently, plentiful supplies of relatively inexpensive gasoline have made the widespread use of gasohol uneconomic. Recently, however, sharp increases in gasoline prices and reduced gasoline allocations have encouraged the growth of gasohol in the U.S. from 3 stations in Illinois in January 1978 to over 1000 gasohol outlets in 28 states by July 1979.

Solar Olympics

The Solar Olympics was a contest open to anyone with a solar collector that could heat water. The contest was open to commercial, private, and institutional entries. The object was to heat a given volume of water (1½ quarts per square foot of collector aperture) to as high a temperature as possible within a two-hour period. At half-hour intervals throughout the contest, average water temperature in each entry's storage tank was measured. A pyronometer was set up and insolation measured every half hour so that collector efficiencies could be calculated. The results are given in the chart below.

The Solar Olympics were part of the free public program. For many onlookers this was their first contact with a solar energy system. The Olympics drew 18 entries, several hundred spectators, and television coverage. The Solar Olympics were very successful in raising public awareness, and in demonstrating how one solar technology works. A beautiful sunny day added to the effect!

The winners of the Solar Olympics were:

Alten Northwest	Highest Temperature (180°F)
Ener Con (Tim Hayes)	Highest Temperature Increase (108°F)
WA Natural Gas	Highest Temperature (181°F)
Dundas	Lowest Cost Collector (all recyclable)
Bruce Meland	Highest Temperature (182°F)

Many thanks to Ken Cooper and Chris Mattock of Solar Applications and Research, Ltd. Vancouver, B.C., and to Carol Oberton and Bruce Lampcov of Ecotope Group, Seattle, for their time and technical expertise, without which there would have been no Solar Olympics. [Ed. note: and to Cassandra Adams, Seattle, for coordinating the event!]

ENTRANT	DESCRIPTION OF THE COLLECTOR	WATER/ APERTURE RATIO	STARTING TEMP. °F.	ENDING TEMP. °F.	MAXIMUM EFFICIENCY %
Alten Northwest 1134 Poplar Place S. Seattle, WA 98144	Pump-operated system consisting of copper tubing in a continuous nonsoldered configuration with aluminum fins, backed by fiberglass insulation and single glazing (glass).	1.6 Qts. per Ft.^{2}	75.2	179.6	.68
Don Cheesman 205 W. 24th Ave. Olympia, WA 98501	Pump-operated system consisting of black synthetic rubber sheets "quilted" together to form a jacket through which the water flows, mounted on ½" masonite with rockwool insulation. Double glazed with clear plastic sheets.	3 Qts. per Ft.^{2}	79.3	141.8	.48
Pat Cole & Matt Crosby Evergreen State College P.O. Box 1434 Olympia, WA 98507	Thermosiphon system consisting of ½" copper tubing soldered to copper fins mounted on ½" plywood backed with 3½" fiberglass insulation & single glazed.	3.2 Qts. per Ft.^{2}	78.8	122.0	.68
John Davis & Wm. Martin Chateau Builders P.O. Box 724 Olympia, WA 98507	Pump-operated system consisting of copper tubing mounted on an aluminum bed backed with insulation in a galvanized sheet metal frame. It is glazed with 2 plexiglas lenses with a dead air space in between.	1.6 Qts. per Ft.^{2}	80.6	159.8	.58
Robert Dodson 31008 39th Ave. S.W. Federal Way, WA 98003	"Solarator" brand collector, pump-operated, consisting of 2 sheets of black plastic heat welded together to create a serpentine configuration of ½" tubing, unglazed. For swimming pool use.	.86 Qts. per Ft.^{2}	73.4	145.4	.46
Dundas 2376-D Walker Valley Big Lake, WA 98273	Combined collector/storage system consisting of 100% recycled materials. A one gallon brown jug set in an oval street light reflector insulated on the back with sawdust and cloth strips and glazed with an old pane of glass.	3.3 Qts. per Ft.^{2}	70.7	116.6	.61
Energy Forum Northwest Univ. of Washington 316 Lewis Hall Seattle, WA 98105	Thermosiphon system consisting of copper tubing mounted in a wood frame and glazed.	3 Qts. per Ft.^{2}	71.6	132.8	.89
Energy Production Systems, Inc. Box 5672 Everett, WA 98206	Pump-operated system (energized by solar cells) consisting of a copper tubing grid with extruded aluminum absorber plate and frame, backed with insulation and glazed.	1.5 Qts. per Ft.^{2}	71.6	166.1	.67

ENTRANT	DESCRIPTION OF THE COLLECTOR	WATER/ APERTURE RATIO	STARTING TEMP. °F.	ENDING TEMP. °F.	MAXIMUM EFFICIENCY %
Energy Value 129 Dorffel Dr. E Seattle, WA 98112	Thermosiphon system consisting of SolaRoll absorber tube mat backed with 1" of Thermax insulation. Single glazing is fiberglass reinforced plastic.	1.5 Qts_2 per Ft.	71.6	159.8	.71
Tim Hayes 18135 Brittany Dr. S.W. Seattle, WA 98166	Pump-operated collector consisting of SolaRoll absorber tube mat backed with 1" of Thermax insulation in a salt-treated wood frame. The single glazing is Glasteel Greenhouse fiberglass mounted in GR+GL Glazing Extrusion.	1.5 Qts_2 per Ft.	68.0	176	1.1
Dr. W. Dean Martin Industrial Education & Technology Eastern Wa. University Cheney, WA 99004	Mirror-covered parabolic reflector system	1.5 Qts_2 per Ft.	74.3	147.2	.47
	Small collector	1.5 Qts_2 per Ft.	75.2	152.6	.70
Bruce R. Meland 63600 Deschutes Mkt.Rd. Bend, OR 97701	Thermosiphon system consisting of 2 .018" stainless steel sheets seam welded around the edges and spot welded uniformly throughout the absorbing surface, forming a jacket through which water flows. The system is insulated on the back and sides & is glazed with tempered low-iron "soletex" glass.	1.5 Qts_2 per Ft.	80.6	182.3	.57
Micro Environment Research Group 6549 Palatine North Seattle, WA 98103	High temperature process collector consisting of a cast aluminum parabolic dish with a cavity absorber at the focus mounted on a sun-following tracker. This thermosiphon system has a small boiler at the focal point. At one point during the contest people's shadows "sidetracked" the tracker and the collector melted a piece of the fiberglass insulation.	1.6 Qts_2 per Ft.	75.2	158.0	
Mid-Willamette Valley Community Action Agen. Energy Program 2035 Davcor Salem, OR 97302	Thermosiphon system consisting of ½" copper tubing grid tied to a corregated sheet metal plate, backed with 3½" fiberglass insulation and single glazed with double strength glass.	1.5 Qts_2 per Ft.	71.6	154.4	.50
Small Tribes Organ. of Western WA Box 578 Sumner, WA 98390	Copper tube collector mounted in a wood frame and glazed with glass and backed with insulation.	1.5 Qts_2 per Ft.	77.0	134.6	.50
Washington Natural Gas 815 Mercer Seattle, WA	Steel absorber plate with a black chrome surface, 90% of which is wetted. Glazing is low-iron glass.	1.5 Qts_2 per Ft.	78.8	181.4	.62
David A. Wilson 14026 Edgewater Lane Seattle, WA 98125	Thermosiphon combined collector/storage system consisting of a styrofoam box glazed with lumar plastic film.	1.5 Qts_2 per Ft.	72.5	143.6	.44

Exhibits

Both commercial and non-commercial exhibitors at SOLAR '79 provided significant opportunity for visitors to view what is available in the Northwest in solar design and system markets. Display areas located inside the Exhibition Hall and outdoors in the Flag Plaza were each well attended. Many facets of solar heat were represented.

In the indoor display area, several kinds of heat storage units were available for comparison: eutectic salt, water, rock, and thermal rods. Both hydronic and air collectors were displayed. Builders, building designers, architects, computer programmers, and do-it-yourself projects presented eye-catching exhibits. Community education and service organizations offered sound advice in attractive booths.

Outdoor exhibits were rewarded with brilliant sunshine, and this combined with the colorful flag pavilion created a truly festive atmosphere. While most exhibits were oriented to collectors, food drying, photovoltaic cells, and a dome house added interest and variety.

Frequent checks with all exhibitors reflected happy attitudes and smiling faces. Crowds were present in sufficient numbers and interest to make exhibiting at SOLAR 79 a rewarding time for all.

EXHIBITORS AT SOLAR '79 NORTHWEST

Alten Northwest
Paul Nishman
1134 Poplar Place So.
Seattle, WA 98144

Alternate Energy Concepts
Bill Ransom
2972 South 6th St.
Klamath Falls, OR 97601

Balance Associates
Tom Lenchek
201 Summit Ave East
Seattle, WA 98102

B & B Heating
1450 - 19th NW
Issaquah, WA 98027

The Chumbley Co, Ltd
Jim Chumbley
16018 Inglewood Road
Bothell, WA 98011

Community Action Team
Bill Overall
Rt 4 Box 4263
St Helens, OR 97051

Dodson Enterprises
Robert Dodson
31008 - 39th Ave SW
Federal Way, WA 98003

Ecotope Group Design Team
Susan Gross
2332 E Madison
Seattle, WA 98112

EnerCon Solar Design
Tim Hayes
18135 Brittany Drive SW
Seattle, WA 98166

Energy Alternatives
Kip Eder
2212 South Main
Moscow, ID 83843

Energy Production Systems
Jon Burgett
Box 5672
Everett, WA 98206

Bonneville Power Administration
Craig Mortensen
PO Box 3621
Portland, OR 97208

Energy Value, Inc.
Perry Lovelace
129 Dorffel Drive E
Seattle, WA 98112

Eureka Design
Ted P. Lehn
1918 - 8th Ave W
Seattle, WA 98119

Inst for Research & Understanding
Fredrick Tuso
Rt 2 Box 663
Quilcene, WA 98376

Miller & Sun Enterprises
Bill Miller
10451 SW 63rd Drive
Portland, OR 97219

Model Solar Projects Program
Claire Dyckman-WA Ofc of Env Ed
NE 158th & 20th Ave NE
Seattle, WA 98155

SS Supply
Lloyd Whannell
Rt 1 Box 1400
Lopez, WA 98201

SCANP
1788 Hillvue Place
Burlington, WA 98233

Jeff Schlegel
2104 McKenzie Ave
Bellingham, WA 98225

Scofield & Company
Bill Sullivan
1715 Dock St
Tacoma, WA 98402

Seattle City Light
Dorothy Nelsen/Diane Shirk
1015 - 3rd Avenue
Seattle, WA 98104

Solar Drier
Jim Peterson
Box 303
Corvallis, OR 97330

Solar Energy Research Inst
Bill Stephenson/Joyce Jackson
1536 Cole Blvd
Golden, CO 80401

Solar Specialties, Inc
Al Popa
1001 Taylor Ave North
Seattle, WA 98109

Solar Sunrise
Ann Coville
12345 - 30th NE
Seattle, WA 98125

Space-Tech Energy Company
Jeff A Gray
PO Box 181
Edmonds, WA 98020

Sun Energy Unlimited
William A Swanson
2485 SW Elmhurst
Beaverton, OR 97005

Sunset Magazine
Fred Nelson
Menlo Park, CA 94025

Systems Architects Engineers
Richard Coad
112-5th Avenue North
Seattle, WA 98109

Thermal Efficiency, Inc
John Stackpole
PO Box 1869
Seattle, WA 98111

U of WA - Energy Forum NW
Robert D Wilkinson
316 Lewis Hall MS DW-20
Seattle, WA 98195

Wang Laboratories
229 Queen Anne N
Seattle, WA

WA Energy Extension Service
Marion Hewitt
312 Smith Tower
Seattle, WA 98104

Technical Sessions - Update

THE FIELD EVALUATION PROGRAM FOR SMALL WIND ENERGY CONVERSION SYSTEMS

Jeff Aldred
Rocky Flats Plant
Energy Systems Group
P.O. Box 464
Golden, Colorado 80401

Public interest in alternative energy sources is increasing, particulary in wind energy systems which are closer to commercialization than many other alternatives. Small Wind Energy Conversion Systems (SWECS) connected to an electric utility system offer a good potential for a cost effective use of this energy alternative. SWECS interconnected to a utility line can provide electricity to a user when the wind is blowing and deliver excess power generated back into the utility transmission system.

However, in order for interconnected SWECS to realize their full energy potential, certain technical and institutional barriers to the integration of this dispersed generation source must be resolved. The technical issues of interconnection are related to the introduction of an unpredictable power source in to the utility system. This creates concerns for safety for utility personnel and equipment, power quality, and operational control over a dispersed power generating source. Institutional barriers focus on the costs and benefits of widespread use of utility interconnected SWECS and the means by which these costs and benefits are passed on to utility customers.

The Department of Energy (DOE) has recognized the importance of small wind systems and has initiated a number of programs designed to accelerate the commercialization of them. The programs include the establishment of a Wind Systems Test Center to provide a capability for intensive long-term testing of SWECS, and a technical management organization chartered to foster the development of new, low cost machines, provide support to the development of industry standards, and to disseminate technical information to industry and to the general public.

In addition, a Field Evaluation Program has been designed as a part of this program to accelerate the commercialization process for SWECS. The program goal is to provide near-term resolution of existing technical and institutional constraints in order that wind energy can effect maximum impact on the nation's energy needs. The over-all objective of the Field Evaluation Program is to advance the federal wind program efforts to identify and remove these barriers. Stimulation to the various segments of the SWECS industry will also be an important benefit of the program.

The primary objectives of the Field Evalution Program are:

1. Provide data to establish procedures for SWECS interconnected or supplemental to a utility system and establish a basis for evaluation of cost of service for these applications.

2. Assist and support state and local governments in the reduction of institutional barriers to the use of SWECS in the private sector.

3. Prepare consumer information regarding the performance and reliability of commercially available SWECS and the procedures and costs for interconnecting SWECS with utility networks.

4. Provide stimulation to the SWECS industry that will maintain current manufacturing and distribution capacities and aid in establishing a sufficient industry field repair sector to allow widespread SWECS deployment.

5. Obtain typical operating experience data on SWECS with a variety of real loads and environments to be used by manufacturers for future design and development efforts.

PROGRAM APPROACH

The Field Evaluation Program solicits the cooperation of State Energy Offices (SEO) to undertake the selection of users and the siting of 125 SWECS, in cooperation with electric utilities, throughout the states and territories of the U.S. The SWECS purchased will have satisfied the program definition of "commercially available." SWECS purchased will be within the one to forty-five kW range and installed interconnected to a utility line. Data will be collected at each site on the load profile and power factor, the technical and institutional procedures for siting and installation, available wind energy, and performance and failure modes of the SWECS. These data will be analyzed and provided in reports to:

- Utilities and utility regulatory commissions for establishment of procedures and cost of service for interconnected SWECS.
- State Energy Offices and other state programs for their use in wind program and incentives planning.
- Potential SWECS users.
- Manufacturers and distributiors of SWECS for design development and marketing efforts.

PROGRAM DEFINITIONS

For the purpose of this program, the following definitions apply:

- A user is an individual, group, business, or institution with an application powered by an electric utility to which a SWECS would be (a) supplemental or (b) interconnected with the intent of utilizing the power generated by the SWECS for that application.

- Commercially available machines include models of which three have been manufactured, sold, and delivered, one of which is in actual operation, as of the date of official program authorization.

- An interconnected application is one in which the SWECS is physically connected to an electric utility line with the ability to transfer excess power into the line.

KEY PROGRAM ELEMENTS

User/Site Selection

Using a technically based approach, users shall be selected in the states and territories for installation of commercially available SWECS. In cooperation with SEO's and their currently available resources, program personnel shall institute a selection procedure which calls for the following steps and associated personnel disciplines:

1. Interface with and provide detailed program and selection procedure briefing to state energy office to enable the SEO to determine the degree of their participation, i.e.:

   - SEO provides sites for program technical review.

   - SEO provides support for program technical selection process within limits of interest and resources.

2. Program Technical Selection Procedure

   a. Evaluate and determine, by use of technical data, adequate wind regime areas within state.

   b. Identify cooperative technically acceptable electric utilities for program participation.

   c. Define, in conjuction with these utilities, potential users within a selected area having acceptable loads and applications.

   d. Randomly select a list of users for further contact, interview, and siting surveys.

   e. Final selection

This procedure will produce a number of technically selected sites in which:

- SWECS are interconnected through agreement with a cooperative utility.

- SWECS are located in an adequate wind regime.

- There is a reasonable match between application, load and SWECS.

- There has been involvement and cooperation of affected state and local agencies.

Hardware Selection

The procurement of commercially available SWECS will help to maintain the developing SWECS manufacturing industry. It is necessary to:

- Determine the SWECS models that are commercially available.

- Select machines for purchase and issue requests for quotes.

- Issue purchase orders to obtain 125 SWECS and provision for spares.

- Obtain operational data from the Wind Systems Test Center to achieve an adequate match between the SWECS and a proposed site.

- Monitor contractual activities to assure timely delivery to selected sites.

Instrumentation

Instrumentation for the program sites is designed to provide the minimum data required by utility companies and SWECS manufacturers to assess the performance and impact of interconnected SWECS and to provide information for future design optimization. These SWECS data are: available wind energy, energy output and energy fed back to the utility power line. A standard instrument package will be installed at each program site to collect data that will provide the above information. The instrumentation unit (IU) will consist of two watt hour meters, one anemometer, and a magnetic tape recorder and will record the following parameters in a form consistent with current utility data formats:

- Electrical energy supplied to the user.

- Electrical energy supplied by the SWECS.

- Wind run available to the SWECS.

- Time recorded to a resolution of 15-minute increments.

Installation and Repair

Contracts with the suppliers of the 125 machines purchased under this program will provide stimulation for the development of an installation and repair network. In addition, the following procedure is intended to provide timely and adequate installation of SWECS at the sites and assure maximum operating time and data acquisition:

1. Negotiate contracts with the SWECS suppliers or their designated representatives for installation and repair of machines to be sited.

2. Perform final site surveys in conjunction with SWECS suppliers.

3. Provide interface between utility personnel, manufacturer and user.

4. Monitor contractor site preparation and installation.

5. Perform system sign-off procedure on completed installation in conjunction with manufacturer.

6. Perform field surveillance of sites until data collection is complete. This includes coordination of mainline repair and failure reporting.

Institutional Interface

Data and experience from installation and operations at the selected sites will be used in the assessment of the institutional and technical barriers to the widespread use of interconnected SWECS. Efforts to reduce these barriers will include:

- Providing the utility industry with information and technical support to determine procedures and cost of service for SWECS interconnections.

- Providing state utility regulatory agencies with data and assessments to aid in their efforts to comply with the provisions of NEA that apply directly to SWECS.

Providing SEO's with technical support and information on current wind programs. This will be accomplished by coordinating site selection and field operations activities in their state with all interested agencies and by developing inventories of and guidelines for programs to accelerate the use of SWECS.

Using the data and experience gained from the program activities to provide guidelines for interconnection of SWECS for manufacturers and potential SWECS users.

The Institutional Interface program incorporates all program activities in order to provide reports and assessments to the agencies, organizations and individuals who are affected by institutional barriers to the widespread use of interconnected SWECS. Figure 1 displays the program interactions, targeted groups and potential impacts.

PROGRAM INTERRELATIONSHIPS

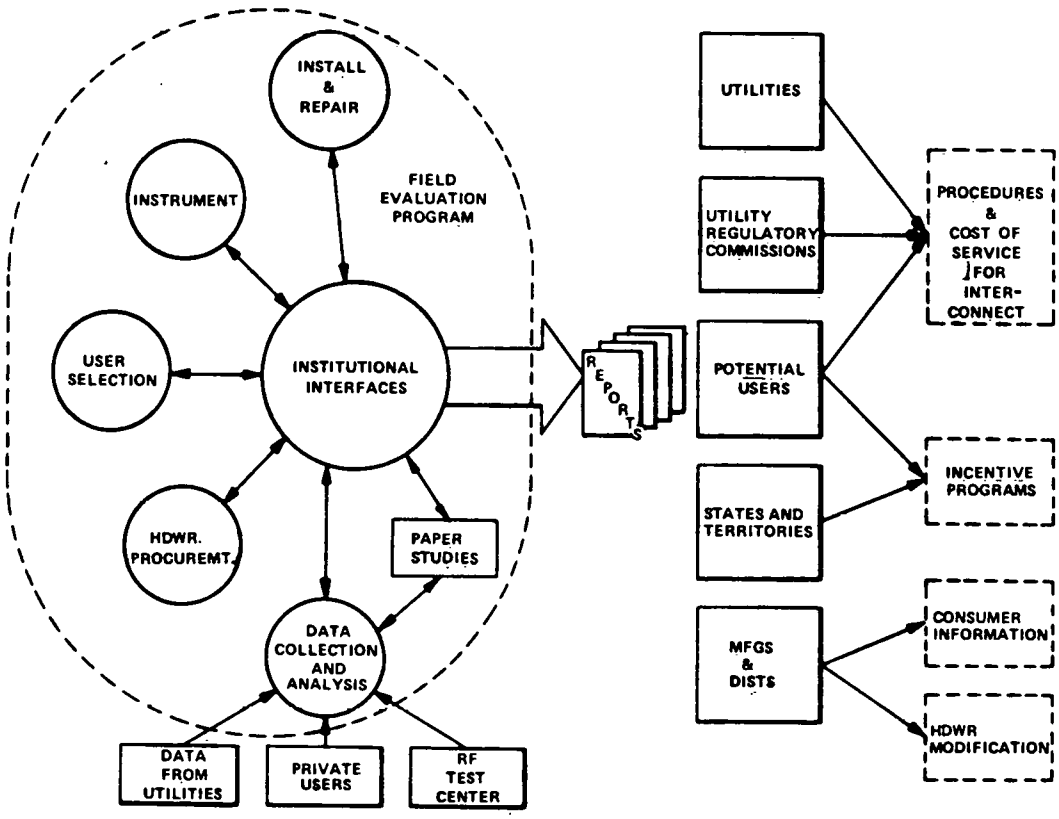

FIGURE 1

THE USE OF STANDARD SURFACE WEATHER OBSERVATIONS TO EVALUATE SOLAR INSOLATION IN THE PACIFIC NORTHWEST - ADDENDUM

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The following illustrations replace those in the first draft of 'The Use of Standard Surface Weather Observations to Evaluate Solar Insolation in the Pacific Northwest', which appeared in the Solar '79 Proceedings.

Figure 1 contains the theoretical values of total daily insolation derived from the TDF-1440 tapes and Atwater's model. While maxima in insolation exist over the San Juan Islands and the Columbia Basin, values generally increase to the south in this region, suggesting that more southerly sites would be more favorable for the effective use of solar collectors. Since synoptic scale weather systems are the predominant mechanism for precipitation in the Northwest, and such systems decrease in frequency of occurrence toward the south (besides often weakening) a decrease in cloudiness with an increase in total insolation is not unexpected. Additionally, the slant angle of the sun increases to the south, further adding to the total insolation.

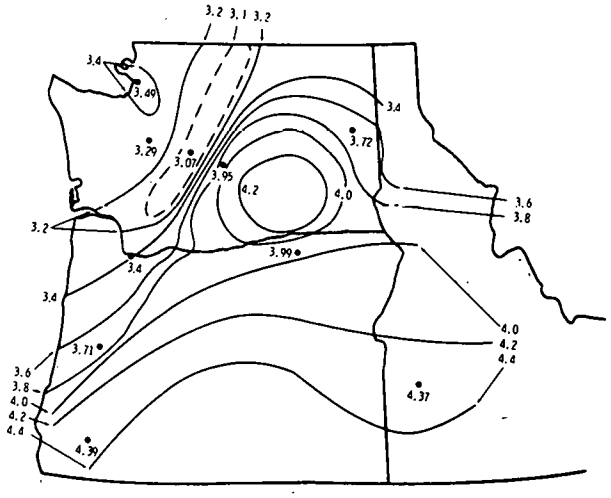

Figure 1. Total Average Daily Insolation (As Calculated from Atwater's Model) Units are kW-hr/(m^2-day)

Diffuse insolation (Figure 2) was found to increase to the east. The model also suggested a trough of low values over the northwest corner of Washington. The insolation pattern to be expected from climatology suggests low values to the south (as we found), with flux values increasing northward as the average sky cover increases (due to increasing scattering by clouds and reflection from the sides and bottoms of clouds). Diffuse insolation would decrease as the sky cover continued to increase, with little or no solar radiation remaining after the cloud tops reflected sunlight back to space, or absorbed what wasn't reflected.

