SOLAR ENERGY DIVISION

Newsletter of the Solar Energy Division of ASME Summer 2006

ANDREAS NEUMANN ■ Editor

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State of the SED - Message from the Incoming Chair

Scott A. Jones

Energy issues are likely to significantly impact the science, economics, and politics of this century. We need skilled technical people, wise leaders, and a well informed public to navigate the energy challenges that face our world. You could be one on them. This year, ASME celebrated its 125th Anniversary, and next year the Solar Energy Division celebrated its 40th Birthday. Over this period, the division's members and leaders have made numerous contributions that further the art, science, and practice of solar energy engineering. Over the next 40 years, I expect such contributions to continue and have an even larger impact on the lives of people everywhere. If you are not already familiar with the division, I welcome you to learn more about us.

The ASME Solar Energy Committee was founded in 1966 by Prof. John Yellott of Arizona State University, and our highest service award is named in his honor. We operated like a division and were granted that status by ASME under our 8th chair, Prof. William Beckman of the University of Wisconsin. Now, I would like to welcome two new members to our division leadership. Dr. Andreas Neumann of the DLR (German Aerospace Center) in Germany is a new member of our Executive Committee. Prof. Aldo Steinfeld has a joint appointment at ETH-Zurich and at the Paul Scherrer Insitute in Switzerland, and is the new Editor of the Division's prestigious Journal of Solar Energy Engineering. As you can see, the Solar Division values international participation. I would also like to thank two ex-officio members of the leadership team for their 5 years of phenomenal service. Mark Thornbloom of FSEC served on the division's Executive Committee, and Prof. Jane Davidson of the University of Minnesota served as the Editor of the Journal of Solar Energy Engineering.

The scope of the solar energy division also includes indirect solar technologies such as wind energy, ocean thermal energy conversion and bioconversion as well as technologies related to building energy conservation. Recently, the Division's Journal of Solar Energy Engineering added the subtitle Including Wind Energy and Building Energy Conservation to better reflect this breadth. Solar and renewable energy technologies can contribute to all the major energy use sectors: electricity, transportation, heating, cooling, and lighting.

Photovoltaic technology converts sunlight photons directly into electricity. Heat from biomass, concentrated sunlight, or temperature gradients in the ocean or saline ponds have been used to make electricity using heat engines based on the Rankine, Brayton, and Stirling cycles. Kinetic energy in wind and water can be converted into electricity via a turbine and generator.

Building heating and lighting loads can be addressed in many ways, from the simple but effective skylight to much more sophisticated systems. Solar heat can also be used to drive adsorption or absorption cooling systems or provide process heat.

Renewable energy technologies can contribute to transportation energy needs via several avenues. Electricity can be used to charge batteries of plug-in hybrid vehicles, an interesting concept that may not only reduce oil use, but also add energy storage and distributed generation to the electrical grid. Electricity can also be used to make hydrogen via electrolysis. Sunlight and atmospheric CO2 converted to biomass can be processed into ethanol or other fuels. Heat from concentrated sunlight can also be used to make hydrogen in a thermochemical water-splitting cycle.

There are many avenues for the use of renewable energy technologies, and also many hurdles. It is often more expensive to utilize diffuse, intermittent renewable energy sources than it is to extract chemical energy concentrated in the Earth's crust over many millennia. However, it was also initially expensive to extract fossil fuels, and it will likely get more expensive in the future. Several renewable energy technologies have shown that costs can decline with deployment and further research and development to become competitive in markets that increasingly value the social benefits of these technologies.

The maximum fraction possible of renewable energy technologies in the energy system is an interesting but minimally studied question. While energy storage may be unnecessary for small market shares, storage is likely needed for a large renewable energy market share. There are several options for storage such as potential energy (hydro dam), kinetic energy (flywheel), thermal storage (liquid, solid, and phase change), chemical storage (fuels), and electrical storage (batteries), with varying costs and other performance characteristics.

Predicting the most valuable player early in the season is tough. Picking the stars of the renewable energy arena in 2050 is no easier, but I can attest that being involved in the process of developing and evaluating them is good, clean fun.

2005 International Solar Energy Conference

Scott A. Jones & Mark Thornbloom

Our annual conference was held jointly with the **2005 Solar World Congress** in Orlando, Florida August 6-12, 2005. There were two special topics: Bringing Water to the World and the History of ISES, in recognition of the 50th anniversary of the International Solar Energy Society. The American Solar Energy Society hosted this year's conference. Over 1600 people from 79 countries attended the conference.

