



# EITC Renewable Energy Workshop 2009

"Opening Up Unlimited Opportunities in a Green,  
Renewable-Energy Based Economy"

## Proceedings

Organized by

Emerging Information and Technology Conference

Co-organized by

Science and Technology Division, TECRO  
Investment and Trade Office, TECRO

Monday, August 3<sup>rd</sup>, 2009  
Taipei Economic and Cultural Office in New York  
1 East 42nd Street, New York, NY 10017

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## **Conference Theme**

### **Theme**

Opening Up Unlimited Opportunities in a Green, Renewable-Energy Based Economy

### **Description**

Recent developments have cast a cloud over the renewable energy business. The capital markets have turned risk-averse, making financing for renewable and alternative energy hard to come by. Declining oil prices make it harder for cleaner transport fuels to compete with gasoline. In a slumping economy, governments will be reluctant to pass climate change legislation that will raise gas and electricity rates.

Despite the dark clouds and lack luster sentiment, renewable energy is still seen to be the way of the future as businesses and corporation realize that the world currently relies heavily on coal, oil, and natural gas for its energy. Fossil fuels are nonrenewable, that is, they draw on finite resources that will eventually dwindle, becoming too expensive or too environmentally damaging to retrieve. In contrast, renewable energy resources – such as wind and solar energy - are constantly replenished and will never run out. Meeting future energy needs in an environmentally responsible way requires scientific breakthroughs to efficiently generate, store, transmit, and use large amounts of power. Governments and businesses need to be constantly at the forefront of the sectors' technology and policies in order to capitalize on market opportunities and socio-infrastructure eco-development.

The United States is poised to transform its economy to create millions of new jobs and help create a cleaner, safer planet by investing in a green, renewable-energy based economy. The United States Congress has passed and President Obama has signed the American Recovery and Reinvestment Act of 2009 into law. This massive \$800 billions spending bill, being truly unprecedented in modern times, will drive new national strategies in renewable energy, smart grid, transmission, advanced vehicles, energy efficiency, and many other aspects of energy, environment, climate and sustainability.

The EITC is proud to host the 2009 Renewable Energy workshop. The workshop will discuss of the following topics:

- Renewable Energy Markets, Policy, Investment, and Future Pathways
- Renewable Energy Opportunities – Business and Research
- Renewable Energy Innovations – Generation, Storage, and Use

## Conference Program

### Registration

08:30am - 09:00am, Monday, August 3, 2009

### Main Auditorium, TECO in New York

1 East 42nd Street, New York, NY 10017

Tel: 212-752-2340, Fax: 212-826-3615

### Welcome remarks

09:00am - 09:10am

### Amb. Kenneth Liao

Director General of Taipei Economic and Cultural Office in New York

### Opening speech

09:10am - 09:30am

Conference Co-chair & Organizer: **Dr. Hsin-Hsiung Chang**, Director, Science & Technology, TECRO

### Minister Lou-Chuang Lee

National Science Council, Republic of China (Taiwan)

### Session I: State of New Jersey's Clean Energy Solutions: Government, Academia, and Industry Working Together

09:30am - 11:00am

Session Chair: **Ms. Jean Chang**, International Trade Specialist, New Jersey Economic Development Authority

*"New Jersey and Taiwan: Opportunities and Synergy"*

### Ms. Jean Chang

International Trade Specialist

New Jersey Economic Development Authority (NJEDA)

*"New Jersey's Energy Master Plan"*

### Mr. Kenneth M. Esser, Jr.

Chief Energy Advisor to Governor Jon S. Corzine

Office of the Governor, State of New Jersey

*"New Jersey's Clean Energy Solutions"*

### Mr. Joseph L. Fiordaliso

Commissioner, New Jersey Board of Public Utilities

*"Smart Power Electronics for Commercial-scale Distributed Generation Interconnection"*

### Mr. Darren Hammell

Executive Vice President of Business Development

Princeton Power

*"Technical, Environmental and Economic Advantages of Power Generation with Biofuels"*

### Mr. Marty Borruso

CEO, Fuel Bio Holdings

*“New Jersey Is Pioneering Offshore Wind in the USA”*

**Mr. Nelson Garcez, Jr.**

Vice President, Generation and Technical Services  
PSEG Global

*“Why We Chose New Jersey?”*

**Mr. Michael Stern**

Director, North American Operations  
CQM Ltd.