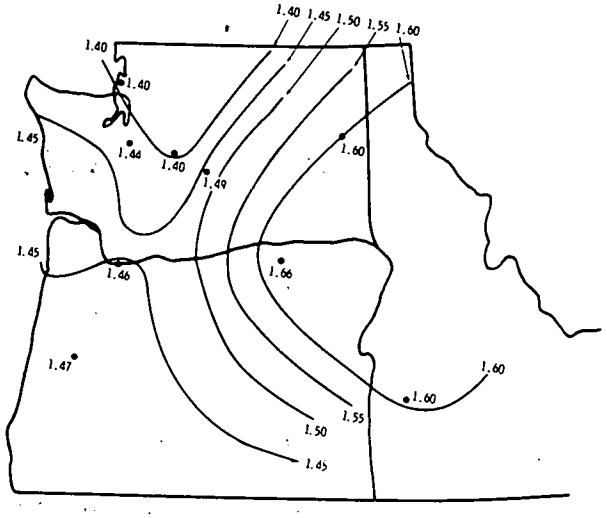

Figure 2. Diffuse Average Daily Insolation (As Calculated from Atwater's Model). Units are kW-hr(m^2-day)

Direct normal and direct horizontal average daily insolation (Figures 3 and 4) appear to be physically consistent with the paths of synoptic storms and the location of rain shadows.

We would add one last note to our 'Proceedings' paper: Mie scattering theory, which describes the interaction of aerosol particles and solar radiation, has been empirically taken into account in Atwater's Model. Our flux values may be somewhat different, on the average, than actual observed values due to the natural variability of aerosol loading in the atmosphere.

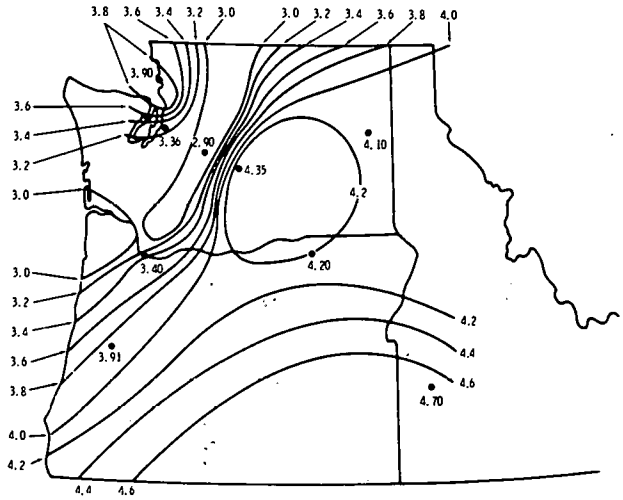

Figure 3. Direct Normal Average Daily Insolation
(As Calculated from Atwater's Model).
Units are kW-hr/(m^2-day)

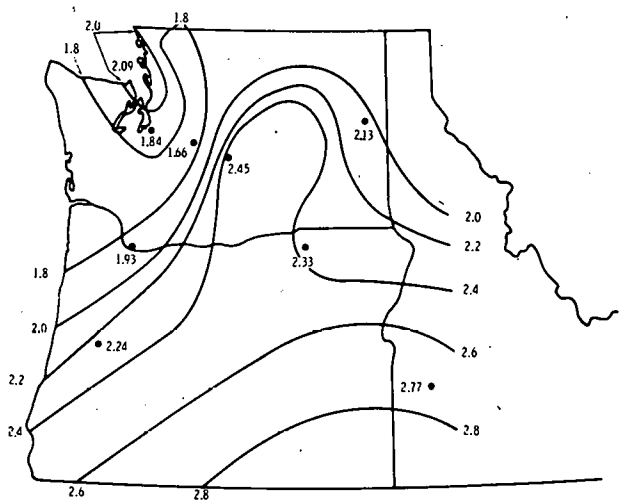

Figure 4. Direct Horizontal Average Daily Insoation
(As Calculated from Atwater's Model).
Units are kW-hr/(m^2-day)

MANUFACTURING COSTS - HELIOSTATS FOR SOLAR THERMAL SYSTEMS

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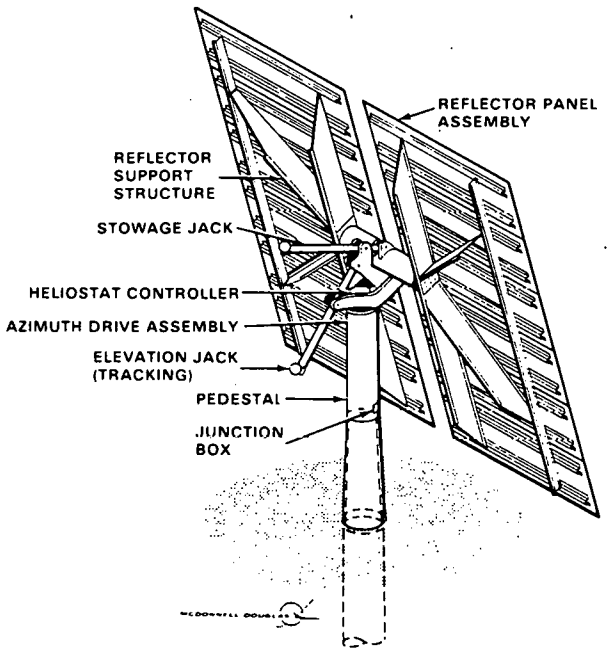
ABSTRACT

Estimates of the cost of manufacturing heliostats for solar thermal energy systems have been made. Manufacturing cost estimates are based on production rates of 25,000 to 250,000 heliostats per year. These estimates, with demonstrated heliostat performance, show that the cost of producing energy from solar heliostat systems may be less than the cost of producing energy by burning foreign oil.

Solar energy collected with heliostats may cost less than energy from burning foreign oil.

A heliostat is a simple device. A dictionary definition is "a device consisting of a mirror...revolved...so as to reflect the sun's rays continuously in a fixed direction" (Ref. 5). Hence, a heliostat is simply a supported mirror that can be rotated on two axes. A recent design is illustrated in Fig. 1.



The design of Fig. 1 utilizes, to a large extent, roll-formed sections which can be produced with high volume techniques with a relatively small investment in tooling.

Figure 1 illustrates the simplicity of a heliostat and the fact that it can be made with well-known materials and manufacturing methods. The controls for sun-tracking, while not detailed in the figure, can utilize clockwork systems such as telescope trackers, with a simple computer to bisect the angle, or sun-sensing systems. Both of these systems are well known.

Heliostats may be used to collect and concentrate solar energy for solar electric systems, process heat, chemical fuel production, or concentration on photovoltaic devices.

Several studies have been made which illustrate that heliostats can be manufactured and sold at installed costs in the $7 to $10 per square foot range, in 1979 dollars. (Refs. 2,3,4) This assumes production quantities of more than 25,000 heliostats per year.

The annual energy reflected from a glass heliostat in Eastern Washington is about 500,000 Btu. Thus, using $7 per square foot and 15 percent fixed charges, the annualized capital cost per million Btu reflected is:

$$\frac{15\% \text{ per year} \times \$7 \text{ per square foot}}{.5 \text{ million Btu per square foot per year}} = \frac{\$2.10 \text{ per}}{\text{million Btu}}$$

At $30 per barrel of oil, which is a conservative estimate of the real cost of imported oil--considering inflation effects, jobs, etc.,--the cost per million Btu is:

$$\frac{\$30 \text{ per barrel}}{42 \text{ gallons/barrel} \times .14 \text{ million Btu/gallon}} = \frac{\$5.10 \text{ per}}{\text{million Btu}}$$

Thus, on the basis of demonstrated performance of heliostats numerous analyses of the real cost of foreign oil, and analytical estimates of heliostat costs under high volume production conditions, the capital-related cost of heliostat energy is about one-half the cost of foreign oil energy.

Heliostat energy systems require a receiver and associated piping in the same way that oil energy systems require a combustion system and heat exchangers. At present, the initial cost of the equipment required to utilize the energy from heliostats is likely to be more than the cost of comparable equipment for oil energy utilization. Also, because parts of the heliostat energy system will be used only while the sun is shining, the annualized capital costs associated with the conversion of reflected heliostat energy are likely to be greater than those for oil energy conversion, even if the initial costs were the same for an equivalent energy rate. The operating and maintenance costs for heliostat systems may be more than for oil systems.

However, detailed cost estimates for solar thermal electric systems indicate the cost of equipment to convert heliostat energy to electrical energy, in the 10 MWe, 50 percent

capacity factor range, is about equal to the cost of the heliostat field. These estimates include storage. Thus, even including the cost of conversion equipment and allowing for possible higher operating and maintenance costs, it appears probable that heliostat energy can compete economically with foreign oil energy.

It should be noted that heliostat energy utilization is by no means limited to electricity production. A much larger contribution to the U.S. energy supply may be made through the application of heliostat energy to uses such as high-temperature process heat or chemical fuels production.

While the economics appear favorable for heliostats, there are still many questions to be answered about lifetime properties, long-term reliability, and operating and maintenance costs. These questions can be answered only through actual operation on a significant scale.

The following outlines a detailed study of heliostat manufacturing costs (Pacific Northwest Laboratory, to be published, Ref. 4).
The approach to this cost analysis was to develop a format which includes most significant cost elements to be considered in heliostat costing. A reference heliostat design was then used and production costs estimated and summarized.

Parts lists were prepared for each subassembly. All basic materials requirements can be obtained from the parts lists. An estimate was obtained on the procurement cost of each part. Generally, vendors were asked for a supportable engineering estimate. However, actual quotations were provided or available on approximately 70 percent of the dollar value of materials. Materials costs estimates are summarized in Table 1.

Table 1. DIRECT MATERIAL COST SUMMARY

	Direct Material Cost, $/H	
	25,000/yr	250,000/yr
Mirror Module	624.40	601.18
Support Structure	361.16	345.03
Azimuth Drive	280.72	264.49
Elevation Drive	703.67	639.66
Motors	174.56	140.96
Pedestal	77.22	72.52
Controls	150.00	130.00
Allowance for Materials Not Detailed	50.00	50.00
Total Direct Materials, Manufacturing	$ 2,421.73	$ 2,243.84

A process was described for the production of the reference design. A typical process description is shown in Table 2.

Table 2. PROCESS STEPS, SUPPORT STRUCTURE ASSEMBLY

1. Receive roll-formed shapes from vendors and transfer to storage. Conventional forklift.
2. Pull samples for statistical inspection during transfer to storage and inspect.
3. Transfer from storage to assembly line.
4. Assemble component in production jig with pneumatically operated clamps and multiple spot weld heads.
5. Spot weld - multiple welds - NDT controls for spot weld quality.
6. Drill holes for attachment to main beam. Multiple drilling head station.
7. Inspect - mechanical integrity and dimensional - mechanized inspection stations.
8. Glue hat section stringers to mirror modules. Mechanized assembly station.
9. Inspect mirror modules with attached heat section stringers. Mirror figure, bond - mechanized station connected by conveyor to assembly station, then to support structure assembly station.
10. Assemble mirror modules to support structure.
11. Match drill mirror module stringer and support structure, jig with drill bushings and hand drill.
12. Install bolts and nuts to complete panel assembly. Bolts installed and nuts placed by hand, pneumatic squeezer.
13. Inspect for mechanical integrity and dimensions.
14. Inspect mirror figure, special station.
15. Transfer to storage with bridge crane and special handling fixtures.

Estimated direct labor costs and capital costs are summarized in Tables 3 and 4. Equipment costs and manpower requirements for manufacturing operations were estimated. Space requirements were established and incorporated into plant layouts.

Table 3. SUMMARY DIRECT LABOR COSTS

	Total Manpower		Total Man Hours/H		Total Direct Labor Cost ($12/Hr)	
	25K	250K	25K	250K	25K	250K
MANUFACTURING						
Mirror Module Assy	22	52	1.83	.43	21.96	5.16
Panel Support Structure Assy	40	210	3.33	1.75	39.96	21.00
Azimuth Drive	86	374	7.16	3.11	85.92	37.32
Elevation Drive Pedestal	88	376	7.32	3.13	87.84	37.56
Controls	28	120	2.33	1.00	27.96	12.00
Central QC	12	40	1.00	.33	12.00	3.96
Load	8	32	.67	.27	8.04	3.24
Total, Mfg.	284	1204	23.64	10.02	283.68	120.24

Table 4. CAPITAL COST SUMMARY

	Heliostats per Year 25,000	250,000
Land and Roads	$ 120,000	$ 550,000
Buildings	4,718,750	19,907,000
Manufacturing Equipment	16,930,000	92,320,000
Support Equipment, allow	1,000,000	3,000,000
Support Facilities, allow	2,000,000	8,000,000
Subtotal	24,768,750	123,770,000
Engineering, 15%	3,715,300	18,565,500
Contingency, 15%	3,715,300	18,565,500
Total	$32,199,350	$160,901,000
Cost per Heliostat, 20% Fixed Charges	$257.60	$128.72

The cost information was summarized as illustrated in Table 5, and with the SAMIS computer program (Jet Propulsion Laboratory, 1979, Ref. 1) which considers overheads and many different financial parameters.

The estimated cost, utilizing the SAMIS program for a production rate of 250,000 heliostats per year, was $3069 per heliostat. These cost estimates are preliminary, based on work still in progress. With the estimated installation cost of $880, this provides an installed cost for a 528 square foot heliostat of $3949, or $7.48 per square foot.

Table 5. ESTIMATED MANUFACTURING COSTS FOR 528 FT^2 HELIOSTATS, 1979 DOLLARS

	Heliostats per Year 25,000	250,000
MANUFACTURING		
Direct Materials	2,421.73	2,243.84
Direct Labor	283.68	120.24
Total Direct	2,705.41	2,364.08
Indirect Manufacturing Expense and Contingency	100.00	50.00
Total	2,805.41	2,414.08
Facilities Cost 20% Fixed Charges, Cost/Heliostat	257.60	128.72
TOTAL	$3,063.01	$2,542.80

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AN ENERGY PHILOSOPHY AND TWO SOLAR ALTERNATIVES

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University of Washington

Abstract: We argue that (1) lack of philosophically defined and publicly accepted population and energy goals has resulted in run-away population size and associated spiraling demands for food and energy already long past environmental limits, (2) both non-renewable and so-called "renewable" resources are realistically projected for essentially total depletion in about 30 years, (3) the existing resultant rapidly growing wide-spread starvation and political instability will probably trigger World War III even before resource exhaustion, (4) if growth stopped and world population stabilized now at the present four billion, the same chaotic end can only be delayed a few more decades, (5) world population of one billion, achievable in one century, could maintain prosperous human and ecologic equilibrium indefinitely on solar-power technology, and (6) the disappearance of starvation and gross economic inequities would remove the need to defend national boundaries and result in world disarmament. We discuss the obstacles to world wide coherent philosophy on a population goal. We describe recent research accomplishments in solar energy conversion and storage that make possible the two (long range and transition period) energy plans.

THE PHILOSOPHY

Introduction

A necessary prelude for peace between author and reader. The essence of this paper is that satisfaction of an uncrowded peaceful world's energy needs will be easy using inexhaustible non-polluting solar energy if the world can agree on and move coherently and expeditiously toward a population goal of one billion people. If this is not done it will be impossible to both meet energy demands and avoid World War III by any technologies. The reason, of course, that discussions of the inextricably intertwined subjects of energy and population are receiving more attention in the developed countries is that a (too slowly) growing awareness of ultimate catastrophies exist. Through calloused indifference in many of us or a sense of helpless futility in others, we have managed to ignore the ultimate catastrophe of death by starvation for hundreds of millions even though the undeniable evidence leaks into our formerly comfortable and isolated societies. Now a growing unity seems possible since even the less ignorant of the jaded majority are being brought to our selfish senses by realization that the world energy-population crisis may escalate to the ultimate catastrophe for us all, nuclear world war. Clearly, we would like peace and prosperity, not just now but for perpetuity. Peace like other forms of human progress requires agreement. Since agreement can never be total, it always requires compromise. Recognize the value and power of compromise. Let us not be paralyzed by our differences and lose the chance for progress in the one area of our (univeral) agreement, peace. If the microcosm consisting of you and I cannot discuss our differences openly in peace, what chance is there for the world? We must be able to disagree without becoming disagreeable so that rapport is not lost and this small kernel of our agreement can grow and become pandemic. In what follows, a finger must be pointed at us all. Individuals, governments, religion, education, capital, labor and science itself have all contributed to the tragedy and must share in this catharsis if we are to succeed. Because drastic changes in thinking and rejection of many long cherished beliefs are involved, it is imperative above all else that the reader keep in mind the fact that the strength of one's convictions is no criterion of their validity. The people who executed "witches" at Salem, burned Galileo's friend Bruno at the stake, ran the Inquisition, drove the Crusades, asserted the world was flat, etc., all believed they were right just as strongly as we do. We now know their central convictions were incorrect. That knowlege should prepare us to accept the possibility that we may also be wrong in many ways. I ask the reader to accept any criticism of what I identify as our past and present errors in the constructive sense it is intended. After all, I am trying to save your skin as well as my own.

A Preview of the Imminent Cataclysm

If you saw a blind man a few steps from a cliff, might not your warning to stop be a little strident? This article is in part an analogous outcry. The human species has an innate propensity to multiply beyond any reasonable finite limit in both numbers and energy demands. The earth, its resources, and its capacity to absorb pollution are all very finite. In addition, the area per person below which humans cannot live in peace as free individuals has some complex but definite lower limit. Because we failed 50 years ago to recognize the obvious and inevitable conflict between the elements of the previous three sentences, and because we failed to take massive dynamic action to (1) establish world population/energy goals, and (2) develop solar power technology and industry, humanity faces a survival crisis today. Before we discuss some of the numerous aspects of the population-energy-pollution-political-etc. crisis or the reasons for it, or the few paths left to avert it, we will have a brief preview of a highly probable scenario (the nature of and the basis for which have already been well established in two outstanding books, one on virtually all aspects of demographic excess by Lester R. Brown[2] and one on energy by Lawrence Rocks and Richard P. Runyon (these latter authors, however, have rather conventional views on population)) showing that the energy crisis is actually a survival crisis. This horrifying and almost hopeless situation was spawned by lack of a coherent philosophy and mediated to its present monstrous proportions by mindless misuse of energy. Who would have thought that being the "bread basket of the world" was inflicting a murderous crime on mankind? The answer to that question is: any far-sighted intelligent person with an education in science and demography! Yet, after we see in this section the hideous error of our ways in the past half century, we will see later below that we plan another colossal mistake as a solution to the first. One naturally asks: if all this is true, how could our "experts" be so wrong? The answer has three parts: (1) existing interests and power structures give publicity to the "experts" who mouth the prevailing canonical orthodoxy (iconoclasts are ignored or suppressed, right or wrong), (2) "authorities" are, too often, persons who use their power to defend the outmoded theories in which they have an egotistical or vested interest, and (3) the populace has not been taught that each free person has an obligation to self and to society to be skeptical of every opinion including one's own (if you profess "respect" for the opinion of some authority, you shold simply have less skepticism for that person's opinion in the area of alleged expertise than of your own on the same subject).

During our fifty years of mechanized agriculture, we have increased farm production of food roughly two orders of magnitude primarily by converting fossil fuels into human

caloric fuels at a ratio often quoted as being in excess of ten calories to one. We have gained great material wealth in the conversion of oil to food and have enabled and encouraged underfed masses in underdeveloped countries to produce much larger underfed masses. Primitive populations multiply to meet the food supply. Instead of a few million starving people we now have hundreds of millions. We have led them onto the thin ice of a demographic dependence that cannot continue. We use the same amount of fossil fuel in one year that took nature a million years to produce. Even without the U.S. energy pig, Japan and Western Europe at present consumption growth rate (doubling every six years) could completely exhaust known supplies of Middle East and African oil in twelve years[1]. The OPEC leaders feel no love for the U.S. In addition, Russia has exploited (1) their hatred for us, (2) their demand for manufactured goods to modernize their nations, (3) their desire for arms to crush Israel (etc) and (4) our 96% dependence on fossil fuels[1] by creating trade alliances and gigantic commitments of fuel production, making itself a major middleman between the Middle East and Western Europe. The U.S.S.R. can now by either armed action or commercial caprice cut off fossil fuel to the U.S. and or its allies. What do you think would happen if the imported oil flow to the U.S. were cut off tomorrow, or in a year, or in a decade? The lights and heat would go off. You would neither be able to drive your car nor to find public transportation. All businesses and stores would close. Food could neither be grown nor delivered to the cities. Starvation, panic, riots, civil strife, chaos would sweep across the land. Only the missiles could still function. In this tempting moment of power imbalance with the U.S. on its knees, would you rely on the militant factions in the commintern to avoid rash moves or demands that could precipitate the final war? Do you think that they are wise because they are gaining the upper hand? To establish that their leadership also makes its share of blunders (if you need convincing), witness the destruction of Russia by the Nazi armies that resulted because Stalin had, simply for lack of ideological submissiveness, just put to death the entire elite Russian military leadership from the 14 Republic commanding generals on down, estimated between 37,000 and 75,000 officers[3] executed in one massive "purge"! Three military super powers brought about their own defeats and partial destruction with a similar apparently easy victim but far less inviting world picture than exists today: (1) the Third Reich turned on Europe, (2) Russia turned on the Reich, and (3) Japan struck at Pearl Harbor. In the present situation, the same or analogous elements are all there: a prostrate America, error-prone human judgment, hatred, decades of waiting, a power structure peopled by merciless men whose childhood memories consist of a numb recollection of slaughtered parents' frozen bodies and the joy of shooting Wehrmacht infantrymen immobilized by the Russian winter. It will not be the way we wanted the missles to leave the silos (under their own power).

Two Major Obstacles: Power and Ignorance

"The trouble with the world today is that the future is not what is used to be" (Paul Valery). This "trouble" is not due to lack of scientific progress, but to an excessive application of technology in a mindless attempt to meet the insatiable demands of gluttonous uneducated developed nations and the blind proliferation of uneducated underdeveloped ones. If you named the 100 most important problems in physics today, ten will be solved this year and progress will be made on most of the remainder. However, I am not aware of any problem that has ever been solved in the humanities where the important problems reside unchanged since earliest recorded history. I attended 21 schools and 10 universities. All of these required excessive study of English and or English literature and descriptive history but none required the study of anything else of relevance to the real world such as biology, economics, science, or how to be a person. As a result we produce a society of surface values, a populace incapable of critical analysis or of questioning the archaic dictates of what effectively is a church-state tyranny whose leaders enforce their outmoded destructive dogmas blind to the mass suffering produced. Here we fought for freedom of religion. Yet the religionists, who should value this most, constantly struggle to destroy it by supporting lobbies attempting to enact their beliefs into law and thereby enforce them on the rest of us. This is what one can expect from dogmatists. The failure of modern society is a failure of the classical curriculum. The claim that it fosters humanitarianism is absurd; the men who implemented the Third Reich and its horrors had a better education in the classics, etc., than any American I have met. By our school system, we have turned democracy into ignorance in action. However that meaningless democracy is rapidly being forced into an even more inflexible socialism by the endless proliferation of government controls necessitated by the increasing numbers of serious interactions resulting from less elbow room (area per person) due to the constant increase of population encouraged, condoned, or ignored by a governmental collection of fearful career oriented politicians that will not take a stand on the critically urgent need for massive world-wide education and research in population control. Our government is shaped, of course, by the pressures of special interest groups and political parties whose postures in turn represent the appetites and beliefs of the great uneducated electorate. Where does the fault lie for the lack of relevance in the curriculum responsible for this ubiquitous ignorance? It lies with all of us! Bigotry perpetuates itself both by pressure groups who oppose scientific modernization of the curriculum (by which I do not mean the "new math" or "whole word" reading) and with relatively passive groups such as my fellow scientists who have not brought enough pressure on the educational establishment. To gain public coherence in action on any issue, including population and energy, we need education. If we revise the curriculum now to include relevance, we can produce in 16 years a new generation of informed voters whose actions will be logically and coherently directed by the internal constraints of common knowledge of the world's predicament and some universal understanding of basic principles. Although we must do this reshaping of the curriculum, we do not have time to wait for its effect. We must re-educate, belatedly, the adults by giving widespread and repeated publicity to the following facts and logical arguments that require drastic downward revision of energy consumption by developed nations, and a worldwide reduction in population toward a goal that we will see is no more than one billion people. (Before we entertain the details, notice that any lower level of population is achievable within six to ten decades by coherent action; although I am not suggesting such an extreme, the world population would fall to zero if no one had any children for 70 years. If instead, there were one billion people born during the next 70 years, that would be the new world population. The age distribution of that population would of course be determined by the time distribution of their births, a matter of simple planning if everyone agrees. Although we would pass through a period in which the average age would rise and then fall, I believe most people would agree that having a larger fraction of gray haired people in the (peaceful and prosperous) population for fifty years is vastly better than nuclear war or prolonged starvation with the entire world living like animals or the crowded but neat, precisely controlled, fusion-powered socialistic super-state in which the citizen is a numbered automaton existing for the state rather than vice-versa).