Two Proceedings were distributed to all attendees at the conference. The ASES/ISES proceedings are available at **www.ases.org**. The ASME proceedings comprise about 100 peer-reviewed papers. Individual papers or the entire CD should be available soon on the ASME website (www.asme.org). The papers cover seven broad topical areas that include Conservation and Solar Buildings, Fundamentals and Theory, Heating and Cooling Applications and Analysis, Photovoltaics, Solar Chemistry and Bioconversion, Solar Thermal Power and Testing and Measurement.

In addition to these papers, the technical content of the conference was enhanced by other events sponsored by ASME, including forums titled Photovoltaic Models-How Good Are They? and the Concentrating Solar Power Industry Forum. ASME also sponsored tutorial sessions on Solar Hydrogen Production and the Measurement of Concentrated Solar Radiation. Finally, Malek Kabariti, the President National Energy Research Center in Amman, Jordan spoke at our lunch time member meeting on "Trans-Mediterranean Renewable Energy Cooperation (TREC) For Development, Climate Stabilization And Good Neighborhood".

At the Conference banquet, we presented the Graduate Student award to Daniel Thomas and discussed the history of the ASME Solar Division.

SED Executive Committee** (not pictured: Agami Reddy) with Graduate Student Award winner of the 2005 SED, **Daniel Thomas** (4th from right), with his thesis advisor, **Dr. Jane Davidson

*ISEC05 Technical Chair **Mark Thornbloom** presents Graduate Student Award winner **Daniel Thomas** of University of Minnesota with a check and his award*

*New SED Chair **Scott Jones** gave a short history of ASME's first 125 years, and announced the Graduate Student award at the awards banquet*

Office Bearers

Executive Committee Members

Carl Bingham, Past-Chair, National Renewable Energy Laboratory, Golden, CO, 303-384-6390, Carl_Bingham@nrel.gov

Scott Jones, Chair, Sandia National Laboratories, Albuquerque, NM, 505-844-0238, sajones@sandia.gov

Jeffrey Morehouse, Vice-Chair, University of South Carolina, Columbia, SC, 803-777-3017, Morehouse, more@engr.sc.edu

Agami Reddy, Secretary Treasurer, Drexel University, Philadelphia, PA, 215-895-1502, reddyta@drexel.edu

Andreas Neumann, Member, German Aerospace Center DLR, Cologne, Germany, 49 (0)2203-601-3214, a.neumann@dlr.de

Administrative Committees

Group Operating Board	**Roy Hogan and Carl Bingham**
Annual Report	**Scott Jones and Agami Reddy**
Education	**David Klett**
Program Chair	**Jeff Morehouse**
Energy Committee	**Jane Davidson**
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Honors and Awards	**Carl Bingham, Mark Thornbloom, and J. Boise Pearson**
JSEE	**Aldo Steinfeld**
Membership Development	**Andreas Neumann**
Govt Relations	**Scott Jones, Tom Mancini**
Publicity/Newsletter	**Andreas Neumann and Carl Bingham**

Division Technical Committee Chairs

Mingsheng Liu, Conservation and Solar Buildings, Univ. of Nebraska, Omaha, NE

Robert Turner, Fundamentals and Theory, University of Nevada at Reno, Reno, Nevada.

Drazen Fabris, Heating and Cooling Applications and Analysis, Santa Clara University, Santa Clara, CA

Pali Singh, Photovoltaics, Villanova University, Villanova, PA

Aldo Steinfeld, Solar Chemistry and Bioconversion, ETH-Swiss Federal Institute of Technology, Zurich, Switzerland

Chuck Andraka, Solar Thermal Power, Sandia National Laboratories, Albuquerque, NM

Andreas Neumann, Testing and Measurement, German Aerospace Center DLR, Cologne, Germany

Scott Schreck, Wind Energy, National Renewable Energy Laboratory, Golden , CO

Kabariti Speaks at Solar Division Membership Meeting

Mark Thornbloom

At the 2005 International Solar Energy Conference in Orlando, ASME members and prospective members met over a brown-bag lunch to discuss activities in the Solar Energy Division and to cheer on their colleagues who won awards for Best Paper in their Track. Attendees were then treated to an informative and engaging speech by Malek A. Kabariti, President of the National Energy Research Center in Amman, Jordan.