The Energy Crisis is Primarily Due to Excess Population

Clearly, the total energy consumption is simply the number of people multiplied by the average energy use per person. Since the world is finite in size, neither energy use nor population can grow unrestrained. If we do not educate people to limit their numbers at a safe level under their own control, the harsh constraints of nature will be imposed appearing as pollution, shortages, starvation and war. We are experiencing all of these. Some wag once computed that a pair of rabbits placed on the continent of Australia with adequate food and no predators could, in 30 years, produce a pile of rabbits the size and shape of that country, proceeding outward with a speed greater than that of light. Another popular and simple calculation shows that if you could feed all the people born and thus avert the deaths and other agonies due to starvation, and if some restraint were

exercised so that population only doubled every 25 years (note that Mexico's 64 million is predicted to double in only 16!), then in just 500 years there would be three people per square foot of earth's land surface! It wouldn't make much difference how much energy you used, would it? Even though these simple exercises are intended to show that population must be limited (and, as we argue below, reduced), we will show that our energy use is also far beyond safe limits. Reductions in population and energy will both be opposed by various groups primarily because of dogma, custom, short-sighted self-interest, lack of social conscience, and other forms of ignorance. Even though virtually every serious problem in the world is caused or aggravated by excess population, that issue will receive more opposition and require more space than the energy question in this section on the philosophy of energy use.

The multi-faceted evidences of population excess vastly beyond a number than can exist in harmonious equilibrium with our finite planet (or with itself) have been documented and explained in many books and in much of the scientific literature. Perhaps the most lucid, coherent, compelling, and authoritative treatment is that by Lester R. Brown[2]. The evidence shows clearly that: (1) in 1970 even though only five countries could export more food than they imported the population is expected to increase one billion (more than 25%) this decade...how many net exporters of food do you expect there will be in 1980?; (2) even if all the food claimed to be producible by the much touted "green revolution" materialized and were evenly distributed, the entire world population would be dangerously malnourished[13]; (3) in malnourished (not starving) countries including Latin America, suppression of immune function causes childhood diseases like measles (that is relatively mild in well-fed countries) to have 40,000% (!) higher morbidity than in the U.S. (the toll in deafness, blindness, mental retardation, paralysis and birth defects alone is incalculable); (4) the world's four supposedly renewable resources (fisheries, forests, croplands and grasslands) are disappearing rapidly and apparently irreversibly under the human onslaught (four of the 30 principal table fish of the world essentially disappeared in this decade with no signs of recovery; tropical forests are being destroyed for fire-wood, etc., at such a rate that climatologists are expressing concern over the effects on terrestrial albedo, atmospheric CO_2, etc., (in 1977 the following forest losses and projections were published[4]: 63% destroyed on the Indian subcontinent, 36% in South America, 100% in the Philippines within a decade, and Indonesia within 20 years!), croplands are decreasing by mineral depletion and top soil erosion, and overgrazing is turning grasslands into desert at 14 million acres per year (estimated to lost 33% in 25 years!); (5) the atmospheric CO_2 level is rising about 3% per decade[9] and, although there is disagreement on the detailed mechanisms, there is almost universal agreement that drastic changes in climate will occur (one possibility is loss of most land surface due to rising sea level); (6) rain is becoming greatly acidified by the oxides of sulfur and nitrogen from combustion products, fertilizers, etc., (in Pasadena 1976-1977 rain pH averaged 3.9 (pure rain pH is 5.7); 51% of the Adirondack Mountain lakes now have pH below 5.0, but in the 1930s only 4% did); (7) nearly half of the 700 million pounds of highly toxic PCBs produced since 1929 remain in the air, soil, and water; Swedish investigators attribute the virtual extinction of Baltic gray seals (20,000 in the 1940s to 200 today) to PCB contamination of the fish[5] (note we also eat the fish); (8) under direct human attack the blue whale population fell from over 30,000 to about 1,000 in one decade[6]; (9) EPA estimates 32,254 potentially dangerous chemical dumps exist in the U.S.[7]; (10) we face exhaustion of world petroleum resources in less than 30 years; and (11) at present growth rates in population and in power use per capita, all fossil fuels (including coal) will be exhausted before the end of the next century[8] and the giant resulting increment in atmospheric CO_2 is expected to drastically affect weather possibly melting the polar ice caps and flooding the cities and farmlands of the world.

What Should the Population Be?

More than a million years was required for the human population to reach one billion (about 1850). The second required only 80 years (1930). We now have four billion and the increase is approximately one billion per decade! Of course, as the population increases, the area per person shrinks correspondingly and is now only 8 acres of which 2 are arable and 2 grazable (4 are infertile deserts, mountains, marshes, ice caps, etc.). In addition the usable land per person is being rapidly eroded by the excessive population pressures as described above. How can we decide what the world population should be? We could use the minimum area needed for protein and caloric production. A simpler approach is to consider energy use. It is clear from CO_2 levels, acid rain, thermal pollution of rivers, eutrophication of lakes, etc. that we are polluting too much by our use of energy for heat, transportation, manufacturing, etc. Yet less than one fourth are polluting; most of the people in the world sleep on the ground in unheated huts and will not ride in an automobile once in their lives. Therefore, if world population decreased everwhere uniformly by a factor of four (to one billion), and if these people lived as we in the U.S. do today, the pollution would be the same, still extremely excessive. However, as we show in later sections below, we can support one billion people in comfort and prosperity (and peace) on solar power. Then the chemical pollution would go away, and, more important, the political pollution would go away. Why? The ratio of population to resources would be such that economic inequities, starvation, crowding interactions, etc., would disappear as would the need for governmental controls and defense of boundaries. Weapons and super-states would become things of the past.

Who Opposes a Population Goal and Why

The more powerful opponents of research and education on fertility control are found among governments, business interests and religionists. We will briefly examine their reasons, fears and arguments for merit:

Governments that oppose (or refuse to actively endorse) on grounds other than religion usually do so for either or both of two reasons: (1) growth will inflate away the public debt which, of course, is simple fiscal dishonesty; and (2) large populations mean power usually expressed as military might which then breeds similar strength in the name of "defense" by competitive nations; the result always has been and always will be war.

Business interests are sometimes sufficiently unenlightened as to believe that a larger population means more customers for products. This overlooks the fact that in our four billion person world there are only four hundred million customers due to world wide poverty, whereas in a one billion person world material wealth would be uniformly high and all would be customers.

One religious group's opposition has two principal bases: (1) the belief that it is a "sin" to interfere with conception except by abstinence, and (2) the notion that abortion is murder based on the idea that once the gametes have joined the resulting diploid human embryonic tissue constitutes a person. In comment on the first of these, it would seem logical that intent has far more bearing on the moral quality of an act than the means to effect it. If you deliberately use hypnosis or trickery to cause a person's death are you less guilty than if you had used a gun? Similarly, how can contraception intentionally effected by periodic abstinence be more moral than the same intent accomplished by other means (i.e. chemical, mechanical, etc.)? Is the fate of mankind to be determined by this kind of illogical dogma? In comment on the misconception that human tissue constitutes a person, it could simply be pointed out that the layers of human cells in tissue cultures are not people, nor are excised tumors or tonsils. A human body without a functioning brain can live and grow but it is not a person. Even at birth the human brain is incomplete and without the higher brain center functions that are necessary to be more than an ape. For months after birth myelination and even neuronal growth and organization are still proceeding. The

large human fore-brain is not yet developed at birth and the newborn functions on brain stem only. In fact, in the birth defect hydranencephaly, the brain quadrants are missing and the entire cranial space is filled with fluid; yet such an infant, with only stem level capability appears normal and is not detected until the third or fourth month when its inability to learn or develop becomes apparent. It remains in the same sub-human (or super-vegetable) state through which the rest of us have passed. A normal newborn has three things of interest here: an appearance and cry that successfully solicit our care and support (evolution has seen to that; mutations whose appearances did not elicit support, such as teratoid morphologies, did not survive to affect the gene pool), and the potential for becoming a person; however, gamete pairs, whose union was prevented intentionally by abstinence, had the same potential. Finally then, in reference to the fetus, genetic potential in a mass of proliferating cells no more makes it at that time a person, than does the intellectual capacity of a bright slum area child make it at that time a millionaire.

Science, The Errors of First Order Logic, and the Only Stable Solution

Because a ball did not roll on a flat floor, first order logic in ancient times declared the earth was flat. Closer inspection of shadows and stars enabled second order logic to determine the earth was round. Today, first order logic would declare it a great boon if science could provide cheap clean unlimited energy for the people. Second order logic would show this to be the key to doom. Taking the energy monkey off the population problem's back would permit renewed growth in numbers, crowding, super-states and weaponry until the unavoidable conclusion. If the energy technology adopted permits increasing population and, therefore, decreasing area per person, you have a non-equilibrium situation and no one can predict the outcome. Thus, stable solutions can exist only if the number of people is static (or decreasing, perhaps, since sufficient area per person occurs at or above some minimum value). Not only must the number be constant, it must also not be too large for the grass to grow between our feet. As shown above four billion does not permit the renewable resources to renew; world experience circa 1850 AD indicates that one billion would, either in an agrarian economy as existed then, or industrialized if by non-polluting energy.

What Should the Energy Goal Be?

In 1972, the world ue of power was 6 trillion watts (6 Tw), equivalent to 40 billion barrels of oil per year!, and the U.S. consumption was 2 Tw, or 10,000 watts (10 Kw) per person. Since 100 watts is approximately one "human-power," our 10 Kw is equivalent to 100 manual laborer servants per capita! Our industry, housing, transportation, etc., were designed and our habits were formed without due regard to energy efficiency. In addition, much of our so called energy "need" is really "appetite," undisciplined gluttony of the unthinking and uneducated. It is easy to show that we can maintain at least as high a living standard at 5,000 watts/capita by (1) normal redesign with the consideration of energy that will result naturally from its higher cost during the next few decades (lighter cars, much better building insulation, industrial process modernization, etc.), and (2) a more mature viewpoint with regard to waste. In a world of 1 billion people using 5 Kw each, the world energy consumption would be 5 Tw, somewhat less than today. As we shall see in the following sections, this energy goal can be met in various ways by solar energy without pollution and without depletion of resources (if our coal is used for protein and plastics it would last over 100,000 years in our one billion person solar powered world[10]).

Fatal Flaws in Our Fuels (The Reason for Solar)

As stated in an earlier section, the worst fault an energy source can have is to appear capable of boundless supply (even short term) inviting continued population growth and therefor continued dwindling of the area per person. We see what the short-sighted spendthrift world has done and is continuing to do with fossil fuels. In spite of (1) projections that U.S. oil supplies won't last 20 years, (2) threats of major change in sea level, (3) growing strife over land, (4) escalating nuclear armament, etc., prominent figures still announce in the media that the world is not crowded! And our electorate which has been required to study English and History only, frets at the inconvenience of "gas lines." A short list of some other flaws follows:

Petroleum is projected to be exhausted in less than 20 years in the U.S. and in less than 30 world wide. The oil spills which will increase in severity and number destroy our shoreline and continental shelf fish ecologies. Its combustion products produce impenetrable and carcinogenic smog in our cities and a climate altering greenhouse over the whole earth. Its conversion to vast quantities of food without population control education or aid is causing far more human suffering and death than all the wars combined. Its manipulation may soon produce unprecedented geo-political blackmail and even trigger World War III.

Coal is similar to oil in its effects but may last a century (at present growth rates) massively increasing the CO_2 blanket, the corrosive oxide content of the air and rain acidity. The franticly increasing strip mining will permanently destroy at least nine states and major river systems. Its use only postpones and worsens the ultimate population crisis which is especially ironic since, if not burned in one frenzied century, it could be used as a source of substrate for yeasts to supply the protein needs of a one billion person solar powered world for over one million years!

Fission may be the (dangerous) bridge between the present insane petroleum era and a benign solar future unless we start massive population control education and accelerate the solar transition plan (see below) now. This could be the case if in 1985 the atmospheric CO_2 level prohibits further use of coal. If we use uranium without the breeder reactor it will last less than 40 years at present growth rates[11]. It is probably too late for the breeder reactor which, due to its ten-year doubling time, could only meet 25% of our electrical demand by 2000 AD! Fission has among its terrible problems: (1) two-thirds of the energy released appearing as thermal pollution, (2) risk of nuclear blackmail; (3) the waste produced in one year circa 1985 is expected to have as much radioactivity as would be produced by 67,000 atomic bombs(!), (4) accidents may occur, and (5) a single $10,000,000 judgment this year has set a potentially bankrupting (and possibly justified) precedent for radiation exposure of uranium workers and miners.

Fusion may turn out to be an expensive myth (if we are fortunate). We may never achieve break even containment of pure deuterium fusion with its "boundless sea" source. The deuterium-tritium reaction, popular because of its much lower ignition temperature, uses a mined resource (lithium) again. Developing shortages of helium, copper, and aluminum may save us from proliferation of fusion plants even if the containment problems are solved.

THE LONG RANGE ALTERNATIVE (PLAN)

Relationship of the Two Plans

The long range plan applies when world population has fallen to the one billion goal and its energy needs can be met by two compatible forms of solar, hydroelectirc and on-site conversion. The transition plan necessarily hybrid in nature, applies while population is falling from that of the chaotic high demand present to that of the peaceful world (and fossil and nuclear power systems are being phased out over the next seven decades or so). The relatively homogeneous system of the long range era is made possible by technological advances of this decade in solar energy conversion and storage coupled with the population decrease. Solar power without storage is almost as incomplete as a car without wheels. Such a system might heat your house, for example, only in the summer during the day! Fortunately, two of the oldest forms of solar energy, biomass and water power, involve storage: trees that grow in the summer months can be burned in the winter without secular change in atmospheric CO_2; warm season water runoff can be stored behind dams to turn turbines in the winter. Later we will discuss some more modern means of solar energy storage (and conversion)

both for the long range plan and for the transition hybrid energy economy. We now show the long range era needs can be met by a relatively homogeneous combination of hydroelectirc and on-site solar conversion systems. This will free both land and people from biomass farming and other energy production tasks. If indicated by world conditions to be in the public interest, an educated populace can willingly, coherently and easily adjust its numbers and or its energy use by five or ten percent on the time scale of about two decades. In the long range era, our monitoring and understanding of the energy/climate interactions will be more complete and the small population/energy adjustments may be used to influence climate and sea level. It seems probable that net CO_2 absorption (by reforestation and decreased combustion as mentioned above) may be necessary for the first century of the long range era. Things will not go so smoothly in the beginning (now). By 1985, we expect to have some understanding of how severe the atmospheric CO_2 problem will be. This information will be used by DOE in deciding the future use of coal[12].

The Hydroelectric Potential

Although the hydroelectric potential of the world, 3 Tw, is 60% of the 5 Tw power goal, only 5% had been developed by 1965. There were a number of reasons for this: (1) fossil fuel was a cheap and convenient form of energy, (2) in a densely populated world earthquake rupture of dams is a serious problem, (3) with present methods, the storage volume behind the dam can be lost by silt deposits, (4) the land covered by water behind the dam is missed on a crowded earth, and (5) the ecological impact of a dam can be very complex. In the long range era, these problems will be gone or soluble. Dams can be located far from cities with large uninhabited crop regions between the large dams and distant low level flood containment barriers or canals that can be part of irrigation systems. Proper design and preparation of the watershed, such as seeding arid regions with savannah grasses that thrive on low rain fall, can minimize erosion and dam volume loss. In many rivers, energy can be extracted without losing arable land for water storage by using low head dams with axial flow turbines which can mechanically pump water to higher elevations for energy storage (in hilly country) or irrigation and or provide electricity for use or storage (note that although storage of electricity is inefficient it is generally better than failure to withdraw any energy from the kinetic flow). Pumped storage is already being incorporated where feasible in high head dams. Future high dam structures might incorporate thin compliant sections parallel to the plane of symmetry to minimize tectonic fracture. Although the problems with dams are less damning than those in most other energy systems, research in the area has not received large support because it is considered the pygmy of the power scene. In fact, in the U.S. only 3% of our total power is supplied by hydroelectric. However, if our entire feasible hydroelectric potential were developed, this 300 watts per capita (w/c) would be 800 w/c at our present 200 million population and 3200 w/c for 50 million people (our share of the long range population goal). Thus we see that hydroelectric potential alone equals 64% of our 5 Kw/c total energy goal in the long range plan. Notice that if we did not develop a single additional percent of U.S. hydroelectric potential (only 37% developed to date), the present 300 w/c becomes 1200 w/c (24% of our needs) at the population goal. It should be pointed out that North America only has 11% of the world's hydroelectric potential. Many other countries, especially heavily populated third world areas, are much better off in this respect. For example Africa has 28% = 4000 w/c and South America has 20% = 1500 w/c at present populations. Now, let us see how we obtain the remaining 36% (1.8 Kw) of our per capita power goal for the long range era in America.

On-Site Solar: The Roof of the Future

We have less than 2 Kw/capita to provide. If the average house or apartment contains 3 people we need 6 Kw per dwelling roof top. This would require only 6 m^2 (approximately 6 square yards) normal to unfiltered sunlight. However because of night, weather and latitude effects a factor of about 6 is needed giving 36 square yards (18 feet by 18 feet) per dwelling. Prior to recent developments, this energy could be stored as heat, for short times (days) only in aquifers, rocks, or heat-of-fusion tanks (n.b. the much publicized cycling problems with Glauber's salt have recently been solved[14]). Also, prior to research just now succeeding, conversion of sunlight to electricity would require multiplication of the above area by an impractical factor of ten because of the ten percent efficiency of solar cells. However, great advances in (1) direct conversion of solar energy to hydrogen by photolysis in synthetic membranes, (2) indefinite storage of hydrogen as interstitial "metal hydrides" (MH), and (3) direct production of electricity in a fuel cell, provide a triad that promises to change the picture of on-site conversion of solar energy. As a result the roof top area needs to be multiplied by a factor of two (or less) for conversion efficiency giving an area of 18 by 36 feet (or less) which is still acceptable for a dwelling roof. Nobel Laureate Melvin Calvin expressed the belief that photolysis of water by synthetic membranes at 75% efficiency (!) should be feasible as a major source of energy in about a decade. He states that we already understand the hydrogen side[15]. There are reports that European investigators have made the oxygen side and have coupled the two. Photolytic production by algae[16] also appears promising. The 1980 conference at DOE's Solar Energy Research Institute should be interesting in this regard. Storage of hydrogen in metals is making rapid progress with a number of economic alloys fitting specialized needs for utilities, transportation and residential applications[17]. Prototype cars and buses have been built and successfully road tested[18]. It is possible that within two decades, your house and your car will run on hydrogen stored in MH tanks. The large tank or "bed" of your house would be charged by your solar roof system and your car would be charged while plugged into the house at night. Service stations would either recharge your car or, conceivably, exchange tanks. Dwelling electricity would be provided by a hydrogen fuel cell at about 60% efficiency, or drain from the public utility as at present.

THE TRANSITION ALTERNATIVE (PLAN)

The Beginning

Until there is widespread conviction regarding the stark reality of the matters set forth in the first section, there will be no coherent population reduction by free choice. Until it begins, we cannot enter the transition period in the complete sense of decreasing numbers coincident with a rising standard of living (notice that the population falls to about 25% of the 1972 value but energy use only decreases to 83%). The transition can be made in only 70 years if one-half the man-woman pairs have only one child and one-half have none. It is quite common for educated people to prefer remaining childless today. Thus a massive program is necessary to stimulate social conscience, as well as to educate in the facts of the world situation. Once the population goal is reached, its maintenance would require an average of two children per adult pair. Although political, educational, social and logistical difficulties of considerable magnitude will exist, they clearly do not even vaguely compare to the suffering of hundreds of millions starving today, let alone what the holocaust would bring to us all. There is no choice.

The Scheme

We wish to increase food production and distribution with fertility control education and assistance. At the same time we wish to decrease atmospheric CO_2 by scheduling biomass growth to exceed combustion additions to the environmental inventory. Both of these ends can be facilitated by massive increases in the already well established SCP industry (single cell protein (yeast) grown on carbonaceous substrate to be derived from coal instead of petroleum). The amount of coal needed for world protein will be such a microscopic fraction (probably less than 10^{-3}) of what is produced today that strip mining should be stopped and the companies paid to restore the denuded land, to work on hydroelectric projects, and on pumped storage for the latter as well as for large scale solar arrays in the southwest. The petroleum industry should be motivated and or aided to enter the processing of coal to SCP substrate and oil to

plastics, chemicals, etc. Public transportation and small (500 cc) personal cars should be encouraged by heavy non-linear taxation of vehicle mass and fuel rationing if necessary. It has been calculated that shifting most of our ton miles of passengers and freight back to rail transportation could save 20% of the total energy expenditure in the U.S. and reduce pollution by about 40%[21]. Both commercial and residential building taxes should in part be determined by computer calcuations of energy use. The work week should be shortened to four days or as needed to remove existing and any resulting unemployment. Large scale manufacturers of displaced products (such as heavy passenger cars, etc.) should be aided in the transition to production of such items as the residential and commercial on-site solar "triad" (photolytic arrays, hydride storage units and fuel cells), Like the automobile, only intensive research and mass-production can make these systems attractive in cost (initially, subsidy may be necessary to develop the market). Strong tax incentives should encourage any new construction to be well insulated multiple-unit apartment buildings having minimum surface to volume ratio and location near employment centers and public transportation. Fewer nuclear plants will be necessary if they can be made more efficient by locations in which the "thermal pollution" two-thirds of the energy can be stored in underground rock formations or aquifers for winter use (community size aquifers to provide winter heating or summer cooling have recently been shown to be practical[19]). The extent to which biomass or any combustible can be used for fuel at a given time will be determined by the extent of reforestation, the status of the CO_2 problem and problems related to the economics of biomass (it is difficult to get more calories out than are put in, the lack of markets equipped to handle biomass in developed countries, etc.). Extensive reforestation should be pushed both for its effects on climate and the accumulation of biomass potential. At present estimates of 10 barrels of biomass oil per year[22], it would take 2.5 acres per person to support 5 Kw/c. However, it is not clear from the literature what energy input is necessary to cultivate, harvest, process and transport this material. Therefore I have not included biomass in the energy budget[20]. Perhaps future developments will produce suitable production efficiencies. In the meanwhile, we see that some areas would have enormous surplus hydroelectric potential if population uniformly reduced by four (i.e. Africa 16,000 w/c), and others undoubtedly not enough. Since the percent of potential to be developed will vary also, corresponding local compensations must be made in the fraction of the energy supplied by direct solar conversion or in the resident population fraction. In areas that, by virtue of latitude and or weather, have too little sunlight for on-site conversion, and have insufficient water power, other forms of energy such as geothermal, biomass (if trees or plants can be grown and processed locally with sufficient net energy gain and if world CO_2 levels permit combustion), or long distance electrical transmission may be possible. The high cost of energy in such regions may discourage settlement and industry. Undoubtedly, additional factors, unpredictable at this time, will influence migration and regional population densities in the solar powered world.

The energy needs at the end of the transition period (and hence for the long range era) may be even less than the 5 Kw/c we have projected above. For example, many industries and crops that now take enormous quantities of energy will have disappeared. For example: deep coal mining will be reduced by a factor of 1000 (as discussed previously) and strip mining will be non-existant; in the non-expanding non-throw-away closed cycle economy there will be almost no mining of metals (including iron, copper, aluminum, uranium, etc.) and little processing of steel (primarily recycling); there will be essentially no weapon manufacture except, possibly, for the small United Nations peace keeping force; because of universal education in biology the demand for crops like tobacco will have disappeared; with the economic and varied form SCP (yeast protein) the demand for animal protein from both land and sea will be greatly diminished, resulting in large reductions in corn and other animal feed crops (note the SCP is already used as an animal feed), and major reductions in the construction and operation of fishing "factory" ships, oil tankers and ore freighters; without the frantic pressure and pressed schedules of the present stressed economy, there may be very little construction and operation of jet aircraft; etc. As a result of less labor expended to get the goods and services that an educated society will demand, the work week will be shortened to perhaps 10 or 12 hours. This is man's one true economic victory, the victory over time, not having to spend every daylight hour to survive.

The single major obstable to all of the progress toward peace described here is organized religion, I have been informed by members of Congress. However, religion has changed its dogmas before; no major denomination today denies the findings of science, nor would any burn Bruno at the stake for stating the earth encircled a sun that has "spots." Religion claims to support conditions that promote peace and decrease human suffering through starvation, disease, etc. I feel optimistic that the church will recognize its obligation and opportunity to save humanity by using its great power to advance the scientific population control so desparately needed at this time. If it does, every child will be wanted, prisons may become extinct, and the church's membership may become universal. Even I would join.

In summary, we have outlined the principal characteristic steps in the transition plan's main goals with emphasis on (1) reducing energy waste to minimize the energy needs and prolong the life of existing fuels, (2) accelerating development and installation of solar conversion and storage systems (especially photolytic, hydroelectric, pumped storage, heat-of-fusion, and metal hydrides, with emphasis on "on-site" systems) to minimize the energy gap as fossil fuels fail or are discontinued before the population goal is reached, and (3) to adjust the nature of industry, housing, energy use, food and employment in directions bringing the economy into equilibrium with ecology, and (4) ultimately to provide a uniform high standard of living for the one billion population goal on the 5 Tw energy goal using solar power after phasing out nuclear plants at the end of the transition period.

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SECURING AN 80% COST OF CONSTRUCTION BANK LOAN FOR A PASSIVELY-HEATED SOLAR HOME WITH NO BACK-UP HEATING SYSTEM: SOLAR WITHOUT SUBSIDIES

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Builders and developers of solar heated housing face a delemma in financing the construction of their houses. While solar energy has received much publicity, loans to citizens have funded a wide range of solar housing alone. Government, at both the state and national levels, has supported solar development through decrees with no funding as well as through highly regulated tax credit laws with limited savings. Lending institutions, however, are still reluctant to finance solar housing.

Alpine Energy Homes has secured an 80% cost of construction loan for financing a passively heated solar home with no back-up heating system. There are three aspects of the design which were instrumental in securing the loan. 1) Alpine Energy Homes' passive system which is built into, rather than added onto a structure is a cost-efficient method of storing the sun's energy. 2) Secondary benefits of the house design are stressed. These include the cost of steel and concrete versus wood construction, prevention of dry rot and insect infestation, reduction of fire hazard, isolation of living space from outside noise, and reduction in the possibility and cost of storm damage. 3) A design approval was secured for federal and state tax credits for the owners of the home.

A SELF-PUMPING DOWNWARD HEAT TRANSFER SYSTEM - VAPOR BUBBLE PUMP

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ABSTRACT

Solar-assisted domestic water heating has been mentioned as the most economical application of active solar collection systems. This type of system is still dependent upon an external energy source to transport the heat collected to the storage and use areas, with the exception of a thermosyphon collector. Altough the thermosyphon system is self-circulating, it is restricted by the necessity of having the storage area above the collector plates. This presents structural and insulation problems for the storage and limits the application (thermosyphon system) when retrofitting existing dwellings.

Several methods have been suggested for self-transporting heat downward including thermodynamic power cycles, vapor latent heat transport systems, osmotic or capillary pumping, a ferrofluid propelled by a permanent magnetic field, and a vapor bubble pump (VBP) transport system. Two of these systems appear to be more promising than the rest, the latent heat transport system and the vapor bubble pump.[1] Considering these two systems the design simplicity of the VBP is more applicable for adaptation to solar heat.

DISCUSSION

The VBP when combined with a solar heat collector is a completely self-sufficient energy source that is extremely suitable for use not only in the Northwest, but throughout the entire country. The lack of an external energy source when combined with the simplicity of design makes the VBP-solar collector attractive for use by homeowners and small businesses.

G. P. Wachtell in [1&2] suggested the VBP as a possible mechanism for a self-pumping downward heat transporting system. The literature reviewed, shows only [1&2] adapting the VBP to solar heat collecting systems. In the other papers, air or a low boiling liquid (freon) were added to the system, from an external source, to lift water and particles from a submerged site. 5 to 9.

A laboratory model was constructed based on schematic and head relationships from[1]. Figure 1. The original model was constructed with 1.75 inch copper tubing fittings for the condenser and separator units, 0.5 inch copper tubing and fittings for the system piping and heat exchanger. The heat source is a 700 watt immersion heater with controller, and the thermal storage a tank containing approximately four (4) pounds of water. Heat was introduced to the system at the rate of

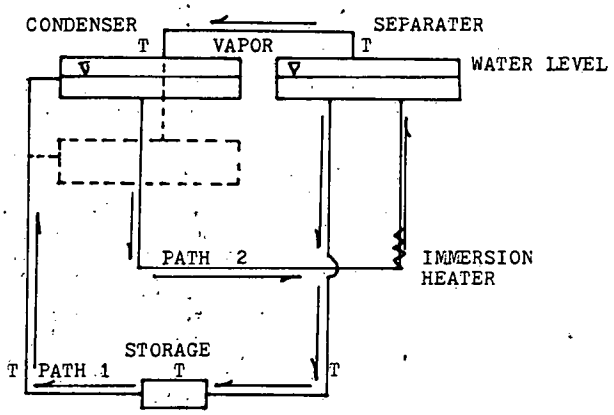

FIGURE 1

400 to 1000 BTU/hr producing steady flows from 1 to 1.25 GPH. Original head relationships were

$$\text{Path 1} \quad Y_1 - (Y_2 - D)$$

$$\text{Path 2} \quad Y_2 - D > Y_3 - D$$

from ref. 1. Initial operation of the model suggested that the head for Path 2 was not as above, but $Y_1 + D$. Flow measurements showed that the flow decreased after one hour of operation by 25% but then remained constant for an additional three hour test period. Temperatures remained steady after the first 0.5 hour of testing, with a inlet temperature of 69°C, and a outlet temperature of 55°C for the duration of the test. A clear plastic tube was substituted for the separater-condenser vapor piping and the test rerun at the same inlet and outlet temperatures. The flows behaved as in the first test, and the water level in the tube remained at its initial elevation, confirming the $Y_1 + D$ relationship for the head for Path 2. The condenser was then raised to the level of the separater, increasing the contact area of the condenser from 0.2 in^2 to 17.5 in^2. This modification produced similar initial flows as configuration 1, but the flows remained constant, for a four hour test period with similar inlet, 69°C, and outlet, 55°C, temperatures, suggesting that condenser area or efficiency is a control for steady state flow

conditions. Further modifications, lowering the heat source, thus increasing the head for Path 2 produced similar flows as configuration 2, indicating that the vapor bubble generation and upward movement of the vapor may be a major flow producing force, not the heads. Increasing the length of Path 1 produced similar steady initial flows for a short period, 15 minutes. The flow than began to surge, ranging from zero flow to flows up to 10 time the initial steady rate for short periods, 1-3 seconds. This condition also indicates that the flow rate is a product of the vapor formation and movement, and that initially there is sufficient vapor for steady flow, but that the condenser is not efficient enough to return the vapor to the system to maintain the steady flow, because of the additional resistance to flow produced by the longer path.

During testing, two different water sources were used, producing different results. Initially, tests were conducted using rapid flowing stream water with a high degree of dissolved oxygen and flows of 1 to 1.25 GPH were recorded. Subsequent testing with well water with little dissolved oxygen produced no measurable flows. Upon aerating the well water and further testing, similar flows (1 to 1.25 GPH) were observed, reinforcing the supposition that gas bubble production is one controlling parameter for steady flow. Aeration will have to be used when demineralised or distilled water is used as a transport liquid.

SUMMARY

The VBP when combined with a solar heat collector is a completely self-sufficient energy source that is extremely suitable for use not only in the Northwest, but throughout the entire country. The lack of an external energy source when combined with the simplicity of design makes the VBP-solar collector attractive for use by homeowners and small businesses.

The VBP is not limited to solar application alone. Today many families, particularly, in the Northwest, are returning to wood heat as a primary heating source. They are also trying to adapt these wood stoves, furnaces, and fireplaces to provide hot water for the household.[3] Some of the same restrictions of the thermosyphon system, apply to this conversion particularly if no additional energy source is used. The VBP would make this type of conversion feasible in just about every instance.

For steady state flows, a liquid with a high percentage of dissolved gases and an efficient condensing unit are necessary. If domestic water is used as a liquid, its source should be known and aeration introduced if little dissolved oxygen is present.

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WIND POWER AT BOARDMAN, OREGON, AND BREAK-EVEN ECONOMICS

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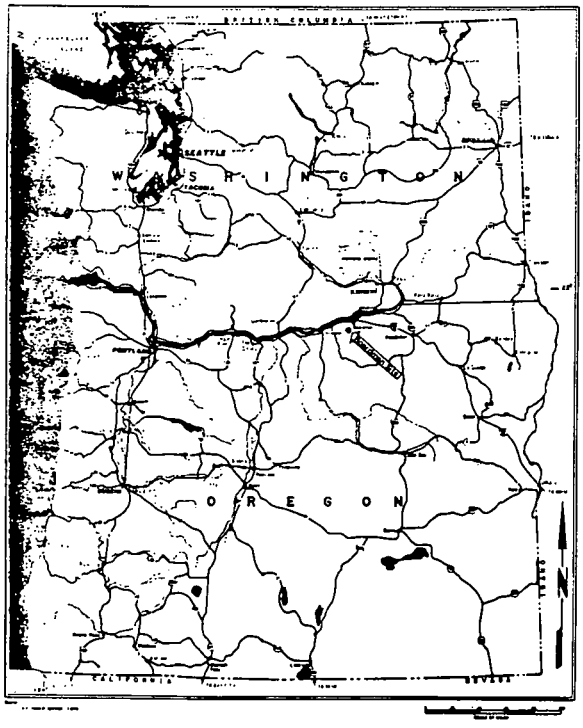
ABSTRACT

Five years of wind data at Boardman, Oregon is analyzed for expected electric energy generation from large (1-3 MWe) horizontal axis wind turbine generators. Break-even investment costs required for wind turbine generators to economically operate in the Pacific Northwest are examined. Three variables can improve the break-even economics: higher average annual capacity factors, higher amounts of capacity credit, and lower fixed costs. Other uncertainties for the wind energy technologies to overcome before being considered for commercial applications are demonstrated operating compatibility within a utility system, reliable performance, and outage data. Only years of on-site testing will answer these questions.

INTRODUCTION

Since April 1973, Portland General Electric Company (PGE) has been monitoring wind speed data from a 230-foot meteorological tower located near the town of Boardman, Oregon in the north central part of the state - just upriver from the Columbia River Gorge (see Figure 1).

Figure 1. Location of Boardman, Oregon



The area, approximately 700 feet above mean sea level, is of relatively flat desert terrain and is not subject to the harsh winter climate characteristic of much of the mountainous regions of the Pacific Northwest. A major highway, rail tracks, and transmission facilities are nearby, as well as a coal-fired plant under construction.

Five years of average hourly wind speed data from this site have been analyzed in order to project hourly electric energy generation from large (1-3 MWe) horizontal axis wind turbine generators. An in-house wind energy system computer model was used to perform the simulation. The results are summarized in Figure 2.

Figure 2. Boardman, Oregon Wind Data[1]

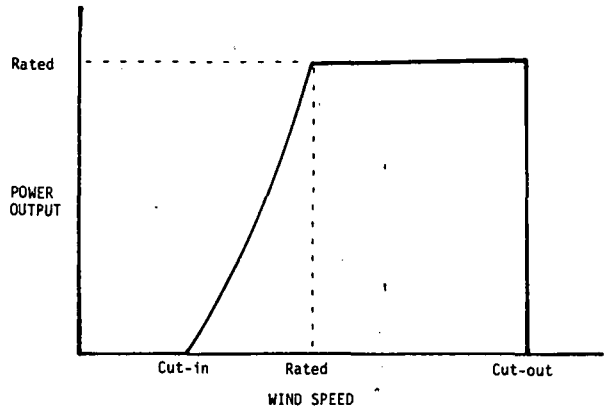
	4/73-3/74	4/74-3/75	4/75-3/76	4/76-3/77	4/77-3/78
Hours of Recorded Data	6993	6844	6174	8562	8562
Data Recovery	80%	78%	70%	98%	98%
Average Wind Speed (mph) @ 130'	15.8	13.7	14.3	12.1	11.6
Maximum Wind Speed (mph) @ 130'	57.1	56.2	50.8	57.1	55.0
Hours Below Cut-in (10.1-10.6 mph) @ 130'	2488-2637	2914-3076	2331-2458	4237-4401	4544-4564
Hours Above Rated (21.4-25.7 mph) @ 130'	1209-1936	752-1312	677-1287	652-1274	517-1067
Hours Above Cut-out (41.3-46.6 mph) @ 130'	36-100	34-78	4-31	3-19	9-11
Availability Factor:					
. Zero[2]	26-33%	18-24%	19-25%	20-27%	18-25%
. Average[3]	30-40%	20-28%	22-32%	20-27%	18-25%
. 20 mph[4]	36-49%	30-42%	34-49%	21-29%	19-26%
. Hours of Data[5]	33-41%	24-31%	27-36%	21-27%	18-25%
MWH/square meter	5.6-5.9	4.1-4.3	3.9-4.1	2.9-3.0	4.3-4.4

1. The ranges in values correspond to two different wind turbine generator designs.
2. Zero wind speed used for missing data.
3. Average wind speed used for missing data.
4. 20 mph wind speed used for missing data.
5. Calculation based upon hours of recorded data.

mph = miles per hour
MWH = megawatt-hours

Since wind power output is a function of the cube of the wind speed (and also of the square of the rotor diameter), the magnitudes of the actual wind speed levels are of prime importance. Therefore, three levels of wind speeds are significant in wind power terminology: the cut-in wind speed, the rated wind speed, and the cut-out speed.

Figure 3. Wind Power Output as a Function of Wind Speed



As shown in Figure 3, the cut-in speed is that wind speed at which a wind turbine generator will start to generate usable electric energy. The rated wind speed is that wind speed at which a wind turbine generator will generate the maximum capacity of the unit. In between the cut-in and rated, the power output varies in proportion to the cube of the wind speed; while beyond the rated, the output is constant as it is limited by the generator rating. The cut-out wind speed is that wind speed at which a wind turbine generator will initiate a shutdown for safety reasons. Therefore, no wind energy will be generated when winds are below the cut-in or above the cut-out.

ANALYSIS OF WIND DATA

As shown in Figure 2, the data recovery ranged from 70-98 percent. Although the missing data does not allow a complete and meaningful simulation, it does give a lower bound and, as shown in the availability factor results, some sensitivity analysis was done. The most conservative approach was to assume that the missing hours were at zero wind speed. A more reasonable assumption was to assume that the missing hours were at the yearly average wind speed but, since the yearly average is barely greater than the cut-in, a 20-mph wind speed was also examined. Here, the dramatic effect on output of wind speed cubed is readily apparent. In addition, the availability factor was calculated based upon the hours of recorded data. This last measure assumed that the missing hours contribute as similar energy as do the recorded hours and, barring any unusual relationships between wind patterns and recording equipment outages, this measure should be the most meaningful.

As shown, the resultant availability factors during the five years of record essentially ranged from 20-40 percent. It should be noted here that these are not annual capacity factors because there is no consideration for planned or forced outages. No data exists to indicate the average annual level of these outages, but if 5 percent is assumed, then the 40-percent availability would correspond to a 35-percent annual capacity factor. At this capacity factor, each 2 MW-sized wind unit could supply the energy-equivalent requirements of 450 residential customers in PGE's system.

The potential wind energy in the area swept by the rotor is indicated by the MWH/meter^2 expression and is based upon the hours of recorded data. The average annual efficiency of converting the potential wind energy to electric energy, based upon the Boardman data, is on the order of 14-23 percent. The ranges in the performance values in Figure 2 reflect the simulation of two different designs of horizontal axis wind turbine generators.

ECONOMIC COMPETITIVENESS

The average annual capacity factor is the key variable in determining whether wind energy is an economically competitive resource. This is due to the fact that the more efficient the unit (i.e., the more energy generated) the lower the unit energy cost, which does minimize the only significant cost - the initial investment. Besides capacity factor, other significant variables are the level of carrying costs associated with the investment and the level of capacity credit.

Figure 4. Wind Power Break-Even Economics

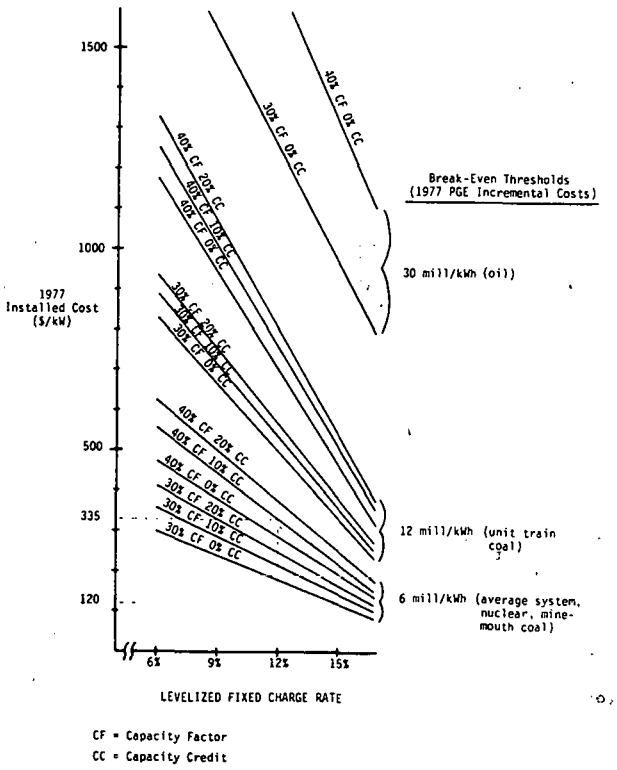


Figure 4 displays the break-even economics that wind energy technologies will have to compete against within the PGE and Pacific Northwest electric utility systems. This figure shows the 1977 installed cost of a wind energy technology required to break even with existing incremental system energy costs. As shown, the break-even installed cost is a function of the three uncertainties: the levelized fixed charge rate, the average annual capacity factor, and the amount of capacity credit.

The levelized fixed charge rate is the uniform annual percentage which, when applied against the investment, yields the present worth equivalent of the expected nonuniform revenue requirements of the investment. The annual capacity factor is the percentage of the energy generated during a year divided by the maximum possible. The amount of capacity credit is the percentage of conventional generating capacity which may be eliminated from a utility's planned expansion requirements if a wind plant is brought on line.

This break-even cost study is a life cycle analysis of all the costs involved, including the wind-related costs, the conventional power plant costs, and the break-even (or threshold) costs. The assumptions used in this study are summarized in Figure 5.

Figure 5 Assumptions

- 7% per year cost escalation
- 9-1/2% discount rate
- 30-year economic life
- 1977 wind turbine generator O&M cost of $6.80/kW-yr
- Future conventional capital cost of $765/kW for a 1977 in-service and a 15% levelized fixed charge rate

The three break-even threshold levels indicated in Figure 4 are for the 1977 PGE system and are included mainly for relative comparison. For example, the oil threshold level is almost meaningless for both PGE and for the region because essentially zero energy is generated from oil-fired generation. This level does show, however, the value of wind energy (i.e., the relative high break-even investment costs of $1000-$1500 per kW) and illustrates why wind-generated energy is more likely to be economically competitive in a utility system where oil-fired energy is a significant contributor. For another example, the unit train coal threshold level represents the operating cost of a future coal plant which, for at least the next 10 years, will be the only coal-fired plant with unit train delivery of coal in the Pacific Northwest. Since PGE's 1977 average system cost was only 6 mills/kWh (and the region's was less), this unit train coal plant, due to its high fuel transportation cost component, could be one of the latter plants dispatched and likely be limited to less than full-year operation. In this sense, the 12-mill/kWh threshold value is marginal, as something closer to 6 mills/kWh would be more indicative of economic viability.

Therefore, as shown by the dashed line in Figure 4, if a utility has a wind site which could support a lifetime average annual capacity factor of 30 percent, 0-percent capacity credit, and has a 15-percent levelized fixed charge rate, it could economically afford to invest in a wind plant costing $120 per kW (total capital cost for a 1977 in-service) whose total energy cost would then equal (in a lifetime present worth sense) an operating cost of 6 mills/kWh in 1977, subject to 7 percent per year escalation thereafter.

WAYS TO IMPROVE ECONOMIC COMPETITIVENESS

There are three ways to improve the break-even investment cost for wind energy technologies: higher average annual capacity factors, higher levels of capacity credit, and lower levelized fixed charge rates. There is little control over the first two, as they are basically wind-site specific, while the third is controllable since it is subject to the financial, governmental, and regulatory communities.

The only way to improve the average annual capacity factor is to have a site or sites where there is more available wind energy. Years of data collection, or correlation to existing data, is the only way to verify if another site has potential for higher average annual capacity factors. The only two ways to improve the level of capacity credit are to have geographically dispersed sites or to provide for dedicated storage. Dedicated storage is new system capacity which could be charged by the wind plant and then be available to be discharged at times of need. Dedicated storage devices could be batteries, flywheels, compressed air, pumped hydro, thermal storage, etc. The only way to improve the levelized fixed charge rate is to have financial incentives, which in turn reduce the fixed costs of owning the investment. These last two variables (capacity credit and fixed costs) will be discussed further in subsequent paragraphs, but suffice it to say that, as shown in Figure 4, the $120 per kW break-even investment cost could be improved almost threefold to $335 per kW if some other site could support a lifetime average annual capacity factor of 40 percent, 10-percent capacity credit, and the owner could realize a 12-percent levelized fixed charge rate.

INTERACTION WITH HYDRO RESOURCE

It must be kept in mind that the Pacific Northwest region is highly dependent upon the relatively cheap hydroelectric resource. This resource performs two functions: energy storage (capacity) and energy production. The storage capacity, which helps meet short-term high electric energy demands, is essentially fixed and is relatively large, whereas the energy production is relatively half as large and is extremely variable since it is a function of the amount of water flowing downriver. For example, the difference between a good water year and a bad water year can be as much as 7000 average MW - the equivalent of ten 1000-MW-sized thermal plants. For at least the next 10-15 years, this large hydroelectric storage capacity, combined with the region's characteristic low number of days that contribute to the system peak load, tends to minimize the need for new capacity (peaking) resources. Energy (base and intermediate load) resources are needed instead.

Hydroelectric-generated energy in the Pacific Northwest represents approximately 50 percent of PGE's energy production and approximately 90 percent of the region's. This high regional dependence is expected to decrease to about 60 percent by 1990 as thermal-generated energy is brought on-line to meet load growth. On one hand, this abundant hydroelectric resource tends to discourage wind energy from economically penetrating the system because of the amount of costly and nonrenewable fuel to be saved; thus, the value of wind-generated energy, is small. On the other hand, however, the hydroelectric capacity could act as system storage, which would effectively shift the timing of wind-generated energy so as to displace the thermal fuel when it does operate. Although system storage does not add capacity to a system (i.e., no capacity credit), it does improve the fuel replacement value of wind-generated energy. And, it is in this sense that wind generators, operating in conjunction with the region's vast hydro storage system, could make that otherwise marginal 12-mill/kWh threshold level much more meaningful. One drawback to this, however, and it was not addressed in this study, is that the cost (monetary as well as environmental, social, and political) for using the system storage was not considered.

CAPACITY CREDIT

In theory, if wind turbine generators are added to an existing system, they can be viewed either as "fuel savers" or as generating units with some level of capacity credit. Fuel savers would be wind units whose operation is used solely to back off the burning of fuel in existing thermal plants and therefore would not be relied upon for system capacity (i.e., zero capacity credit). However, in the extreme opposite sense, wind turbine generators could theoretically have 100-percent capacity credit (which implies 100-percent reliability), but this is unrealistic since no power plant, even a hydroelectric one, is that dependable. Plus, the biggest hurdle is that wind turbine generators are limited to full capacity output only at times when winds are at or above rated wind speeds (but less than the cut-out), and are then further restrained to partial capacity output when winds are between the cut-in and rated wind speeds. In other words, no wind capacity output is available when wind speeds are below the cut-in or above the cut-out. As shown in Figure 2, operation at rated capacity at Boardman would be limited to 6-26 percent

of the time, while zero capacity would be realized between 36-53 percent of the time. Again, bear in mind that these percentages are based upon the five years of somewhat incomplete data and are without consideration for plant outages.