Mr. Kabariti spoke on "Trans-Mediterranean Renewable Energy Cooperation "TREC" For Development, Climate Stabilization And Good Neighborhood". An important step towards a stable, sustainable and peaceful world could be made by a Trans-Mediterranean Renewable Energy Cooperation (TREC). The TREC project would initiate a common market and an interconnection infrastructure for renewable energies among the countries surrounding the Mediterranean Sea.

The technologically highly developed European countries in the North are using fossil fuels heavily for their energy demands, thereby excessively burdening the global atmosphere with greenhouse gas (GHG) emissions. The countries to the south and east of the Mediterranean have vast but unused sites offering superior solar and wind energy resources. High-voltage direct current (HVDC) interconnections enable low-loss transmission to be made over great expanses at low cost.

The proposed Trans-Mediterranean Renewable Energy Cooperation could turn the formerly contradictory goals of climate protection and economic development into mutual reinforcing objectives by making clean energy production in North Africa and Near East, increasing industrial and socio-economic development in North Africa and Near East countries, and helping to transform the Mediterranean from a region of various divides and conflicts into a region of harmonized socio-economic development, cooperation and good neighborhood. Mr. Kabariti closed his talk with a request that U.S. interests consider supporting this worthy effort in the region.

ISEC05 Technical Chair Mark Thornbloom and NERC President Malek A. Kabariti at the Solar World Congress, co-located with the 2005 ISEC

HONORS & AWARDS

An appreciation award has been handed over to Past Chair **Carl Bingham** for his service on the SED Executive Committee.
The Graduate Student Award has been assigned to **Daniel Thomas** of University of Minnesota. A short summary of his work is presented within this newsletter issue.

ISEC05 Technical Chair Mark Thornbloom presents Past Chair Carl Bingham with an appreciation award for his service on the SED Executive Committee

ASME Frank Kreith Energy Award

Solar Energy Division and Advanced Energy Systems Division

The Solar Energy and Advanced Energy Systems Divisions of ASME are soliciting nominations for the ASME Frank Kreith Energy Award. The award was established by the divisions in 2005 to honor an individual in recognition of significant contributions to a secure energy future through innovations in conservation and/or renewable energy technology. Contributions may be through research, education, and/or practice. The award is named in honor of Dr. Frank Kreith and recognizes his contributions to the fields of heat transfer and energy.

Eligibility: Only candidates whose names have been submitted in nomination will be considered for the award. Criteria for the award will be based on, but not limited to any of the following:

1. Significant research contributions in energy conservation and renewable energy
2. Significant contributions to education related to energy conservation and renewable energy
3. Significant contribution to the practice of engineering through invention, design or implementation of innovations in the field of energy conservation and renewable energy
4. Significant service to society that has lead to a more secure energy future.

Nominations: Nominations should be submitted using the standard ASME form for Society Awards that can be downloaded at **http://files.asme.org/asmeorg/Governance/Honors/SocietyAwards/7758.doc** . The nomination package should also include a curriculum vita of the nominee, a statement of the candidate's research, educational and professional accomplishments, limited to two pages, and five recommendations. Recommendations should be on the ASME form that can be downloaded at **http://files.asme.org/asmeorg/Governance/Honors/SocietyAwards/7760.doc** The recommendations should provide detailed evidence of the candidate's contribution to a secure energy future through innovation(s) in conservation and/or renewable energy technology. An electronic copy (PDF format is preferred) of the candidate's package, including curriculum vitae, letters of recommendation, and the nomination form should be prepared and forwarded to the Chair of the ASME Frank Kreith Energy Award Selection Committee for review.

Deadline: All copies of the nomination package must be received no later than **January 1, 2007**.

Send nominations and inquiries to:

Chair, ASME Frank Kreith Energy Award Selection Committee
Dr. A. Hunter Fanney, Ph.D.
National Institute of Standards and Technology
100 Bureau Drive, Mail Stop 8632
Gaithersburg, MD 20899-8632
Contact: Email - hunter@nist.gov; Fax - 301-975-5433

Results of the 2005 SOLAR SPLASH Competition

The twelfth annual Solar Splash Intercollegiate Solar/Electric Boating Championships were held in Buffalo, NY during June 22-26th, 2005. Twenty-two boats were entered, with sixteen making it to Buffalo and through the Qualifications. The five day competition was held in perfect 'solar weather', and the teams were able to take maximum advantage, with many "fastest and best" times and distances being recorded in various events. This year was the fifth and last Solar Splash held in Buffalo, with the 2006 Solar Splash to be hosted by the University of Arkansas in Fayetteville, AR on June 21-25, 2006.