Therefore, due to the unreliable nature of the wind energy resource and the relatively low worth of near- to mid-term capacity need in the Pacific Northwest, the amount of capacity credit is likely to be in the 0-20 percent range. Dedicated wind storage can, however, increase this level of capacity credit, but only at the expense of higher investment costs. It should be noted here that the amount of capacity credit is also a function of wind energy penetration. That is, as more wind energy capacity is added to a utility system, the amount of capacity credit declines because a higher percentage of system generation is subject to the vagrancies of wind availability. Geographical dispersion of wind turbine generators could improve this situation somewhat because probabilities indicate that the wind is always blowing somewhere. However, to arrive at any confident level of capacity credit, many years of wind speed data at dispersed sites have to be analyzed.

FINANCIAL INCENTIVES

Another variable that can improve the attractiveness of wind energy technologies is the reduction of the carrying costs associated with the investment. In this study, the levelized fixed charge rate does reflect these carrying costs, whose major components are: return of investment (depreciation), return on investment (interest, dividends), federal and state income taxes, and ad valorem (property) taxes. If financial incentives could be made available, they would have the effect of lowering the carrying costs which, as shown in Figure 4, improves the break-even economics. Potential incentives could be: low-interest loans, investment tax credits, grants, accelerated depreciation methods, fossil fuel displacement credits, property tax credits, and income tax credits. Also, electric utility regulators could allow higher rates of return on wind-generating plant investments.

STILL IN THE RESEARCH STAGE

The large-scale central station wind-driven electric energy technology is currently in its research, development, and demonstration (RD&D) phase of its life cycle. At present, no large-scale commercial units exist. Years ago, remote areas of rural America did utilize small-scale dispersed commercial units, but these were quickly phased out when the more reliable and less expensive electric energy was made available. Today, however, in light of ever-increasing fossil fuel prices and the federal government's desire to reduce America's oil dependency, the RD&D phase of wind energy development has received accelerated attention and investment. But, in order for wind generators to become a commercially available alternative for the electric utility industry, they must meet certain requirements - the first of which is to successfully complete its RD&D phase. This completion is not expected for several more years as the first demonstration units are just starting up and need several years of experience to demonstrate their operating compatibility, reliability, and generation performance. Once this happens, they will then become a commercially available alternative, subject to the acceptability criteria of any new plant addition (i.e., economics, reliability, mix of resources, environmental, social, political, etc.). Also, and probably just as important to a prospective owner, is advance knowledge of, and confidence in, the wind data of proposed sites. As shown in this paper, advance knowledge of wind data allows prediction of wind plant performance by year and, thus, expected economics.

CONCLUSION

It's generally known that the Columbia River Gorge area, along with the coastal areas of Oregon, is rich in the wind energy resource. It has been shown here that one area of the Columbia River Gorge - the Boardman, Oregon area - is one good example of a potential site for employing large-scale central station wind turbine generators. Based on five years of on-site data collection, the potential for economic viability, even within the low-cost Pacific Northwest, is encouraging and could be improved further if financial incentives are made available to the electric utility industry. The current RD&D efforts by both the federal government and the electric utility industry are attempting to demonstrate the technical feasibility, operating reliability, and system compatibility of harnessing this resource. The commercial availability as a generating alternative may not be far away.

NS/Bklm2A3

ESTIMATING PASSIVE SOLAR PERFORMANCE AND ECONOMICS

Tom Wilson
Alan D. Kiphut
Oregon Department Of Energy
Salem, Oregon 97310

ABSTRACT

While working with F-CHART and PASOLE computer programs, it became evident that a simple method for simulating the performance of passive designs was needed. With this in mind, the Oregon Department of Energy has written an interactive computer program (PASFRAC) which combines the Solar Load Ratio (SLR) method, the F-CHART 3 data base and utility heating load data. A separate subroutine has been developed to perform economic analyses. Both computer programs, and their parameters, are described below.

PASFRAC - ESTIMATING PASSIVE SYSTEM PERFORMANCE

This program contains a variety of parameters to allow for the use of existing, readily available data formats and the best available information. The parameters are:

1. City Call Numbers
The F-CHART program provides degree days and insolation values for a number of cities in Oregon and the rest of the U.S. The Oregon locations used from this file are Astoria, Burns, Corvallis (corrected data), Medford, North Bend, Pendleton, Portland, Redmond and Salem. The same F-CHART call numbers for these cities are used in the PASFRAC program.

2. Heating Load Coefficients
If an actual heatload is not available or inappropriate, a heat loss analysis of the building components must be performed. This heat loss factor, expressed in BTU/degree day, can then be used in the program.

3. Wall Type
There are four wall types which can be simulated: a) Water Trombe, b) Water Trombe with night insulation, c) Mass Trombe, and d) Mass Trombe with insulation. Direct gain systems may be approximated by a Mass Trombe system. Attached greenhouses are difficult to simulate generally and are not included in this program.

4. Load Method
This parameter indicated the method for calculating heat loss. Either heatload data or degree day calculations can be used. Parameter 5 shows areas in Oregon for which heatload files are available. Degree day calculations use the coefficient from parameter 2, the correction factor from parameter 8, and the degree day values from parameter 1.

5. Heatload File
Actual utility heatload data was used to establish values for different areas of the state. Currently, heatload figures are on file for the following regions: The Valley, Coast, East/Central, and Southern, with separate values for existing homes, existing insulated homes and new homes.

6. Solar Absorbtance
This is the absorbtance of the surface collecting the radiation. This does not include the losses due to glazings - these are taken into account in the program.

7. Collector Area
This is the area of mass wall absorbing radiation.

8. Correction Factor for Degree Day Calculations
Values for heat loss which are calculated by multiplying the load coefficient (BTU/DD) by degree days are generally incorrect. We have observed these values to be as much as twice the actual load data. Conventionally, a factor known as the NEMA constant has appeared in heat loss equations to compensate for periods of negligible heat demand. For this program, we have simply called this a correction factor, and recommend a value of .5 to .6.

PASFRAC PROGRAM OUTPUT

Using the parameters described above, the program delivers monthly figures for load, absorbed radiation, Solar Load Ratio, Solar Heat Fraction, and delivered load from solar.

ECONOMICS PROGRAM

To perform economic analyses, a general subroutine was written in Fortran. Input parameters to this subroutine are: Initial system cost; amount of down payment; fraction of heating load met by alternate system; fuel costs of a conventional system during the first year; first year maintenance and insurance costs of the alternate system; number of years of the loan for a system; number of years to run the analysis; rates of inflation for fuel and maintenance costs; loan interest rates; discount rate; marginal income tax rate of the owner, and various options for State and Federal tax credits.

The subroutine computes various values for each year of the analysis. These include the principle still owed on the loan, the amount of interest paid, fuel cost savings over a conventional system, tax credit savings, income tax savings due to interest deductions, and expenditures on maintenance/insurance. The subroutine also calculates the number of years until the system achieves positive savings and payback.

A Fortran program was written to call this subroutine and allow interactive changes in the various parameters. The output of the program is similar to that produced by F-CHART, presenting a table of output parameters by year, and the years of payback and positive savings. Having a separate economics program allows the consideration of several scenarios (inflation rates, tax credit options, etc.) for the same system with a given heating fraction. This avoids having to perform a solar analysis for each economic analysis. As a stand alone economics program, it

is applicable for analyzing several different types of actions: in addition to active and passive solar systems, the economics of geothermal systems and insulation measures have been analyzed.

CONCLUSIONS

The Oregon Department of Energy has used PASFRAC and the economic program to analyze the economics of installed passive systems through the Oregon tax credit program. Of the systems certified by the Department at the time of the analysis, over 85% achieved payback within a 30 year period. Most of the systems that achieve payback do so in under 20 years, and with the benefit of the Oregon tax credit, the majority of the systems reach positive savings in 2 years.

REFERENCES

Balcomb, J.D. and McFarland, R.D., A Simple Empirical Method for Estimating the Performance of a Passive Solar Building of the Thermal Storage Wall Type, 2nd Natl. Passive Solar Conference, Vol. 2, pp 277-289, 1978.

Figure 1

Example of PASFRAC Output

	A	B	C	D	E
Jan	1.14	5.91	.19	.11	.65
Feb	2.74	5.12	.54	.30	1.54
Mar	7.26	3.93	1.85	.73	2.87
Apr	13.46	2.35	5.72	1.00	2.35
May	19.36	1.21	16.47	1.00	1.21
Jun	19.05	.68	28.70	1.00	.68
Jul	19.05	.50	37.89	1.00	.50
Aug	11.11	.59	18.90	1.00	.59
Sep	5.29	1.39	3.81	.94	1.31
Oct	2.22	2.78	.80	.42	1.17
Nov	.97	5.17	.19	.10	.52
Dec	.72	5.75	.13	.06	.35

A. Absorbed Radiation (MBTU)
B. Monthly Load (MBTU)
C. Solar Load Ratio
D. Solar Heating Fraction
E. Delivered Load (MBTU)

Figure 2

ECONOMIC ANALYSIS OF $3,600 PASSIVE INSTALLATION

```
ENTER PURCHASE COST,FUEL COSTS, SOLAR FRAC, MAINT? 3600,400,.5,28
FRACTION DOWN? .1
TAX CREDIT OPTION (0=NONE,1=STATE,2=FED,3=BOTH)? 1
ANNUAL PAYMENT IS  380.57
YEAR OF POSITIVE SAVINGS--  2
YEAR OF PAYBACK--  15
 1   400.00   200.00   794.57     0.00   113.40  -481.17  -481.17  3183.43
 2   432.00   216.00   399.65   900.00   111.42   827.77   298.48  3121.20
 3   466.56   233.28   400.79     0.00   109.24   -58.27   270.06  3052.76
 4   503.88   251.94   402.01     0.00   106.85   -43.22   253.85  2977.46
 5   544.20   272.10   403.29     0.00   104.21   -26.98   252.25  2894.64
 6   587.73   293.87   404.66     0.00   101.31    -9.48   267.99  2803.53
 7   634.75   317.37   406.10     0.00    98.12     9.40   304.19  2703.32
 8   685.53   342.76   407.63     0.00    94.62    29.75   364.36  2593.08
 9   740.37   370.19   409.26     0.00    90.76    51.69   452.48  2471.82
10   799.60   399.80   410.98     0.00    86.51    75.33   573.06  2338.43
11   863.57   431.78   412.80     0.00    81.85   100.83   731.19  2191.71
12   932.66   466.33   414.74     0.00    76.71   128.30   932.61  2030.31
13  1007.27   503.63   416.79     0.00    71.06   157.91  1183.78  1852.77
14  1087.85   543.92   418.96     0.00    64.85   189.81  1491.96  1657.48
15  1174.88   587.44   421.27     0.00    58.01   224.18  1865.34  1442.66
16  1268.87   634.43   423.71     0.00    50.49   261.22  2313.10  1206.35
17  1370.38   685.19   426.30     0.00    42.22   301.12  2845.52   946.42
18  1480.01   740.00   429.04     0.00    33.12   344.09  3474.17   660.49
19  1598.41   799.20   431.95     0.00    23.12   390.37  4211.96   345.97
20  1726.28   863.14   435.03     0.00    12.11   440.22  5073.37     -.00
      (a)      (b)      (c)      (d)      (e)      (f)      (g)      (h)
```

a= conventional fuel costs; b= backup fuel costs; c= down payment, mortgage,maintenance/insurance; d= tax credit; e= tax write off; f= net savings; g= accumulated savings; h=principal remaining.

PNWSEA and Affiliates

PLANNING MEETING OF SEA BOARD MEMBERS & GUESTS
August 9, 1979

On Thursday August 9th, members of PNWSEA's Board met with representatives from all of PNWSEA's local affiliate chapters. Present were the board members from Columbia SEA, Western Washington SEA, Inland Empire SEA and Willamette Valley SEA. Also present were Don Aitken, Chairperson of the Passive Division of the American Section of the International Solar Energy Society AS/ISES and Lee Salmon, AS/ISES chapter coordinator.

The meeting focused on the future role and scope of PNWSEA activities. Some present felt that PNWSEA should be disbanded and that state or local solar associations would be a better focus of solar activity. Most present, however, saw a need for a regional conference, regional networking activities (a newsletter at least), and a regional perspective on energy issues (e.g., a need exists for unity amongst solar advocates concerning Senator Jackson's regional power bill).

It was agreed that a need exists to upgrade the services PNWSEA offers to its members. The following actions for improving the organization were proposed:

1) All PNWSEA Board members should be nominated by a vote of their individual chapters (this would require a by-laws change).
2) PNWSEA and local solar association dues structures should be made uniform to avoid confusing the public.
3) The PNWSEA Board should seek to fund a full-time staff position (to be located where Sunstrokes is published, currently Seattle) to work on the newsletter, network around the region, and be a focal point for PNWSEA activities.

Lastly, Lee Salmon and Don Aitken urged organizations in the region to use the services of AS/ISES and to become more involved in the organization.

MINUTES OF THE PNWSEA ANNUAL MEETING
August 11, 1979

Board members present: Boleyn, Brown, Drumheller, Eder, Goodnight, Reynolds

News of last year's activities:

1) There are four officially recognized subchapters - Western Washington SEA, Columbia SEA, Inland Empire SEA, Willamette Valley SEA.
2) Dues structure was adopted to encourage joining local SEAs & PNWSEA (combined membership). After conference (Solar '79) dues are $10/yr if member of local SEA or AS/ISES; if not a member of these then dues are $15/yr.
3) PNWSEA Board endorsed Clark County PUD's Passive Solar Home Award Program.
4) PNWSEA now an official, non-profit, tax-exempt (501-c-3) organization.
5) Board resolved that future AS/ISES conferences be held in ERA states.
6) Board took a position on Northern vs Southern California SEA's autonomy.
7) Selection of a logo for PNWSEA.

Motion approved to accept new logo with shaded background, as it appears on the back page of SunStrokes, Summer 1979, No.5.

The Fall 1981 National Passive Conference will be in the Northwest. PNWSEA will be officially invited to bid on this - actually we already have.

Solar '79 status report: over 1300 registrants! A great job. Thanks Jill Goodnight.

Lee Salmon, AS/ISES Chapters Caucus, gave a series of reasons to join AS/ISES and some history: ISES started with some radical pioneers, scientists, and backyard tinkerers. Now AS has 4,600 members in 28 chapters. There are a total of 10 to 12,000 members in the chapters; therefore, many chapter members are not AS/ISES members also. One of the problems is that it costs too much ($25/yr). The benefits are:

1) Subscription to Solar Age magazine (this costs $20/yr just by itself). Solar Age has many good issues-related articles as well as good technical information.
2) Low cost availability of detailed technical information such as the proceedings of the 3rd Passive Conference (non-member price is $65, member cost is only $19).
3) Reduced conference fees from 25 - 30%.
4) Present availability of low cost group life insurance; possible expansion to include medical insurance if enough people are interested.
5) Dues are tax-exempt.
6) Inclusion into Topical Divisions; ability to affiliate with 2 out of 9 topical divisions. Some of these have newsletters.
7) Membership directory of all AS/ISES members to help people get in contact with others.
8) Voting privileges. Chapters Caucus working on supplying 25% of AS/ISES board members from chapters to increase voting strength of chapters.

What do we want AS/ISES to do for us? AS/ISES is a coordinating organization. We need to decide on our strengths and AS/ISES can help us put our resources into action. Volunteers are a renewable resource if used correctly. We all need help to reach out and assist others in their efforts.

Suggestions:

1) Canada has a good citizen participation program - check it out, duplicate if possible.
2) Generate an inventory of skills of members, suggest priorities and ideas to match the skills. Help members get in contact with each other.
3) Add new people to mailing list - not just true believers. Use mailing of newsletters and other information as an outreach function to such people as legislators, bankers, utilities, civic officials, media contacts, etc.
4) Solar education. Put a packaged slide show together to present to clubs and organizations. Bring fact sheet to organizations.
5) Communicate - the obstacle to communication is usually the feeling that it has already been accomplished.

AS/ISES is not a "political" organization (non-profit status and definition of purpose). AS/ISES can and does provide technical input to effective political organizations such as Solar Lobby. Address: American Section/ International Solar Energy Society, P.O. Box 1416, Killeen, TX 76541.

Note: Both SOL (Solar Oregon Lobby) and Citizens for a Solar Washington are political organizations that are working with SEA's and other groups.

New Business:

Motion passed: "To consider, within the next month, combining our next solar conference (1980) with the Canadian National Solar Conference (to be held in Vancouver B.C.) or to have a 30 to 60 day time lapse between conferences".

Motion passed: "Board directed to propose (in cooperation with local SEA's) chapter representation on Board".

Suggestion that PNWSEA alter dues structure such that affiliate SEA's pay only one charge (i.e.,$10)and membership in PNWSEA is automatic.

Motion to dissolve PNWSEA failed.

Motion passed: "The Board is directed to provide by October 1st, 1979 a clear and publicly understandable picture of PNWSEA and its relationship to the local SEA's with attention to:

a)dues structure - common fiscal year
b)a name that is identifiable to the public
c)clear connection to local affiliated groups"

The Board has three positions open. Names solicited for nomination will be mailed out to members for election to the Board. Nominations so far are: Perry Lovelace, Bruce O'Halloran, John Owen, Bruce Bolme, Norm Clark, Mary Lawrence, Laird Parry, John Hogan, John Jennings, Doug Still, George Reynoldson, Dan Smith, Greg Higgins and Bill Kingrey. Ballots will be mailed out - write-ins will be accepted.

Motion passed: "PNWSEA secure funding to support one full-time person to perform the following functions:

1)Information outreach - providing responsive output to SEA's and other Pacific Northwest groups.
2)Library networking - promote establishment of other libraries that are coupled to resource people in the region.
3)Solicit input and publish SunStrokes. Produce more frequent news "briefs" for up-dated news.
4)Help facilitate local projects by providing information and support.

INLAND EMPIRE SOLAR ENERGY ASSOCIATION

The Inland Empire Solar Energy Association (IESEA) is a public nonprofit educational association whose primary purpose is to further the use and development of solar energy and its related arts. With members from a region covering Wenatchee to Coeur d'Alene and Sandpoint to the Tri-Cities, IESEA holds public seminars, lectures, panel discussions and workshops on topics of immediate concern. With energies primarily focusing in Spokane, IESEA's meetings are held monthly or bi-monthly.

During their first year they published a newsletter with items and articles of interest. Now for the next year they have combined efforts with the Pacific Northwest Solar Energy Association (PNWSEA) in putting out a quarterly newsletter containing articles of regional interest. They also joined forces with the Center for Environmental Understanding on putting out a newsbulletin.

Membership participation is growing and needs to be encouraged even more. Areas needing input and attention include designand materials, passive solar, economics, legislation, publicity, fundraising and newsletter.

For further information and for those with ideas, please contact by letter or phone:

- Deborah Warner-Witt/2822 13th Street
  Coeur d'Alene, ID 83814 (208)667-3077
- Cris Salsbury/N. 4609 Post Street
  Spokane, WA 99205 (509)326-6009
- John Shaw/8001 Englewood Crest Drive
  Yakima, WA 98908 (509)965-0891

WESTERN WASHINGTON SOLAR ENERGY ASSOCIATION

WeWaSEA is a grass roots organization formed in 1978 by those interested in furthering the use of solar energy--in households, business, government and the community. Our concern for solar energy includes direct and indirect solar radiation, wind, renewable biological products and other facets of energy conservation and renewal. Members include interested individuals and energy professionals in many fields. This variety of personal input helps WeWaSEA to achieve its main purpose of being a link between people who want timely and credible information on solar energy and the professionals and groups who can provide such aid. This purpose is supported by our monthly newsletter and meetings, tours, speakers, films, equipment displays, legislation and tax updates as well as professional discussions on solar design, maintenance and installation.

WeWaSEA serves Washington State west of the Cascades. We are a subchapter of the Pacific Northwest Solar Energy Association, which is an affiliate of the American Section of the International Solar Energy Association.

Committees include program, legislation, library, publicity, technical review and workshop. Our meetings are open to the public and are held the second Wednesday of every month at 7:30 p.m. in the Washington Natural Gas Building in Seattle. Our mailing address is WeWaSEA, PO Box 1869, Seattle, WA 98111.

WILLAMETTE VALLEY SOLAR ENERGY ASSOCIATION

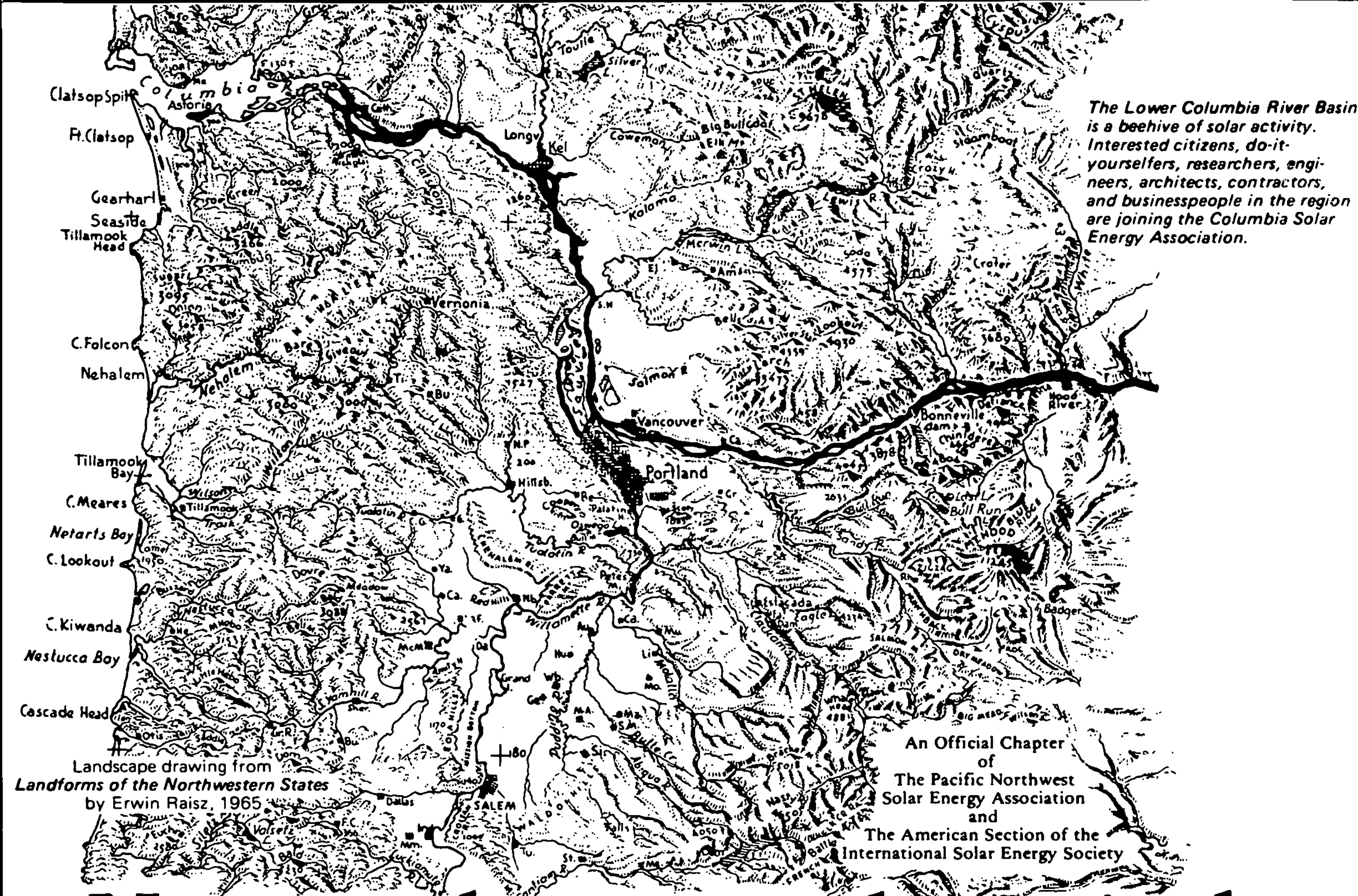
The Willamette Valley Solar Energy Association (WVSEA) was formed at a meeting of local solar enthusiasts held in May of 1979. The purpose of the association is to further solar energy and related arts, sciences, and technologies with concern for the ecologic, social, and economic fabric of the region. The organization will seek to raise the level of public awareness of solar energy's potential. This is to be accomplished through the exchange of ideas and information, by means of meetings, publications, workshops, demonstrations and tours of local solar projects. The geographic boundaries are the southern half of Oregon.