The 2005 team from Cedarville College repeated their World Intercollegiate Championship performance of the year before. Cedarville won the Endurance event, the Qualification event, and the Visual Display, plus placing second in the Workmanship judging and third in the Sprint event. The Cedarville boat and team were good at almost everything! However, Cedarville was truly challenged by the University of Arkansas team which finished in second place, winning the Slalom event and placing second in both the Sprint and Endurance events. As it turned out, the Arkansas boat missed taking this year's championship by 'having trouble' in the initial event, the Maneuverability Qualification event. Arkansas had to make three runs to finally qualify, which 'cost them' over 50 points, and they only missed the Championship by 39 out of the 1,000 total possible!

The contest for third place was won by California Polytechnic University, Pomona, which edged out the "Most Improved Team Award" winner, the U.S. Naval Academy. Fifth place went to the team from Washington State University. Other winning teams included Webb Institute with the "Outstanding System Design Award", Ecole de Technologie Superieur from Montreal with first place for their Technical Report, and the University of New Orleans winning the Sprint event. The College of New Jersey and Kansas State University were contenders, finishing in sixth and seventh place, respectively.

For more detailed results, pictures, the competition rules, and information on this and previous years' competitions, visit the website at **www.solarsplash.com**. Information on this year's 2006 up-coming competition, an overview of the events, and applications will also be found on the website.

Solar Splash 2005: Turn during the Endurance Event

Summary of the Graduate Student Award Work

DESIGN OF AN ENERGY EFFICIENT RESIDENTIAL ROOF

Daniel Thomas, Department of Mechanical Engineering
University of Minnesota, Minneapolis, MN

Abstract

The overall aim of the research discussed is to develop a residential roof system that will reduce home energy consumption. The roof system is critical to building a better house. The Department of Energy reports that roofs represent 16% of the heating energy use and 14% of the cooling energy use in post-2000 new construction. My research investigates the feasibility of using a sandwich panel roof to meet the structural and thermal requirements for homes in both northern and southern US climates. It is projected that such a panel roof could reduce the energy used to heat and cool homes by at least 10%. On a nationwide basis, if all new homes use the advanced roof design, energy savings are projected to be 1.31 ×1017 J (0.124 quad) over a ten year period with an accompanying environmental benefit of 1.8 ×109 kg carbon. The energy savings is equivalent to 20 million barrels of crude oil.

Introduction

A roof/attic system which has the insulation at the roof plane (Fig. 1), rather than the attic floor, has been demonstrated to reduce space conditioning energy consumption, particularly in hot dry climates [1]. The major energy savings comes from placing the HVAC system in a conditioned attic, thereby reducing energy loss and related moisture problems. The conventional method of constructing such a roof places the insulation in the space between wood rafters or I-joists. This method is time consuming to erect and suffers energy losses due to thermal bridging, buoyancy-induced flow, and infiltration. The wood roof truss system currently in use by a majority of builders has been around since 1956 and has various limitations in energy performance, labor efficiency, and structural design. A self-supporting panelized roof structure is an intriguing solution to these problems and has several important advantages over conventional practice.

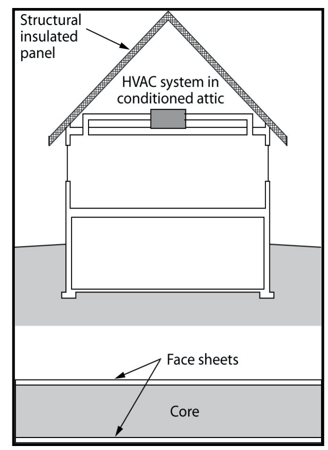


Figure 1. Insulated panel roof system concept with sandwich panel detail

- **Improved energy performance**. In addition to the energy savings earned by placing the mechanical equipment and ducts in a conditioned space, a sandwich panel roof would also eliminate the thermal bridges and cavities associated with blown-in or batt insulation.
- **Reduced moisture and health problems**. Cavities between rafters and insulation are potential sites for moisture condensation and mold growth. Sandwich panels could reduce or eliminate these cavities as well as air or moisture transfer in the roof.
- **Reduced material use and waste**. Manufactured roof panels would reduce both factory and on-site waste. Further savings could be achieved by replacing or eliminating conventional shingles.
- **Reduced assembly time**. Manufactured roof panels would require less skilled on-site labor and thus reduce construction time and labor costs.
- **Increased usable space**. By eliminating trusses, a panel roof system would open up a usable, conditioned space.