THE WVSEA board, through its desire to promote a high level of membership participation which also extends into the community, has formed the following WVSEA subcommittees: 1) workshops--to organize workshops leading to hands-on construction experience on greenhouses, food driers, flat-plate collectors and other solar components and systems; 2) land use/ordinance--to help local municipalities in establishing land-use evaluation conducive to the use of alternative energy in subdivision layouts, solar access rights, etc; 3) political action--to help WVSEA communicate solar-related information to the city council, planning commission, and other public and private bodies affecting solar use in our communities; 4) membership--to promote growth of WVSEA; 5) lectures/program--monthly lecture programs by knowledgable solar people to the WVSEA membership and general public; 6) solar resource/publication--to help establish where pertinent solar publications can be found in the community, in the local region, or national references; 7) book sales--to provide substantial discounts on energy-related references to WVSEA members; 8) newsletter--a monthly publication listing the WVSEA activities and programs, Pacific Northwest activities as well as national conferences and events, with special articles focusing on the works of local solar designers and contractors.

WVSEA has a regularly scheduled meeting on the second Tuesday of each month, with individual WVSEA subcommittee meetings as required.

Present board members are Steven Baker, Allan Gubrud, John Hogan, Art Paz, and Jean Reeder.

For further information, contact the Willamette Valley Solar Energy Association at PO Box 524, Springfield, Oregon 97477 or call (503)747-8823.



The Lower Columbia River Basin is a beehive of solar activity. Interested citizens, do-it-yourselfers, researchers, engineers, architects, contractors, and businesspeople in the region are joining the Columbia Solar Energy Association.

Landscape drawing from
Landforms of the Northwestern States
by Erwin Raisz, 1965

An Official Chapter
of
The Pacific Northwest
Solar Energy Association
and
The American Section of the
International Solar Energy Society

New members are welcome in the Columbia Solar Energy Association.

- *Solar Energy works in the Pacific Northwest. Existing successful projects as well as the many solar projects now in design and construction attest to the growing place of solar in the region.*
- *The Columbia Solar Energy Association, founded in late 1978, is a non-profit grassroots organization dedicated to further solar energy and the related arts, sciences and technologies with concern for the ecologic, social and economic fabric of the region.*
- *Meetings are held monthly and have included presentations and lectures by special guest speakers and by members. Updates on solar news and the opportunity for fellowship are important parts of the meetings.*
- *CSEA members will be listed in the Annual Directory and will receive reduced admission to the Annual Northwest Solar Conference, in addition to other benefits.*

Columbia
SOLAR
ENERGY
ASSOCIATION

SEND TO:
Columbia Solar Energy Association
4015 SW Canyon Road
Portland, Oregon 97221

☐ Please enroll me as a member. *Annual dues of $10 enclosed.* *

*($5 to members of the Pacific Northwest Solar Energy Association)

Name

Street **Home Phone**

City, State **ZIP CODE** **Work Phone**

Meeting information and membership directory form will be sent in acknowledgment.

PNWSEA

pacific northwest solar energy association
2332 e. madison, seattle, wa. 98112

What are we?

PNWSEA is a grassroots, technical-professional organization whose primary purpose is to further the development of solar energy with concern for the environmental, social and economic fabric of the region. This is being accomplished through such activities as those listed below. PNWSEA serves to inform the public and institutional and governmental bodies of the Northwest states of Washington, Idaho, and Oregon and seeks to raise the level of public awareness of its purposes. We are affiliating with the American Section of the International Solar Energy Society (ISES-AS).

Who are we?

We are strictly a pro-solar organization and want to attract a wide base of pro-solar people regardless of background, employer, political affiliation, or attitudes about other energy sources. We want the best technical expertise, the strongest pro-solar advocates and activists, members of solar industries, and educators--as well as those citizens simply interested in keeping up with solar progress in our region.

What do we do?

Depending upon the strength of our members involvement, and keeping in mind that PNWSEA activities will be centered to a large extent around the activities of local chapters, our goals are as follows:

* provide a means of information exchange among members, primarily through the publication of the PNWSEA newsletter, SunStrokes, four to six times per year;
* coordinate the annual Northwest solar conference and exhibit;
* provide the general public, the media and policy makers with an independent source of credible and technically sound solar information for applications in the Northwest;
* serve as a clearinghouse for identifying solar projects, speakers, building sector participants, information sources and directories, etc., in the Northwest;
* facilitate the organization of workshops and educational seminars through local affiliates, drawing upon the materials and technical resources developed through its membership & clearinghouse activities;
* develop other activities and directions as initiated by its membership.

PACIFIC NORTHWEST SOLAR ENERGY ASSOCIATION
Membership Application Form

NAME _____ PHONE _____
ADDRESS _____ CITY _____ STATE _____ ZIP _____
AFFILIATION _____

PLEASE CHECK THE AREAS OF YOUR GREATEST PERSONAL INTEREST AND CIRCLE THE AREAS ON THE LEFT IN WHICH YOU HAVE EXPERTISE AND/OR WOULD LIKE TO ASSIST IN DEVELOPING MATERIALS FOR PNWSEA USE:

INTEREST AREAS

// annual conference & exhibit
// general information
// system design--passive, active, hybrid
// installation and maintenance
// equipment supplier directory
// research--system performance, economics, area of research:_____
// consumer protection
// financing, appraising, insuring, etc.
// regulatory code, zoning & sun rights
// legislative activity
// educational institutions
// information networking, newsletter
// utility interface
// media relations
// speakers' bureau

SOLAR TECHNOLOGIES

// solar hot water
// solar heating (passive & active)
// solar cooling (passive & active)
// large wind systems
// small wind systems
// biomass
// small head hydro
// solar-thermal
// solar-thermal-electric
// photovoltaics
// wind data collection
// solar radiation data collection
// biomass availability data
// water power data
// energy efficient design
// other:_____

ANNUAL MEMBERSHIP

	UNAFFILIATED	member AS-ISES*	member of an affiliated PNWSEA chapter #
UNEMPLOYED	$5.	$5.	$5.
STUDENT	10.	5.	10.
REGULAR MEMBER	15.	10.	10.
CONTRIBUTING MEMBER	$50.		
SUSTAINING MEMBER	100.		

* AS-ISES: American Section of the International Solar Energy Society. If you are a member, please list the topical division(s) of which you are a member.

\# This amount applies when combined PNWSEA and affiliated dues equal the regular $15. dues. For a list of these associations write to PNWSEA.

ANY CORRESPONDENCE, INCLUDING PNWSEA APPLICATIONS WITH DUES OR NEWSLETTER CONTRIBUTIONS, SHOULD BE SENT TO:

PACIFIC NORTHWEST SOLAR ENERGY ASSOCIATION

2332 EAST MADISON
SEATTLE, WA 98112

Conference Participants

THE FOLLOWING IS A LIST OF NAMES, ADDRESSES AND SOLAR INTERESTS OF PERSONS ATTENDING SOLAR '79 NORTHWEST, AS INDICATED ON REGISTRATION FORMS. THE KEY TO THE INTEREST CODES TO THE RIGHT OF EACH NAME IS AS FOLLOWS:

1-Solar Heating/Cooling, Domestic Hot Water
2-Homebuilding
3-Greenhouses
4-Biomass & Woodheat
5-Industrial & Commercial
6-Education
7-Legislation & Community Action
8-Regional Power
9-All Other, Including Solar Electric, Simulation, Radiation Monitoring

THE NAMES ARE ALPHABETIZED WITHIN ZIP CODES FOR CONVENIENCE IN LOCATING PERSONS BY NEIGHBORHOOD OR TOWN. IT IS HOPED THAT THIS LISTING WILL ENCOURAGE FOLLOW-UP ACTIVITY BETWEEN PERSONS ATTENDING THE REGIONAL SOLAR CONFERENCE.

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ID NAT ENG LAB

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M P SCOFIELD
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1115 E BELMONT
CALDWELL ID 83605

CLYDE EGELUND 127
CANYON CTY WINTERIZ PROG
1115 E BELMONT
CALDWELL ID 83605

JAMES GIPSON 129
JAMES GIPSON, ARCHITECT
187 EAST BEACON LIGHT
EAGLE ID 83616

GEORGE HARRINGTON 123
US FISH WILDLIFE SERV
RT 1 HWY 44
EAGLE ID 83616

MICHAEL WERT
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SANDY OR 97055

ED COLOMBI 123
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DEER ISLAND OR 97054

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409 LINCOLN ST
THE DALLES OR 97058

TOM AYRES
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CANNON BEACH OR 97110

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PLUMBING SERVICE CO, INC
90 RIDGEWAY AVE
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BEAVERTON OR 97002

WILLIAM A SWANSON 15
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2485 SW ELMHURST
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9069 SE JANNSEW RD
CLACKAMAS OR 97015

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8TAR RT BOX 1367
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HILLSBORO OR 97123

HAROLD & LATOEDA MCFARLAN29
615 S FIRST
HILLSBORO OR 97123

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RYCO MFG INC
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OREGON JOURNAL NEWSPAPER
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2035 DAVCOR
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TOM WILSON 9
WESTERN SUN/OREGON DUE
3640 LIBERTY RD S #48
SALEM OR 97302

ERNEST & BETTY GRAVES 31
SOLAR TECH
257 DEARBORN N
SALEM OR 97303

RON RICH
685 LARRY AVE N
SALEM OR 97303

KEN KONGSLIE 21
2990 DEERING DR NW
SALEM OR 97304

RAY JOHNISEE 123
JOHNISEE BROTHERS CONST
PO BOX 12787
SALEM OR 97309

FRANK SCHMIDT
522 SW 7TH AVE
ALBANY OR 97321

CATHERINE M KAPEK 123
362 SW 8TH ST
CORVALLIS OR 97330

DAVE ROBISON 257
OREGON DEPT OF ENERGY
LT I BLDG
SALEM OR 97301

JOHN CHRISTIAN 137
MID WILLAM COMMY ACTION
2035 DAVCOR
SALEM OR 97302

CHARLES E HAWKES
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SALEM OR 97302

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MWV COMMUNITY ACTION AG
2035 DAVCOR
SALEM OR 97302

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SALEM OR 97302

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ENVIRONMENTAL INTERFACES
2795 RANDI LANE NE
SALEM OR 97303

GARY TIEGS 167
ENVIRONMENTAL INTERFACES
2795 RANDI LANE NE
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RT 1 BOX 244-2
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REP NANCIE FADELEY
OR STATE LEGISLATURE
HOUSE OF REP
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RT 3 BOX 780-B
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2035 DAVCOR
SALEM OR 97302

JEFF REMPFER 12
245 LUTHER ST S
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JAMES D ELKINS 125
VALLEY ROLLING MILLS INC
2025 HYACINTH NE
SALEM OR 97303

RICHARD A MARX 125
VALLEY ROLLING MILLS INC
2025 HYACINTH NE
SALEM OR 97303

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LINCOLN CITY OR 97367

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614 E 15TH APT B
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88285 GREENHILL
EUGENE OR 97402

RONALD A PRICE 127
C/O 978 W 3RD
EUGENE OR 97402

DONALD PFEIFER 231
720 NW 35TH
CORVALLIS OR 97330

OWEN D OSBORNE 16
OSU EXTENSION SERVICE
114 DEARBORN HALL
CORVALLIS OR 97331

WILLIAM R MCMAHON 14
OR STATE UNIV
BOX 183
JEFFERSON OR 97352

DOUGLAS PARMETER
RT 2 BOX 183D
SHERIDAN OR 97378

KEN BEESON 87
527 EAST 18TH
EUGENE OR 97401

BILL COLLINS 213
BOARD FOOT WOODWORKERS
767 W 8TH
EUGENE OR 97401

H GEORGE & SHARON GODDAR123
156 E 19TH AVE
EUGENE OR 97401

JANE LIDZ 123
UNIVERSITY OF OREGON
961 LAWRENCE
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UNIV OF OR
1010 ALDER
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BALZHISER & COLVIN ENG
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POLK CO HSG AUTH
204 SW WALNUT
DALLAS OR 97338

MARILYN SLIZESKI 123
DALLAS HOUSING
13490 KINGS VALLEY HWY
MONMOUTH OR 97361

CHARLES L BLIEGE 1
HITEK, INC
42673 AMES CREEK DR
SWEET HOME OR 97386

DUANE BISCHOFF 132
90205 GREENWOOD DR
LEABURG OR 97401

NANCY COSPER
CASCADE MAGAZINE
BOX 1492
EUGENE OR 97401

MARLAND H HENDERSON 1
WHITE BIRD & SUN
425 GARDEN WAY N
EUGENE OR 97401

MIKE MUMFORD 156
SCHAUDT, STEMM & WALTER
388 HIGH ST
EUGENE OR 97401

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LANE CO EXTENSION SERVICE
950 W 13
EUGENE OR 97402

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CARY CONST
1480 W 11TH
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EPA
ROUTE 2 BOX 190A
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SAN JOSE STATE UNIV
STAR ROUTE 1 BOX 11
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POLK CO HOUSING
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1235 MILL #2
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LANE CTY HSNG/COMM DEV
141 KNOOP LANE
EUGENE OR 97404

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2579 ALDER
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THOMAS MOFFETT 214
32250 FOX HOLLOW RD
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STEPHEN STILL 19
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355 BROKEN OAK LOOP
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1259 MOSS
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KLH INC
386 LODERQUAI LANE
EUGENE OR 97404

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365 W 29TH AVE
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TOM LAVELLE
EUGENE REGISTER GUARD
665 W 29TH PL
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BANDON OR 97411

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1205 QUINCY
COTTAGE GROVE OR 97424

J PATRICK STEVENS 19
80 BENNETT CREEK RD
COTTAGE GROVE OR 97424

H D AXTELL 19
EUGENE WATER & ELEC BD
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EUGENE OR 97440

JEAN REEDER
EUGENE WATER/ELECTR BOARD
PO BOX 10148
EUGENE OR 97440

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DISTRICT 6 MANPOWER
880 SE JACKSON
ROSEBURG OR 97470

RUSSELL K RADCLIFFE
428 W CENTER
ROSEBURG OR 97470

JOEL GOSS 14
MARQUESS ENGINEERING
151 N 4TH
SPRINGFIELD OR 97477

ARTEMIO PAZ
86950 CEDAR FLAT
SPRINGFIELD OR 97477

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BOX 86
UMPQUA OR 97486

DOUG KENDALL 213
11141 TAKILMA RD
CAVE JUNCTION OR 97523

ARDEN HANDSHY 2
BOX 921
JACKSONVILLE OR 97530

QUINTIN MCBAIN 124
WEYERHAUSER
328 JEFFERSON
KLAMATH FALLS OR 97601

DOUG STILL 187
PO BOX 188
COTTAGE GROVE OR 97424

CASCADE JOURNAL OF NW
1 W 5TH AVE BOX 1492
EUGENE OR 97440

RICHARD S WHEELER 231
PO BOX 10023
EUGENE OR 97440

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CROACH HARRIS PLBG/HTNG
2448 W HARVARD
ROSEBURG OR 97470

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SPRINGFIELD OR 97477

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JIM PIERCE 514
ODYSSEY ENGINEERING
2508 DUMAS DR
SPRINGFIELD OR 97477

F JEROME HUNTER 134
HUNTER, SHUTE & MARTIN
1175 E MAIN
MEDFORD OR 97501

SCOTT CUMMINGS
SUNERGI
1998 FOOTS CREEK RD
GOLD HILL OR 97525

A WONDERLIGHT
12138 REDWOOD HWY
WONDER OR 97543

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2972 SOUTH 6TH ST
KLAMATH FALLS OR 97601

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CRESWELL HIGH SCHOOL
PO BOX 522
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NEDCO/OREGON APPROP TECH
BOX 1525
EUGENE OR 97440

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MARK HOOD 128
ROSEBURG ELEC WHOLESALE
1520 NE STEPHENS
ROSEBURG OR 97470

MARVIN A DENMARK 126
855 N 54TH ST
SPRINGFIELD OR 97477

ROBIN LILLEY 712
SPRINGFIELD PLNG DEPT
126 N FOURTH ST
SPRINGFIELD OR 97477

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SUNNY VALLEY KOA
140 OLD STAGE RD
SUNNY VALLEY OR 97478

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TAKILMA OR 97523

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GRANTS PASS OR 97526

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90472 SHEFFLER
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1259 CENTENNIAL
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KERRY HOLMAN 123
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BELLEVUE WA 98005

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ENGINEERED SYSTEMS
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SUNDAY SOLAR SYSTEMS
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REDMOND OR 97756

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SISTERS OR 97759

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SCIENCE APPLICATIONS
13400B NORTHRUP WAY #36
BELLEVUE WA 98005

V K RAJPAUL 123
BOEING AEROSPACE CO
25 SKAGIT KEY
BELLEVUE WA 98006

LYLE LUTTON 312
THE SOLARIUM

SISTERS OR 97759

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BEVERLY KYO
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BOX 701
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PUGET SOUND POWER & LIGHT
PUGET POWER BLDG
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14605 56TH AVE WEST
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6221 143 SW
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WAYNE M ROBERTS 123
27055 8TH AVE S
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SIXTO GALLARDO 713
ACTIVE MEXICANOS
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BRAD SHINDER 238
1425 S PUGET DR
RENTON WA 98055