Analysis:

Scope: Performance criteria for the panel roof system were developed together with a major US homebuilder. These criteria define structural, thermal, architectural, and other constraints for compliance with building codes and integration with typical house designs. Of particular importance to the structural analysis is the limit on roof deflection, as well as criteria for the roof load and the horizontal span which affect the deflection. The relevant building code [2] specifies that deflection cannot exceed 1/240th of the horizontal span.

The total roof load has two components: a distributed load, which includes the live load, snow load, and dead load (weight of the panel plus shingles etc.), and a thermal expansion load due to the temperature difference across the panel. Both loads vary by geographic location, so two sets of load conditions were defined, one for a southern and one for a northern US climate. Loads also vary by time of year, so the worst case summer and winter loads were considered for each climate.

The work to-date considers the structural feasibility of a base case panel that is 5.5 m long and 2.4 wide. The length is based on a 4.6 m horizontal span and an 8/12 roof. The panel width has a minimal effect on structural performance and was selected for ease in transport, handling and manufacturability. The core thickness is selected to meet a desired R-value. Various materials are considered for the face sheets and core. The face sheet materials considered are oriented strandboard (OSB), steel, and three types of fiber-reinforced plastics (FRP). The foam core materials considered are expanded polystyrene (EPS), extruded polystyrene (XPS), polyurethane (PUR) and poly(vinyl-chloride) (PVC), each in the range of available bulk density (and thus thermal conductivity).

Method: Panel designs are analyzed for failure in four main failure modes, shown in Fig. 2: deflection, core shear failure, local buckling and face sheet yield or fracture. The stresses and deflections used to calculate the risk of failure for each failure mode arise from the distributed load and thermal expansion load. The deflections caused by both loads are superimposed and the total compared to the maximum allowable deflection. Similarly, the stresses caused by each load are superimposed and compared to critical stress criteria for the other three failure modes. With a few exceptions, deflection is the limiting failure mode.

A structurally feasible design is one which satisfies the failure mode criteria and does not exceed a panel weight limit of 570 N/m2. The panel is treated as a beam [3], and simply supported end conditions were selected to provide a conservative estimate for deflection, the limiting failure criterion [4, 5]. The analysis also assumes a perfect bond between face sheets and core, an assumption that will be addressed in future work

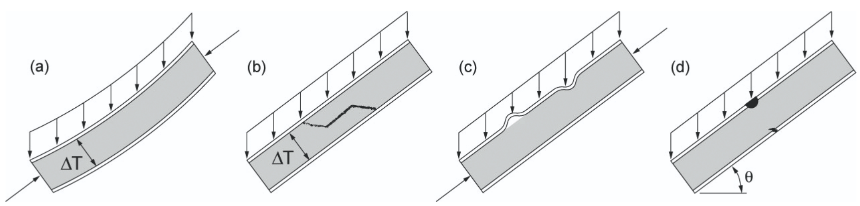


Figure 2. Sandwich panel failure modes considered: (a) deflection, (b) core shear failure, (c) local buckling and (d) face yield or fracture

Results and Conclusions:

Structurally feasible sandwich panel designs are possible in both climate conditions using most of the face and core materials considered. Figure 3 shows structurally feasible designs for an XPS core and a home in southern regions of the US. It demonstrates several important conclusions.

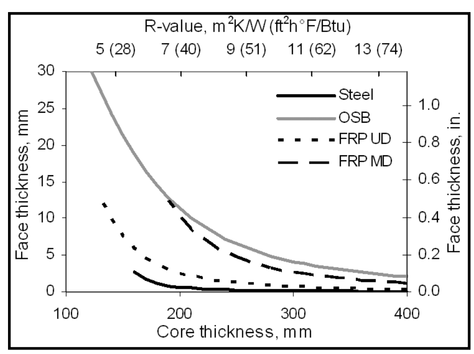


Figure 3. Required face sheet thickness with varying core thickness, for a 48 kg/m3 XPS core, for a 5.5 m long panel to be used in northern locations in the US

First, feasible designs are possible for steel, OSB, an FRP with multidirectional fiber reinforcement (FRP MD) and an FRP with unidirectional fiber reinforcement (FRP UD). Chopped fiber reinforced plastic is unsuitable because of its high coefficient of thermal expansion, which leads to large deflections. A higher coefficient of thermal expansion is also the reason FRP MD face sheets are required to be considerably thicker than FRP UD face sheets.

Second, there are material combinations for which there are no feasible designs. For example, the minimum core thicknesses for steel or FRP panels is dictated by the weight limit. The weight limit eliminates some designs that meet the failure criteria, but do so with a very dense core or thick face sheets (both of which are expensive solutions).

Third, face sheet thickness varies inversely with core thickness because the panel design is limited by the deflection failure criterion. Increasing core thickness decreases the deflection caused by both the distributed and thermal expansion loads. In the same way deflection, as the limiting failure mode, determines the how other parameters affect the required face sheet thickness. Reducing the panel length and using a core with a higher shear modulus than XPS would both reduce the required face sheet thickness from the values shown in Fig. 4.

The current work has not produced a complete design for a panel roof system, but has indicated that it is possible to design such a system meeting the structural and insulation requirements. It has shown the limitations and potential problems with using sandwich structure for the panels. It has also highlighted the important design parameters and key aspects of the design to consider when improving the concept in future work, which will consider integration of heat recovery, photovoltaics and/or solar hot water collectors.

References:

[1] Hendron, R., Farrar-Nagy, S., Anderson, R., Reeves, P., and Hancock, E., 2004, "Thermal Performance of Unvented Attics in Hot-Dry Climates: Results from Building America," ASME Journal of Solar Energy Engineering, 126, pp. 732-737.

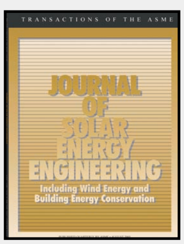
[2] International Code Council, 2003, 2003 International Residential Code for One- and Two-Family Dwellings, International Code Council: Country Club Hills, IL.

[3] Zenkert, D., 1997, The Handbook of Sandwich Construction, Emas, Cradley Heath, UK.

[4] Kucirka, M. J., 1989, "Analysis and design of sandwich panel residential roof systems", Civil Engineering, Massachusetts Institute of Technology.

[5] Morse-Fortier, L. J., 1995, "Structural implications of increased panel use in wood-frame buildings," Journal of Structural Engineering, 121(6), pp. 995-1003.

Opportunities for Publication



Journal of Solar Energy Engineering

Including Wind Energy and Energy Building Conservation

Prof. Aldo Steinfeld, Editor

The **ASME Journal of Solar Energy Engineering** is published quarterly and is available in print as well as electronic media on-line at **http://scitation.aip.org/ASMEJournals/Solar/**

The Editorial Board includes international experts who are responsible for topical areas including fundamentals and theory, heating and cooling, solar optics, solar collectors, solar thermal power, photovoltaics, wind energy, solar space applications, solar chemistry and bioconversion, conservation and solar buildings, energy storage, testing and measurement, emerging technology and energy policy.

The Journal welcomes papers that include original work of permanent interest in all areas of renewable energy and energy conservation as well as discussions of policy and regulatory issues that affect renewable energy technologies and their implementation. Papers that do not include original work but nonetheless present quality analysis or incremental improvements to past work may be published as Technical Briefs. Review papers are accepted but should be discussed with the Editor prior to submittal.

Papers can be submitted online at:
http://journaltool.asme.org/Content/index.cfm

For indexing information:
http://journaltool.asme.org/Content/AbstractIndex15.cfm?notoolbar=1

Upcoming Events

2006 ANES

Vera Cruz, Mexico
October 4-6, 2006
Abstracts 2/06
Full Papers 4/06

2006 ISES Renewable Energy

Chiba, Japan
October 9-13, 2006

2006 ASME International Mechancal Engineering Congress and Exhibition

Chicago, IL, USA
November 5-10, 2006