PETER A HOLT 127
15205 232ND NE
WOODINVILLE WA 98072

CAROLYN D GEISE 231
TERMINAL SALES BLDG #712
FIRST & VIRGINIA
SEATTLE WA 98101

TOM KEEL
THE PATON CORP
1018 SEATTLE TOWER
SEATTLE WA 98101

GLENN MARTIN 19
JOHN GRAHAM COMPANY
1110 THIRD AVE
SEATTLE WA 98101

JAMIE ROGERS
204 JOSHUA GREEN BLDG
SEATTLE WA 98101

PATRICK SMILEY 19
JOHN GRAHAM COMPANY
1110 THIRD AVE
SEATTLE WA 98101

JOELLEN COURTNEY 68
416 E ROY - H
SEATTLE WA 98102

SCOTT MACGREGOR 185
RICHERT & ASSOC
4311 SE 36TH
MERCER ISLAND WA 98040

CRAYTON ETCHESON 9
THE BEVELING STUDIO
16128 NE 87TH
REDMOND WA 98052

PAUL R MARTIN 17
607 S 17TH ST
RENTON WA 98055

EVAN SIMMONS 123
RT 1 BOX 694A
VASHON WA 98070

PY BATEMAN
KRAB-FM/VIACOM CABLE
1000 UNION 202
SEATTLE WA 98101

JIM HILLIER 19
JOHN GRAHAM COMPANY
1110 THIRD AVE
SEATTLE WA 98101

GURUMEKH KHALSA
UPI
6TH AND WALL
SEATTLE WA 98101

RICHARD L MOORE 123
DEPT HOUSING & URBAN DEV
1321 2ND AVE
SEATTLE WA 98101

JEFF SANDYS 19
THE PATON CORP
1018 SEATTLE TOWER
SEATTLE WA 98101

ERNEST J TEICHERT
NATL PARK SERV
4TH & PIKE
SEATTLE WA 98101

DAN HARDIN
226 13TH AVE #C
SEATTLE WA 98102

ROSEMARY M ESPE
7107 226TH PLACE
MT LAKE TERRACE WA 98043

DAVID L WILSON 124
11441 WILLOWS RD
REDMOND WA 98052

KONDO I NASSOR 961
817 N 4TH #204
RENTON WA 98055

STEVEN SPICKELMIRE 123
QUALITY CARPENTRY SERVICE
BOX 247
VASHON WA 98070

PATRICIA BROWN 1
JOHN GRAHAM CO
1110 THIRD AVENUE
SEATTLE WA 98101

MILTON HUERTAS 19
JOHN GRAHAM COMPANY
1110 THIRD AVE
SEATTLE WA 98101

EDWARD MAH 19
JOHN GRAHAM COMPANY
1110 THIRD AVE
SEATTLE WA 98101

ERLING OLSEN 19
JOHN GRAHAM COMPANY
1110 THIRD AVE
SEATTLE WA 98101

ARUN SHAVERI 19
JOHN GRAHAM COMPANY
1110 THIRD AVE
SEATTLE WA 98101

DON COATE 37
1104 E NEWTON
SEATTLE WA 98102

MARGUERITE G HEARD 123
WALDRON POMEROY POLK SMTH
416 E ROY APT B
SEATTLE WA 98102

PETER HIATT 21
UNIVERSITY OF WASHINGTON
520 12TH AVE EAST-B
SEATTLE WA 98102

THOMAS E LENCHEK
BALANCE ASSOCIATES
201 SUMMIT AVE E
SEATTLE WA 98102

JULIE SCHOTT
2006 FEDERAL EAST
SEATTLE WA 98102

SHARON WILLONGHLEY 237
202 13TH AVE E
SEATTLE WA 98102

BOB BERGSTROM 125
STAFFORD/HILL LTD
4020 ASHWORTH AVE W
SEATTLE WA 98103

ANNE EMIGH
9239 DAYTON
SEATTLE WA 98103

CLYDE HAGLUND 123
7003 PALATINE N
SEATTLE WA 98103

JERRY MONTI
6525 PALATINE AVE N
SEATTLE WA 98103

JOHN TITCOMB
4333 PHINNEY AVENUE N
SEATTLE WA 98103

Q CASSUTT 397
400 YESLER BLDG
SEATTLE WA 98104

JIM DEWEY
CITY BLDG DEPT
503 MUNICIPAL BLDG
SEATTLE WA 98104

TIM HOYT 214
EWU
733 SUMMITT AVE E #210
SEATTLE WA 98102

GREG LYLE
2309 11TH E
SEATTLE WA 98102

ED SIEGEL
2813 BROADWAY E
SEATTLE WA 98102

TALLIS WOODWARD 214
U OF W LAW SCHOOL
733 SUMMITT AVE E #210
SEATTLE WA 98102

SCOTT BOOTH 1
8801 MIDVALE N
SEATTLE WA 98103

THERON GILES
1215 N 50TH
SEATTLE WA 98103

ANN HOFFMAN 234
9517 INTERLAKE N
SEATTLE WA 98103

BRUCE GHALLORAN 854
145 N 175TH
SEATTLE WA 98103

RON WILSON 27
4463 WOODLAND PK AVE N
SEATTLE WA 98103

EDWARD R CHU 19
SEATTLE CITY LIGHT
1015 3RD AVE
SEATTLE WA 98104

MARTIN DICKER
KING CTY ENERGY PROJECT
516 SMITH TOWER
SEATTLE WA 98104

CHARLES KATZ
703 BELLEVUE AVE E A-42
SEATTLE WA 98102

DEBBIE SAVICKAS 1
816 E PROSPECT #4
SEATTLE WA 98102

DEANNA STROM
226 13TH AVE #C
SEATTLE WA 98102

CLAYTON YOUNG
2366 EASTLAKE E
SEATTLE WA 98102

JEFF COLLUM
1148 N 96TH
SEATTLE WA 98103

PAUL QUIMARIN
2101 NE 52ND
SEATTLE WA 98103

ED KENNEL
CLEAN ENERGY PRODUCTS
3534 BAGLEY N
SEATTLE WA 98103

CYNTHIA M PUTNAM 67
FREMONT RECYCLING
3505 EVANSTON N
SEATTLE WA 98103

MICHAEL BAKER 534
SEATTLE ENERGY OFFICE
914 ARCTIC BLDG
SEATTLE WA 98104

DENNIS CONTE
DHR WEATHERIZATION
400 YESLER BLDG
SEATTLE WA 98104

JEROME DIEPENBROCK 12
ISLEY & SHREVE ARCHITECTS
316 2ND AVE S
SEATTLE WA 98104

LINDA KENTRO 26
427 BELLEVUE EAST #301
SEATTLE WA 98102

ROBERT H SCHNEIDER 167
THE BUMGARDNER PRTNSHIP
2021 MINOR AVE E
SEATTLE WA 98102

AUDREY L VANHORNE 1
VAN HORNE & VAN HORNE
103 BELLEVUE AVE E
SEATTLE WA 98102

LANCE YOUNG
2366 EASTLAKE E
SEATTLE WA 98102

JAMES COVINGTON 124
111 N 49TH ST
SEATTLE WA 98103

E FRED GYLLAND 158
THE PATON CORP
6517 FREMONT N
SEATTLE WA 98103

BJORN LUNDE
MICRO ENVIR RESCH GRP
6549 PALATINE N
SEATTLE WA 98103

MARY ELIZABETH SMITH 127
SEATTLE CITY LIGHT
8213 ASHWORTH AVE N
SEATTLE WA 98103

JIM BICKNELL
SEATTLE CITY LIGHT
1015 3RD AVE
SEATTLE WA 98104

JUDY DAHLBERG
SEATTLE CITY LIGHT
1015 3RD AVE RM 922
SEATTLE WA 98104

LINDA SUTLIFF DOLAN 47
SEATTLE CITY LIGHT
1015 THIRD AVE #926
SEATTLE WA 98104

THOMAS DOWNEY 123
OFC OF HOUSING DEVELOPMT
400 YESLER WAY
SEATTLE WA 98104

BILL FREDERICK 123
KING COUNTY COUNCIL
COURTHOUSE ROOM 402
SEATTLE WA 98104

WALTER H GREISSINGER
551 FIRST AVE S
SEATTLE WA 98104

ROGER HORNBUCKLE
SEATTLE CITY LIGHT
1015 3RD AVE
SEATTLE WA 98104

ROBERT A LOWE
CITY OF SEATTLE
MUNICIPAL BLDG
SEATTLE WA 98104

SEAN MCDONALD
SEATTLE CITY LIGHT
1015 3RD AVE
SEATTLE WA 98104

RONALD F MURPHY
STICKNEY & MURPHY ARCHS
100 S KING
SEATTLE WA 98104

STEVE POOL
SEATTLE CITY LIGHT
1015 3RD AVE
SEATTLE WA 98104

PAT ROBERTSON
SEATTLE CITY LIGHT
1015 THIRD AVE
SEATTLE WA 98104

STEVE SHIMAMOTO
CITY BLDG DEPT
503 MUNICIPAL BLDG
SEATTLE WA 98104

MICHAEL SULLIVAN
SEATTLE ENERGY OFFICE
920 ARCTIC BLDG
SEATTLE WA 98104

RICHARD DUNBAR 213
311 1ST AVE S
SEATTLE WA 98104

DIANA GALE
CITY COUNCIL
11TH FLR MUNICIPAL BLDG
SEATTLE WA 98104

ALEX HARRIS
CITY BUILDING DEPT
503 MUNICIPAL BLDG
SEATTLE WA 98104

BOB HULL
911 WESTERN
SEATTLE WA 98104

NOTA G LUCAS
SEATTLE ENERGY OFFICE
920 ARCTIC BLDG
SEATTLE WA 98104

WILL MILLER
SEATTLE CITY LIGHT
1015 3RD AVE
SEATTLE WA 98104

MARY LYNNE MYER 127
OFC OF NEIGH PLANNING
400 YESLER BLDG
SEATTLE WA 98104

J P RECCHI
SEATTLE CITY LIGHT
1015 3RD AVE
SEATTLE WA 98104

JOHN ROSE 257
SEATTLE TRUST SVNGS BANK
701 2ND AVE
SEATTLE WA 98104

DIANE SHIRK
SEATTLE CITY LIGHT
1015 3RD AVE
SEATTLE WA 98104

ZOLTAN SZIGETHY 257
SEATTLE TRUST & SAVINGS
804 2ND AVE
SEATTLE WA 98104

TOM ENGLISH 123
OFC OF HOUSING DEVELOPMT
400 YESLER WAY
SEATTLE WA 98104

DICK GIBBONS
DHR WEATHERIZATION
400 YESLER BLDG
SEATTLE WA 98104

MARION HEWITT
WA ENERGY EXTENSION SVC
312 SMITH TOWER
SEATTLE WA 98104

JOHN DAVID KOCH 16
551 1ST AVE S
SEATTLE WA 98104

E MANDELBAUM 397
400 YESLER BLDG
SEATTLE WA 98104

ANN-MARIE MITROFF
SEATTLE CITY LIGHT
1015 3RD AVE
SEATTLE WA 98104

DOROTHY NELSEN
SEATTLE CITY LIGHT
1015 3RD AVE
SEATTLE WA 98104

WILLIAM M RILEY 125
CITY LIGHT
1015 3RD AVE
SEATTLE WA 98104

BOB ROYER
MUNICIPAL BLDG
OFFICE OF THE MAYOR
SEATTLE WA 98104

FAYE SMITH
SEATTLE ENERGY OFFICE
920 ARCTIC BLDG
SEATLE WA 98104

KEN TARP
CITY BLDG DEPT
503 MUNICIPAL BLDG
SEATTLE WA 98104

STEVE FLETCHER
SEATTLE CITY LIGHT
1015 3RD AVE
SEATTLE WA 98104

LUCY GORHAM 76
NEIGHBORHOOD TECHNOLOGY
909 FOURTH AVE
SEATTLE WA 98104

ED HOLT 157
SEATTLE ENERGY OFFICE
914 ARCTIC BLDG
SEATTLE WA 98104

CONRAD LEE
SEATTLE ENGINEERING DEPT
MUNICIPAL BLDG
SEATTLE WA 98104

SHANNON MCCORMICK
WASH ENERGY EXTENSION
312 SMITH TOWER
SEATTLE WA 98104

DALENE MOORE
SEATTLE ENERGY OFFICE
920 ARCTIC BLDG
SEATTLE WA 98104

GREG POHL
SEATTLE CITY LIGHT
1015 3RD AVE
SEATTLE WA 98104

JEREMY ROBERTSON 18
SEATTLE CITY LIGHT
1015 THIRD AVE
SEATTLE WA 98104

MIMI SHERIDAN
SEATTLE CITY LIGHT
1015 THIRD AVE
SEATTLE WA 98104

ROBERT SNYDER
CITY BLDG DEPT
503 MUNICIPAL BLDG
SEATTLE WA 98104

ALETA M THOMPSON 15
KING COUNTY ENERGY PLNG
516 SMITH TOWER
SEATTLE WA 98104

DOUG WILDS
DHR WEATHERIZATION
400 YESLER BLDG
SEATTLE WA 98104

TAMERA DEW 123
5234 19TH NE
SEATTLE WA 98105

BOB HOGAN 367
JONES & JONES
PO BOX 5265
SEATTLE WA 98105

KARIN LINK
ECOTOPE
4142 11TH AVE NE
SEATTLE WA 98105

TOM MITCHELL 19
708 NE 42ND
SEATTLE WA 98105

MICHAEL J SOLDANO
1315 NE RAVENNA BLVD
SEATTLE WA 98105

TOM VEITH 132
LAIR-SWANSON, INC
704 NE NORTHLAKE WAY
SEATTLE WA 98105

GREGORY R STAATS 921
WINDERCO SUPPLY CO
4425 1ST NW
SEATTLE WA 98107

HANS J DANKERS 145
115 FLORENTIA #4
SEATTLE WA 98109

THOMAS A HOULIHAN
1219 WESTLAKE N
SEATTLE WA 98109

CYNTHIA MARKEY 76
1400 QUEEN ANNE N #301
SEATTLE WA 98109

ALAN YAMAGIWA
SEATTLE CITY LIGHT
1015 THIRD AVE
SEATTLE WA 98104

TERRY L EGNOR 637
THE BUSH SCHOOL
5615 LATONA NE
SEATTLE WA 98105

SALLY KING 7
5240 UNIVERSITY WAY NE #E
SEATTLE WA 98105

PHILO LUND
5758 76TH NE
SEATTLE WA 98105

STAN NEALEY
BATTELLE HARC
4000 NE 41ST
SEATTLE WA 98105

TUCKER SPARKMAN
4748 9TH NE
SEATTLE WA 98105

SARAH M GHIGLOINE
KJR RADIO
2600 26TH SW
SEATTLE WA 98106

DONALD K AKIRA 12
WALDRON POMEROY POLK SMTH
1721 8TH AVE N
SEATTLE WA 98109

JOHN W FEAREY
SEATTLE CENTER
305 HARRISON ST
SEATTLE WA 98109

THOMAS C HOWARD 15
WALDRON POMEROY POLK SMTH
807 W ARMOR ST
SEATTLE WA 98109

TED MARTIN
SEATTLE CENTER
305 HARRISON ST
SEATTLE WA 98109

TERRY BERGGREN
4203 BROOKLYN AVE NE #306
SEATTLE WA 98105

JILL GOODNIGHT
4740 40TH NE #D
SEATTLE WA 98105

BRIAN KIRKPATRICK 134
LAS FLORES
5033 36TH NE
SEATTLE WA 98105

TIM MAGEE 123
5723 28TH NE
SEATTLE WA 98105

BRAD SHANNON 273
5121 26TH NE
SEATTLE WA 98105

BOYD SWANSON 132
LAIR-SWANSON, INC
704 NE NORTHLAKE WAY
SEATTLE WA 98105

WILLIAM D JOBE 231
3710 21ST SW
SEATTLE WA 98106

DOUGLAS J CANNING 719
NW ENVIR CONSULTANTS INC
158 THOMAS ST-SUITE 35
SEATTLE WA 98109

DONALD J FOOTE 125
WALDRON POMEROY POLK SMTH
1721 8TH AVE N
SEATTLE WA 98109

GUY M HUGHES
BPA SEATTLE
415 1ST AVE N-RM 250
SEATTLE WA 98109

DON MCDONALD
SEATTLE CENTER
305 HARRISON ST
SEATTLE WA 98109

DIANA CAMPBELL 13
3986 UNION BAY CIR NE
SEATTLE WA 98105

HAROLD & LOETA GOODNIGHT
4311 37TH AVE NE
SEATTLE WA 98105

JEFF LAIR 132
LAIR-SWANSON, INC
704 NE NORTHLAKE WAY
SEATTLE WA 98105

JAMES MARTELL 123
5234 19TH NE
SEATTLE WA 98105

MARIO SHAUNETTE 12
4215 9TH NE
SEATTLE WA 98105

MARK E THOMETZ
2221 NE 46TH
SEATTLE WA 98105

LEIGH FRANCIS 179
119 NW 39TH
SEATTLE WA 98107

RICHARD COAD
SYSTEMS ARCHITECTS ENGRS
112-5TH AVE N
SEATTLE WA 98109

W Q HOOK 1
WALDRON POMEROY POLK SMTH
1721 8TH AVE N
SEATTLE WA 98109

PAUL H LINDENMEYER
BOEING AEROSPACE CO
165 LEE ST
SEATTLE WA 98109

GRANT MORRIS 156
SEATTLE PARKS & REC
802 ROY ST
SEATTLE WA 98109

AL POPA
SOLAR SPECIALTIES, INC
1001 TAYLOR N
SEATTLE WA 98109

FRANK SCHONBACHLER
SEATTLE CENTER
305 HARRISON ST
SEATTLE WA 98109

ROLLIN WIMPY 132
1819 QUEEN ANNE AVE N #5
SEATTLE WA 98109

CHRISTOPHER C MORGAN
MORGAN & LINDSTROM
267 SHANNON DR SE
BAINBRIDGE ISLAND WA 98110

M Q DAVIES 125
UNIFIELDS CORP
BOX 429
SEATTLE WA 98111

RICHARD ARMSTRONG 639
THE BUSH SCHOOL
405 36TH AVE E
SEATTLE WA 98112

EVAN BROWN
ECOTOPE GROUP
2332 E MADISON
SEATTLE WA 98112

JO-ELLEN COURTNEY
1821 25TH AVE E
SEATTLE WA 98112

ROY Q FARRELL 128
1403 MCQILVRA BLVD E
SEATTLE WA 98112

THOMAS KAYSER
508 21ST AVE E
SEATTLE WA 98112

CAROL OBERTON 237
ECOTOPE GROUP
2332 E MADISON
SEATTLE WA 98112

JIM PULLEN
18 GALER ST
SEATTLE WA 98109

GEORGE SWANSON
B S NOTKIN & ASSOC
820 JOHN ST
SEATTLE WA 98109

MICHAEL BONOFF
10444 NE S BEACH
BAINBRIDGE IS WA 98110

JEFFREY L TURNER 123
RENAISSANCE NW LTD
PO BOX 10329
BAINBRIDGE IS WA 98110

JOHN STACKPOLE
THERMAL EFFICIENCY INC
PO BOX 1869
SEATTLE WA 98111

REBECCA Q BARNES 21
1203 18TH AVE E
SEATTLE WA 98112

JOHN & GOLDIE CAUGHLAN
1508 MCGILVRA E
SEATTLE WA 98112

SHARON DAVIDOFF 219
KRAMER, CHIN & MAYO
901 26TH AVE E
SEATTLE WA 98112

ANGELA FORD-STEPHERSON 13
UNIV OF WA-DEPT OF ARCH
2032 E NEWTON
SEATTLE WA 98112

DONNA MAUDERS 182
2408 E VALLEY
SEATTLE WA 98112

OTTO SMITH 9
ECOTOPE GROUP
2332 E MADISON
SEATTLE WA 98112

JOHN RAABE 123
COOPERATIVE DESIGN
500 AURORA N
SEATTLE WA 98109

JOHN WEISS
BPA SEATTLE AREA OFFICE
415 FIRST AVE N
SEATTLE WA 98109

DAVID R DESSINGER
BOX 10946
BAINBRIDGE ISLAND WA 98110

KYLE BJORKLUND 21
BOX 12799
SEATTLE WA 98111

LINDA WILSON
SEATTLE TIMES

SEATTLE WA 98111

DAVID BAYLON
ECOTOPE GROUP
2332 E MADISON
SEATTLE WA 98112

JUDITH CHANEY 13
UNIVERSITY OF WASHINGTON
2021 E MILLER
SEATTLE WA 98112

KEN EKLUND
ECOTOPE GROUP
2332 E MADISON
SEATTLE WA 98112

SUSAN GROSS
ECOTOPE GRP DESIGN TEAM
2332 E MADISON
SEATTLE WA 98112

JOHN MCCARTHY 134
1808 E THOMAS #1
SEATTLE WA 98112

ANNIE STEWART
747 16TH E
SEATTLE WA 98112

BETTE ROBBINS 156
SEATTLE PARKS & REC
100 DEXTER AVE N
SEATTLE WA 98109

MABEL WHITNEY
1703 TAYLOR N
SEATTLE WA 98109

VALDON D GREEN 126
8986 FERNCLIFF AVE NE
BAINBRIDGE ISLAND WA 98110

TERRY BRATVOLD
WA NATURAL GAS
BOX 1869
SEATTLE WA 98111

GREG ALBERTSON 127
WILDWOOD CARPEN COLLECTV
2408 EAST VALLEY
SEATTLE WA 98112

BELINDA BOULTER
ECOTOPE GROUP
2332 E MADISON
SEATTLE WA 98112

JEFF COLE
ECOTOPE
2332 E MADISON
SEATTLE WA 98112

KENNETH F FALES 27
FALES & ASSOCIATES
1851 E SHELBY ST
SEATTLE WA 98112

RON JOHNSON 179
2434 E MILLER
SEATTLE WA 98112

PETER A NESTINGER 2
2012 E MILLER ST
SEATTLE WA 98112

PETER STONER 123
1847 E SHELBY ST
SEATTLE WA 98112

DAVIS STRAUB
ECOTOPE GROUP
2332 E MADISON
SEATTLE WA 98112

STEVE BRYAN 123
1500 NE 62ND
SEATTLE WA 98115

ROBERT M DORRES 1
JOHN ANDERSON & ASSOC
7330 23RD NE
SEATTLE WA 98115

KEN & MARK HAMILTON
ASSOCIATED VIDEO SERVICES
9229 SAND PT WAY NE
SEATTLE WA 98115

H DANIEL MARTEN 12
6826 25TH AVE NE
SEATTLE WA 98115

SCOTT SANDER
7515 57TH PL NE
SEATTLE WA 98115

MERRILINN ZEPPA 1
UNIVERSITY OF WASHINGTON
7014 58TH AVE NE
SEATTLE WA 98115

WILLIAM PROSCIA 192
BOEING AEROSPACE
3665 BEACH DR SW #201
SEATTLE WA 98116

FRANK & MARY HOSICK
HOSICK DESIGN
6502 3RD NW
SEATTLE WA 98117

JEANIE TAYLOR 347
3005 NW 80TH
SEATTLE WA 98117

JAY HINCHEY 13
2501 2ND W
SEATTLE WA 98119

JOSEPH WEINSTEIN
ENERGY VALUE, INC
129 DORFFEL DR E
SEATTLE WA 98112

DEAN CLARK 126
2520 NE 82ND
SEATTLE WA 98115

WILLIAM W DURLAND 237
216 NE 94TH
SEATTLE WA 98115

ALLEN JONES
1022 NE 68TH
SEATTLE WA 98115

LYNN MARTIN
PACIFIC SEARCH MAGAZINE
5721 NE 65TH
SEATTLE WA 98115

WELDON SKIRVIN 216
2520 NE 82ND
SEATTLE WA 98115

VINCENT T BROWN 12
ALTERNATIVE ENERGY SYSTEM
1927 42ND AVE SW
SEATTLE WA 98116

BILL ASTON 371
8039 27TH NW
SEATTLE WA 98117

PERRY & KRISTIN LOVELACE
1220 NW 77TH
SEATTLE WA 98117

DOROTHY L MITCHELL 321
3913 S AMERICUS
SEATTLE WA 98118

TED P LEHN 931
EUREKA DESIGN
1918 8TH AVE W
SEATTLE WA 98119

BILL BADGELEY
4540 2ND NE
SEATTLE WA 98115

PEGGY J CONFER 234
7049 34TH NE
SEATTLE WA 98115

RICHARD LEE GILMORE 3
7049 34TH NE
SEATTLE WA 98115

A B LAVIGNE 127
UNIVERSITY OF WA
8025 30TH AVE NE
SEATTLE WA 98115

BRUCE NORMAN 978
7017 23RD NE
SEATTLE WA 98115

ROBERTA ARNETT SWAN 257
6282 20TH NE
SEATTLE WA 98115

ALLEN D ELLIOTT 139
4020 AIKINS AVE SW
SEATTLE WA 98116

JEFFREY A BROADHEAD 79
SHAPIRO & ASSOC
7309 2ND AVE NW
SEATTLE WA 98117

MARY MINOR 13
LIVE WITHOUT TRIDENT
7737 12TH AVE NW
SEATTLE WA 98117

DIANE PARYPA 21
RON PARYPA, BUILDER
6408 60TH PL SOUTH
SEATTLE WA 98118

DAVID J LOWN 1
310 W HOWE ST
SEATTLE WA 98119

DENNIS BELL 127
UNIVERSITY OF WASHINGTON
7316 20TH AVE NE
SEATTLE WA 98115

JACKIE COOK
8544 SANDPOINT WAY NE
SEATTLE WA 98115

SHANNON GREENE
8802 37TH NE
SEATTLE WA 98115

JAY LUBOFF
8802 35TH NE
SEATTLE WA 98115

JOYCE PROBERT 123
3817 NE 91ST
SEATTLE WA 98115

JOHN WILLIAMS 123
3304 NE 80TH
SEATTLE WA 98115

JEFF GOEDE 231
3608 47TH SW
SEATTLE WA 98116

DAVID ERICKSON 125
DCD HOUSING
3047 NW 73RD
SEATTLE WA 98117

GREGORY A MYERS 721
2846 NW 67TH
SEATTLE WA 98117

MARCI GAMBLE GUTHRIE 124
2048 13TH AVE W
SEATTLE WA 98119

EGIL MATHEISEN
HEAT TRANSFER ENGINEERING
2500 GILMAN DR W
SEATTLE WA 98119

LELAND HALE 541
WASH STATE ENERGY COUNCIL
2112 THIRD AVE #303
SEATTLE WA 98121

PEDER JENSEN
317 17TH AVE
SEATTLE WA 98122

JANE E SHAFER 167
LEAGUE OF WOMEN VOTERS
1406 18TH AVE
SEATTLE WA 98122

PETER P MCGUIRE
THE BOEING CO
BOX 3707
SEATTLE WA 98124

JIM HART 123
HART INC
11555 27TH AVE NE
SEATTLE WA 98125

ROB LERNER 3
NORTHERN SUN GEN CONTR
13035 42ND AVE NE
SEATTLE WA 98125

ART SKARET 17
JAMES PRODUCTS
5657 34TH AVE SW
SEATTLE WA 98126

CASSANDRA ADAMS 618
2809-1/2 MT RAINIER DR S
SEATTLE WA 98144

BOB LAMSON
ALTEN NW
1134 POPLAR PL S
SEATTLE WA 98144

R SCOTT MCCONNELL 129
WALDRON POMEROY POLK SMTH
455 S 156TH ST #242
SEATTLE WA 98148

GARY S GLENN 125
BOEING
15812 13TH AVE SW
SEATTLE WA 98166

JEFFREY BELLOWS 123
1209 E DENNY
SEATTLE WA 98122

THOMAS J MARTIN
3811 E HOWELL ST
SEATTLE WA 98122

RETO STREHLER 125
DAWSON PLUMBING CO
1522 12TH AVE
SEATTLE WA 98122

NAT SUKUMARAN
THE BOEING CO
BOX 3707
SEATTLE WA 98124

KAREN ISAACSON
11341 5TH NE
SEATTLE WA 98125

GERALD H MARTIN
MINI HOUSES BY MARTIN
11305 12TH AVE NE
SEATTLE WA 98125

ALLEN DESTEIGUER 247
16340 INTERLAKE AVE N
SEATTLE WA 98133

CLAIRE DYCKMAN 687
803 LAKE WASH BLVD S
SEATTLE WA 98144

PAUL NISHMAN
ALTEN NORTHWEST
1134 POPLAR PLACE S
SEATTLE WA 98144

JEFFREY CHAMBERLAND 568
16221 15TH AVE NE
SEATTLE WA 98155

TIMOTHY M HAYES 124
ENERCON SOLAR
18135 BRITTANY DR SW
SEATTLE WA 98166

BIRNY BIRNBAUM 7
NCAT
1505 TENTH AVE
SEATTLE WA 98122

DALE MILLER 123
THE PHOENIX GROUP
1139 34TH AVE
SEATTLE WA 98122

NEIL WARREN 123
THE HASTINGS GROUP
1516 EAST OLIVE WAY
SEATTLE WA 98122

GLENN A WALLACE
THE BOEING CO
BOX 3707
SEATTLE WA 98124

KIRK KELSEY 124
11538 RIVIERA PLACE NE
SEATTLE WA 98125

TONY & ANN MARTIN 127
3755 SW SOUTHERN
SEATTLE WA 98126

MICHAEL SMITH 157
AIR TEC CO
1000 1ST AVE S
SEATTLE WA 98134

TOM ECKMAN
SOIC
315 22ND AVE S
SEATTLE WA 98144

BRUCE THELEN 3
2015 32ND AVE S
SEATTLE WA 98144

DALE R STEPHENS 271
SUN PRODUCTS
19837 36TH AVE NE
SEATTLE WA 98155

VICTOR M DAVIS 126
12454 16TH AVE S
SEATTLE WA 98168

STEVE HUGHART
717 22ND AVE
SEATTLE WA 98122

TOM RICHARD
1127 15TH AVE
SEATTLE WA 98122

BILL BEVERLY 9
BOEING ENGINEERING/CONSTR
BOX 3707 M/S 9A-47
SEATTLE WA 98124

BOB EVANS 3
NORTHERN SUN GEN CONTR
13035 42ND AVE NE
SEATTLE WA 98125

DAVE LEPTICH 13
NARAMORE BAIN BRADY ETC
1924 NE 127TH
SEATTLE WA 98125

JENNY ROLLOG 237
7736 27TH SW
SEATTLE WA 98126

DUKE LEBARON
WOOD STOVE & MORE STORE
5627 42ND SW
SEATTLE WA 98136

CARL B HELLER 123
510 32ND AVE S
SEATTLE WA 98144

JOANNE MASON
10109 51ST SW
SEATTLE WA 98146

MRS F GREER PULKKA 47
SIMPSON TIMBER CO
900 4TH AVE
SEATTLE WA 98164

RALPH SCHLICHTIG 19
11212 3RD AVE S
SEATTLE WA 98168

JAMES SCHUFREIDER 123
MARCO
11265 5TH AVE S
SEATTLE WA 98168

S F ROBERTSON
US COAST GUARD 13TH DIST
915 2ND AVE
SEATTLE WA 98174

MARK A SKULLERUD 123
20110 21ST NW
SEATTLE WA 98177

MICHAEL ERICSON
10057 WATERS AVE S
SEATTLE WA 98178

PETER KONICHEK 159
BOEING COMPUTER SERVICES
565 ANDOVER PARK WEST
TUKWILA WA 98188

HOWARD M RIDER 125
PACIFIC NW BELL
ROOM 1208 1600 7TH AVE
SEATTLE WA 98191

L J FRITSCHEN
COLL OF FOREST RES
UNIVERSITY OF WASHINGTON
SEATTLE WA 98195

THOMAS Q SUSOR 15
1-421 HEALTH SCI BLDG BJ5
UNIVERSITY OF WASHINGTON
SEATTLE WA 98195

E N O FRANCIS 2
4530 W SHERIDAN
SEATTLE WA 98199

HOWARD KENOYER 123
8717 8TH AVE W #3
EVERETT WA 98204

JAMES BRUVOLD
ENERGY ENG
BOX 342
ANACORTES WA 98221

STEPHE E WALUM 213
SEW CORPORATION
14026 8TH AVE S
SEATTLE WA 98168

LESLIE HOLMES 13
UNIVERSITY OF OREGON
13022 SECOND NW
SEATTLE WA 98177

MIKE CARLING
5619 S LEO
SEATTLE WA 98178

JOHN M MARIKOS 19
UNIVERSITY OF WASHINGTON
12017 71ST AVE S
SEATTLE WA 98178

JOLLY MILLER 1
SOLARCRETE NORTHWEST
915 INDUSTRY DR
TUKWILA WA 98188

JOHN R BODOIA 163
UNIVERSITY OF WASHINGTON
DEPT OF MECH ENG FU-10
SEATTLE WA 98195

MARIETTA MILLET 961
UNIVERSITY OF WASHINGTON
GOULD HALL JO-20
SEATTLE WA 98195

CHRIS TODD
UNIVERSITY OF WASHINGTON
FK-10
SEATTLE WA 98195

RON KIHLMAN
PRIDE & SUTHER, INC
4237 24TH AVE W
SEATTLE WA 98199

A F NEUMARKEL 12
A F NEUMARKEL CONST
11019 37TH DR SE
EVERETT WA 98204

BOB PORTER 192
508A W SHORE RD
ANACORTES WA 98221

LEE JOHNSON
US DOE REGION X
1992 FEDERAL BLDG
SEATTLE WA 98174

DOUG RIGG 123
1123 NW RICHMOND BEACH RD
SEATTLE WA 98177

CARY E CHILDERS 127
DIRKS CONST CO
7551 S LAKERIDGE DR
SEATTLE WA 98178

DENNIS R ASTELL 135
1725 S 209TH
SEATTLE WA 98188

WILLIAM TYGRET 1
SOLARCRETE NORTHWEST
915 INDUSTRY DRIVE
TUKWILA WA 98188

DR JOHN T A ELY 9
UNIVERSITY OF WASHINGTON
PHYSICS DEPT
SEATTLE WA 98195

MARK SMITH
DEPT ARCH - JO-20
UNIV OF WASHINGTON
SEATTLE WA 98195

ROBERT D WILKINSON
UNIV OF WASHINGTON
316 LEWIS HALL-DW-20
SEATTLE WA 98195

ANNE MARTIN
2600 26TH W
SEATTLE WA 98199

JON BURGETT
ENERGY PROD SYS
BOX 5672
EVERETT WA 98206

RON SMITH 123
SPARKS & SMITH
1008 FIFTH ST
ANACORTES WA 98221

REP JOEL PRITCHARD
2888 FEDERAL BLDG
SEATTLE WA 98174

R P ROBERTSEN 1
CITY OF SEATTLE, COM DEV
10502 14TH AVE NW
SEATTLE WA 98177

BARBARA EASTAN
10447 WATERS AVE S
SEATTLE WA 98178

ROD JONES 1
SOLARCRETE NORTHWEST
915 INDUSTRY DRIVE
TUKWILA WA 98188

PRAN N WAHI
BOEING COMPUTER SERVICES
505 BAKER BLVD
SEATTLE WA 98188

ASHLEY EMERY
UNIVERSITY OF WA
DEPT OF MECH ENGR
SEATTLE WA 98195

FRANCIS A SPELMAN
UNIVERSITY OF WASHINGTON
I-421 H S B
SEATTLE WA 98195

VALERIE EASTERLY
SEATTLE TRUST & SAVINGS
2409 28TH WEST
SEATTLE WA 98199

DENNIS ROGERS
302 CENTRAL BLDG
EVERETT WA 98201

JACK DANFORTH
SNOHOMISH COUNTY PUD
BOX 1107
EVERETT WA 98206

ROLLIN FRANCISCO 23
FRANCISCO CONST
19526 OLD BARN RD
ARLINGTON WA 98223

THOMAS Q QOETZ 216
325 MCREA RD
ARLINQTON WA 98223

JOHN L BACON 162
MT BAKER SCHOOL DIST 507
2133 N SHORE RD
BELLINQHAM WA 98225

PETER DREWES 1
ENERQY RESOURCE
2514 QRANT
BELLINQHAM WA 98225

WALDEN HAINES
HAINES TREE & SPRAY
4700 E OREQON
BELLINQHAM WA 98225

MICHAEL KARP 123
PO 159
BELLINQHAM WA 98225

JOHN MCDANIEL 123
210 LOTTIE
BELLINQHAM WA 98225

ROBERT ROSS
1203 W HOLLY ST
BELLINQHAM WA 98225

STEPHEN DAVID SPEAKES 213
1400 MOORE #0-9
BELLINQHAM WA 98225

JOHN WADE 123
TI CONST
BOX 1293
BELLINQHAM WA 98225

DAN MORRIS
7190 FISKE RD
CLINTON WA 98236

JOHN H QOODRICH 134
RT 1 BOX 10-1
EASTSOUND WA 98245

ANNE V MALEAN 127
5420 KACKMAN RD
ARLINQTON WA 98223

CRAIQ BRAND
BRAND CONSTRUCTION
2324 QRANT ST
BELLINQHAM WA 98225

MICHAEL EISENBERQ 137
SOLAR CONCEPTS
904 E CHESTNUT
BELLINQHAM WA 98225

HELIX ENQINEERINQ CO 12
2324 QRANT ST
BELLINQHAM WA 98225

A WAYNE KIQERL 123
WHATCOM CTY OPPOR COUNCIL
3437 REDWOOD AVE #9
BELLINQHAM WA 98225

MARTI MCKIBBEN 327
LUMMI TRIBAL CENTER
1503 J ST
BELLINQHAM WA 98225

JOSIANNE SCHANTZ
2565 HARBOR LANE
BELLINQHAM WA 98225

RALPH C STOCKER 1
SOLAR SYSTEMS INC
1240 PORTAL DR
BELLINQHAM WA 98225

DENNY WILLIAMS-ROARK 123
WILDWOOD CONST
BOX 2541
BELLINQHAM WA 98225

M S WOODS
1206 W LEISURE
SEATTLE WA 98239

THOMAS J WEINDL 268
ORCAS POWER & LIQHT CO
BOX 187
EASTSOUND WA 98245

KEITH & PHYLLIS MCKENZIE 29
NORTHWEST SOLAR BUILDERS
18920 11TH AVE NE
ARLINQTON WA 98223

JACKSON CARTER 13
CAMAS CONSTRUCTION
1103 HARRIS
BELLINQHAM WA 98225

LYLE Q ERLEWINE 172
JOHNSON/ERLEWINE & ASSOC
1410 ELEVENTH ST
BELLINQHAM WA 98225

JOHN HERFORD 123
4015 SILVER BEACH AVE
BELLINQHAM WA 98225

DAVID KNIQHT 123
4015 SILVER BEACH AVE
BELLINQHAM WA 98225

QLENN MUTCHLER 135
1204 RAYMOND ST
BELLINQHAM WA 98225

THOMAS E SISK 123
APOLLO CONSTRUCTION
BOX 2701
BELLINQHAM WA 98225

VIVIAN M TESOSEOK 36
2616 KWINA RD
BELLINQHAM WA 98225

CRAIQ LINTS
827 ERSHIQ
BOW WA 98232

MARK QARRIDO
BROOKE DEVELOPMENT
BOX 341
FREELAND WA 98244

FORREST FIELDER
101 EVERSON-QOSHEN RD
EVERSON WA 98247

JACK STURQEON
PLAN FORMATION UNLIMITED
6822 211TH PL NE
ARLINQTON WA 98223

DAVID E CHRISTENSEN 176
ARCHS JOHNSON/ERLEWINE
1410 11TH ST BUILDINQ
BELLINQHAM WA 98225

RAINY FARKLER 136
1602 T ST
BELLINQHAM WA 98225

ROQER JONES 123
FAIRCHILD CONSTRUCTION
203 N QARDEN
BELLINQHAM WA 98225

DOUQLAS J LANDSEM 125
STRADLINQ & STEWART
119 N COMMERCIAL STE 1100
BELLINQHAM WA 98225

SCOTT PIPER
1100 BELLINQHAM TOWERS
BELLINQHAM WA 98225

LIANA SMALLWOOD
2616 KIVINAR RD
BELLINQHAM WA 98225

RICHARD VAWTER 123
WESTERN WASHINQTON UNIV
PHYSICS DEPT
BELLINQHAM WA 98225

SCANP
1788 HILLVUE PL
BURLINQTON WA 98233

HERB HUNT 2
LIVINQ DESIQNS
BOX 207
FREELAND WA 98244

SANDY FUQATE 2
SELF-HELP HOMES
6759 NOON RD
EVERSON WA 98247

TERRY GALVIN 1
1715 E SCENIC AVE
FREELAND WA 98249

HENRY VAIL 123
804 ARAYLE AVE
FRIDAY HARBOR WA 98250

JODY GOSSELIN
SS SUPPLY CO
RT 1 BOX 1400
LOPEZ WA 98261

DAN & SARA HUNTINGTON
META PUBLICATIONS
BOX 128
MARBLEMOUNT WA 98267

ROY LEISCHMAN
MARVL PRODUCTIONS
BOX 515
MUKILTEO WA 98275

DR R A KING 2
2216 N MARINERS WAY
OAK HARBOR WA 98277

DANIEL JOHNS
5174 S PASS RD
SUMAS WA 98295

JAMES DANIELS 19
139 FIRST ST
BREMERTON WA 98310

DOUG LINDSTEDT
OLYMPIC SOLAR SYSTEMS
15 NW RIDDELL RD
BREMERTON WA 98310

TOM KARNIS 124
21 HOLLYBURN
GIG HARBOR WA 98335

ROBERT LAWSON 236
PO BOX 222
HANSVILLE WA 98340

JIM O'CONNOR 93
PO BOX 273
FREELAND WA 98249

JERRY NELSON
BOX 499
LA CONNER WA 98257

JOHN OTTENHEIMER 19
RT 1 BOX 1378
LOPEZ ISLAND WA 98261

LARRY JOHNSON
NW CONSERVATORY PRODUCTS
9109 41ST AVE NE
MARYSVILLE WA 98270

VINTON SCHMIDT
506 CLOVER LANE
MUKILTEO WA 98275

MICHAEL J TOWNSEND 128
BOX 717
OAK HARBOR WA 98277

ROLAND ARPER 187
SILVERDALE FUEL
1742 WINFIELD
BREMERTON WA 98310

DAVID GRELLIER 13
KNOX DESIGNERS LTD
6868 BENTLEY CIRCLE NE
BREMERTON WA 98310

LARRY B NEFF 43
UNITRADE INTERNATIONAL
1329 FORD AVE
BREMERTON WA 98310

WILLIAM O'NEIL
ENVIRO-CON
BOX 492
GIG HARBOR WA 98335

JONATHAN T STRATMAN 247
SUNLAB
ST RT 1 BOX 153
KINGSTON WA 98346

RICHARD GROUT 128
720 HALVORSEN RD
FRIDAY HARBOR WA 98250

CHARLES STOCKER 125
8 QUINAULT WAY
LA CONNOR WA 98257

LLOYD WHANNELL 239
SS SUPPLY CO
RT 1 BOX 1400
LOPEZ WA 98261

CHARLES H BRITTEN 148
2025 URBAN AVE
MOUNT VERNON WA 98273

HORACE Q BRADT 123
5114 HOPE LANE
OAK HARBOR WA 98277

GEORGE EUSTERMAN 12
1898-40 PRAIRIE RD
SEDRO WOOLLEY WA 98284

KEN BENHAM
1055 E CALLAHAN
BREMERTON WA 98310

JAMES M GROH 152
GENERAL ELECTRIC CO
2925 ALDER ST
BREMERTON WA 98310

RICHARD PETERSON 13
KNOX DESIGNERS LTD
6868 BENTLEY CIRCLE NE
BREMERTON WA 98310

MEL WILSON
6803 40TH ST NW
GIG HARBOR WA 98335

DAVID A KNAPMAN
RJ EVANS CONSTRUCTION
BOX 2 SUNDANCE ADDT
PORT ANGELES WA 98362

JIM RICKS 18
HOME COMFORT, INC
6451 MITCHELL BAY RD
FRIDAY HARBOR WA 98250

DENNIS ROGERS 127
15018 64TH NE
LAKE STEVENS WA 98258

RAPHAEL REDA 213
7876 BEACH DR
PORT ORCHARD WA 98366

DUNDAS WINN
2376-D WALKER VALLEY
MT VERNON WA 98273

T C HENSCHEID 213
T C HENSCHEID REMODELING
4363 N 600 W
OAK HARBOR WA 98277

RICHARD HANN 123
4387 MINAKER RD
SUMAS WA 98295

GREG BRANCH 123
BRANCH DEVELOPMENT CORP
307 GREAT NORTHWEST BLDG
BREMERTON WA 98310

JOHN B HAGER 123
9140 OLSON RD NW
BREMERTON WA 98310

CLIFFORD J RIO 156
OLYMPIC SOLAR SYSTEMS INC
15 NW RIDDELL RD
BREMERTON WA 98310

MATTHEW C WORSWICK
ENERGY AWARENSS COALITION
7820 OLYMPIC VIEW DR
GIG HARBOR WA 98335

RICHARD FERGUSON 13
NESS CONST
9952 SE CORNELL RD
PORT ORCHARD WA 98366

WALTER A KENDRICK 159
5981 LONG LAKE RD SE
PORT ORCHARD WA 98366

DANFORD A MOORE 128
2085 LINCOLN AVE SE
PORT ORCHARD WA 98366

GARY M CLARK 123
CLARK LANDSCAPING
1316 7TH ST SE
PUYALLUP WA 98371

WILLIAM J SIENKIEWICZ 123
BUILTWELL STRUCTURES
8302 113TH ST E
PUYALLUP WA 98371

ROD WINGET 9
BOX 548
SUMNER WA 98390

BOB SULLIVAN
1543 DOCK ST
TACOMA WA 98402

CLINTON G CABLE 625
1402 S 8TH
TACOMA WA 98405

JEFF ROOT 152
MD ROOT & ASSOC
4905 N 29TH
TACOMA WA 98407

JERRY STOKESBERRY 123
J'S CONSTRUCTION
1510 S 41ST
TACOMA WA 98408

ROBIN N HERZFELD
110 HAMAN LN
TACOMA WA 98467

KAREN HARDING 689
FT STEILACOOM COM COLL
9401 FARWEST DR SW
TACOMA WA 98498

STEVE LAWRENCE 139
1375 POTTERY AVE
PORT ORCHARD WA 98366

ROBERT E & JEAN R TANK 123
4701 LONG LAKE RD SE
PORT ORCHARD WA 98366

GRANT GRIFFIN 751
PIERCE CO PLANNING DEPT
1430 EAST MAIN-SUITE B
PUYALLUP WA 98371

FREDERICK TUSO
INST FOR RESRC & UNDERSTD
RT BOX 663
QUILCENE WA 98376

JIM BELLAMY
1543 DOCK ST
TACOMA WA 98402

BILL SULLIVAN
SCOFIELD & CO
1715 DOCK ST
TACOMA WA 98402

SUSAN BLACK 457
3207 NO. 11
TACOMA WA 98406

PAUL W SPORICH 138
3008 NORTH 33 ST
TACOMA WA 98407

BRUCE SEVEREID
PIERCE CTY MANPOWER PLNG
2401 S 35TH ST
TACOMA WA 98409

DOUGLAS OWINGS 12
WESTERN WASH UNIV
5515 W 53RD
TACOMA WA 98467

JOHN BOYCE 127
8703 WILDWOOD DR
TACOMA WA 98499

JOHN C LEE 13
4446 BANNER RD SE
PORT ORCHARD WA 98366

LEVI ROSS
324 E ST
PORT TOWNSEND WA 98368

STEVE OFFENBECHER 124
CRESCENT REALTY
9406 112TH ST E B &C
PUYALLUP WA 98371

LYLE ESTABROOK 123
BOX 4024
SOUTH COLBY WA 98384

MICHAEL O BITTERLINE 152
SEIFERT & FORBES PS
925 TACOMA AVE S
TACOMA WA 98402

ROBERT H WOLPERT 126
MCGRANAHAN MESSENGER ASSO
950 FAWCETT SUITE 300
TACOMA WA 98402

RANDY FULLER 457
3207 NO. 11
TACOMA WA 98406

JOHN E SPORICH
3007 NO 33RD ST
TACOMA WA 98407

ROBERT J POWERS 126
6309 7TH ST NW
TACOMA WA 98424

DAVID BROOKS 14
FT STEILACOOM COM COLL
9401 FARWEST DR SW
TACOMA WA 98498

DUGLAD & GREGORY STEWART
MATHEWS HEATING OILS INC
PO BOX 98025
TACOMA WA 98499

BY & MARIE MACINTYRE 49
NATURAL POWER MFG
4600 RAMSEY RD SE
PORT ORCHARD WA 98366

RICHARD SHIPMAN 139
RR #3 BOX 155B
PORT TOWNSEND WA 98368

DON R PRENGEL 2
CRESCENT REALTY
9406 112TH ST E
PUYALLUP WA 98371

DAVID W FARR 12
RT 1 BOX 249
SUMNER WA 98390

LARRY STORSET 152
SEIFERT & FORBES PS
925 TACOMA AVE S
TACOMA WA 98402

SUSAN KILLEN 317
2117 NORTH 26TH ST
TACOMA WA 98403

MICHAEL PEARSON 457
3207 NO. 11
TACOMA WA 98406

W DENNIS & PEGGY COFFEY 123
1416 S 51ST
TACOMA WA 98408

ROBERT QUISENBERRY 138
R MERRIMAN ASSOC
14902 29TH AVE CRT E
TACOMA WA 98445

MICHAEL COHEN 257
PO BOX 99905
TACOMA WA 98498

ART CLARKE CARTER
2614 50TH CT SE
OLYMPIA WA 98501

JO CURTZ 734
COMMON CAUSE
659 CAPITOL WAY
OLYMPIA WA 98501

ROGER L VON GOHREN 143
3125 LORNE ST
OLYMPIA WA 98501

CONRAD DRISCOLL 134
CRABSHELL ALLIANCE
237 N SHERMAN
OLYMPIA WA 98502

WARN V TOMS
7302 HUCKLEBERRY
OLYMPIA WA 98502

HARRY BRUNSDON 127
SENATE ENERGY & UTIL COM
201 INSTIT BLDG AS-32
OLYMPIA WA 98504

JACK RAGSDALE 167
WA ST PLNG & COM AFFAIR
FN-41
OLYMPIA WA 98504

RICHARD WATSON
SENATE ENERGY & UTIL COM
201 INSTIT BLDG AS-32
OLYMPIA WA 98504

PAUL ANTON 147
WASH DEPT OF COMMERCE
101 GEN ADMIN
OLYMPIA WA 98505

WILLIAM L WILSON 17
811 TICONDEROGA PL NE
LACEY WA 98506

DAVID HASKELL
8600 GREENWOOD CT
OLYMPIA WA 98507

MAUREEN SHEIMO 31
RT 1 BOX 994
ELMA WA 98541

CONRAD METCALFE
EVERGREEN STATE COLLEGE
2320 BLVD RD
OLYMPIA WA 98501

JANET BRISLAWN 21
3242 A FRENCH LOOP RD NW
OLYMPIA WA 98502

CONSTANCE HARRINGTON 4
US FOREST SERVICE
3625 93RD AVE SW
OLYMPIA WA 98502

DAVID WEBER 152
1306 GILES AVE
OLYMPIA WA 98502

DAVID KAPUS
STATE OF WASHINGTON
206 GEN ADM BLDG
OLYMPIA WA 98504

JIM SEDORE 135
WASH ST DEPT NAT RES
FOREST LAND MGMT CENTER
OLYMPIA WA 98504

SENATOR AL WILLIAMS
WASHINGTON STATE SENATE
201 INSTIT BLDG AS-32
OLYMPIA WA 98504

HENRY DATE
KAOS FM
222 N CENTRAL
OLYMPIA WA 98506

FRED & DOROTHY CLAGETT 78
COMMON CAUSE
PO BOX 1726
OLYMPIA WA 98507

WILLIAM MARTIN
CHATEAU BUILDERS
BOX 724
OLYMPIA WA 98507

PAMELA J MURPHY 237
STAR RT 1 BOX 207
GRAYLAND WA 98547

MARTIN OATMAN
411 BOUNDARY ST
OLYMPIA WA 98501

CAROL COSTELLO
WA ST ENERGY OFFICE
400 E UNION
OLYMPIA WA 98502

CHUCK LINDERS 135
WASH STATE PARKS & REC
1416 GILES
OLYMPIA WA 98502

JIM & LENORE VINING 2
CHRISTIAN CONTRACTORS
BOX 3640
LACEY WA 98503

SENATOR R H 'BOB' LEWIS
WASHINGTON STATE SENATE
201 INSTIT BLDG AS-32
OLYMPIA WA 98504

KEITH SHERMAN 487
STATE PURCHASING DIVISION
216 G A BLDG
OLYMPIA WA 98504

CHRISTOPHER WOODSUM 79
ST BLDG CODE ADVIS CNCIL
400 CAPITOL CENTER BLDG
OLYMPIA WA 98504

SUE DEUTER 13
EVERGREEN STATE COLLEGE
2706 FISHTRAP RD
OLYMPIA WA 98506

PAT COLE 167
BOX 1434
OLYMPIA WA 98507

ROY A WARREN 126
PO BOX 7549
OLYMPIA WA 98507

TOM MARK
GRAYS HARBOR CO PLANNING
BOX 390
MONTESANO WA 98563

HENRY F ROMER 159
1501 SOUTH CAPITOL WAY
OLYMPIA WA 98501

SHERRY L DONAHOE 123
DEPT OF FISHERIES
6547 LITTLEROCK RD
TUMWATER WA 98502

CHIP PATULLO 237
2712 LEWIS RD
OLYMPIA WA 98502

MARY ANDERSON
WA STATE ENERGY OFF
400 E UNION
OLYMPIA WA 98504

SENATOR KING LYSEN
WASHINGTON STATE SENATE
201 INSTIT BLDG AS-32
OLYMPIA WA 98504

RALPH V STEVENS 167
SUPT OF PUB INST
OLD CAPITOL BLDG
OLYMPIA WA 98504

SENATOR DIANNE H WOODY
WASHINGTON STATE SENATE
201 INSTITUTIONS BLDG
OLYMPIA WA 98504

MAVIS STUHRT
MANORWOOD HOMES
543 73 WAY NE
OLYMPIA WA 98506

JOHN B DAVIS
CHATEAU BUILDERS
BOX 724
OLYMPIA WA 98507

ROGER W LUTHER
BOX 709
ABERDEEN WA 98520

STEVE PETITT 236
GRAYS HARBOR BLDG DEPT
BOX 390
MONTESANO WA 98563

JIM R ALLEN 123
ST RT BOX 398
ABERDEEN WA 98570

RICHARD CAUGHIE 231
ST RT 1 BOX 430
UNION WA 98592

GLENN CLIFFTON
KELSO PARKS DEPT
BOX 209
KELSO WA 98626

FREDERICK N BAILEY
BOX 430
OCEAN PARK WA 98640

JERRY GRASER 17
1321 X ST #C-7
VANCOUVER WA 98661

JEAN JENNINGS
CLARK COUNTY PUD
PO BOX 1626
VANCOUVER WA 98663

LARRY PUDWILL 126
10210 NE 23RD
VANCOUVER WA 98664

RICHARD C MARCH 137
ENERGY ENTERPRISES
1730 10TH PL NE
E WENATCHEE WA 98801

MARK WISER 739
CHELAN/DOUGLAS COM ACTION
620 LEWIS ST
WENATCHEE WA 98801

JUDY CURTIS 26
WASHINGTON STATE UNIV
PO BOX 391
OKANOGAN WA 98840

AILEEN JEFFRIES
ALTER ENERGY SYS

WINTHROP WA 98862

JOHN ELLIS
CENTRALIA COLLEGE
ROUTE 1 BOX 1082
RAINIER WA 98576

JIM DEMETRO 13
SOLAR HABITAT
21727 NE ALLWORTH RD
BATTLE GROUND WA 98604

SCOTT EDWARDS
LOWER COLUMBIA COMM ACT
BOX 2126
LONGVIEW WA 98632

BRUCE BOLME
16102 NE 10TH AVE
RIDGEFIELD WA 98642

GORDON MCCUTCHEON
ALPINE ENERGY HOMES
4512 N PLOMONDON
VANCOUVER WA 98661

JODY MOORE
2611 G ST
VANCOUVER WA 98663

H L COFFMAN
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BRITISH COLUMBIA HYDRO
& POWER AUTHORITY

VANCOUVER BC

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