## **Break**

11:00am - 11:20am

## **Keynote speech**

11:20am - 12:10pm

Session Chair: **Prof. Minking Chyu**, University of Pittsburgh

*“Thermal Transport in Renewable Energy Systems”*

**Prof. Yogesh Jaluria**

Board of Governors Professor  
Interim Dean, School of Engineering  
Rutgers, the State University of New Jersey

## **Lunch**

12:10pm - 1:30pm

## **Session II: Renewable Energy Opportunities – Business and Research**

01:30pm - 03:30pm

Session Chair: **Prof. Wei-Jen Lee**, Director of the Energy Systems Research Center, the University of Texas at Arlington

*“Hydrogen Economy in Utility Power Generation”*

**Prof. Minking Chyu**

Chair, Department of Mechanical Engineering and Material Science  
Leighton Orr Professor of Engineering  
University of Pittsburgh

*“Accelerate the Path to Renewable Energy by Business Model Innovation”*

**Dr. Sean Shaw-Hwa Wang**

President, ITRI International  
(a subsidiary of Industrial Technology Research Institute, Taiwan)

*“Enabling Technologies for Customer Demand and Budget Management in the Deregulated Environment”*

**Prof. Wei-Jen Lee**

Department of the Electrical Engineering  
Director, the Energy Systems Research Center  
The University of Texas at Arlington

*“Patented Environmentally Friendly Technology for Low-Cost Solar-Grade Silicon Manufacturing”*

**Mr. Peter Mei**

Chairman & CEO, 21-Century Silicon, Inc.

**Break**

03:30pm - 03:50pm

**Session III: Renewable Energy Innovations – Generation, Storage, and Use**

03:50pm - 05:50pm

Session Chair: **Dr. Jen-Yao Chung**, Senior Manager, IBM T.J. Watson Research Center

*“Development of a Passive Micro Direct Methanol Fuel Cell”*

**Prof. Chin Pan**

Dean, College of Nuclear Science, National Tsing Hua University

*“Sensor-related Energy Saving Technologies”*

**Prof. Ping-Hei Chen**

Distinguished Professor, Department of Mechanical Engineering, National Taiwan University

Program Director, Department of Engineering and Applied Science, National Science Council, Republic of China (Taiwan)

*“Third Generation Solar Cell”*

**Prof. Wei-Fang Su**

Department of Material Science and Engineering, National Taiwan University

*“Biomass-Ethanol Conversion: A Renaissance of Fermentation Technologies”*

**Prof. J.H. David Wu**

Department of Chemical Engineering and Department of Biomedical Engineering, University of Rochester

**Closing remarks**

05:50pm - 06:00pm

Conference Co-Chair: **Dr. Sean Shaw-Hwa Wang**, President, ITRI International

## Abstracts and Biographies

### Opening Speech

#### **Lou-Chuang Lee**

Minister, National Science Council  
Republic of China (Taiwan)

#### BIOGRAPHY



#### **CONTACT INFO:**

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#### **EDUCATIONAL:**

- Ph. D. Physics, California Institute of Technology, 1975
- M. S. Physics, California Institute of Technology, 1972
- B. S . Physics, National Taiwan University, 1969

#### **EXPERIENCE:**

- Minister, National Science Council, Executive Yuan, 2008-present
- Professor, Graduate Institute of Space Science, National Central University, 2006-present
- President, National Central University, 2006-2008.
- President, National Applied Research Laboratories, 2003-2006.
- Chief Scientist, National Space Program Office, Taiwan, ROC, 1997-2001;  
Director 2001-July 2004.

- Dean, College of Science, National Cheng Kung University, 1995-2001; Professor 1995-2005.
- Professor, Geophysical Institute and Department of Physics, University of Alaska, 1978-1995.
- Visiting Assistant Professor, Institute for Physics Science and Technology, University of Maryland, 1977-1978.
- Research Associate, NASA/Goddard Space Flight Center, 1975-1977.

**HONORS AND AWARDS:**

- Fulbright Distinguished Scholar, 1988.
- Academic Award, Ministry of Education, Taiwan, ROC, 2001.
- Academician, Academia Sinica, Taiwan, ROC, 2002.
- Presidential Science Prize, Taiwan, ROC, 2005.
- Fellow, The Academy of Sciences for the Developing World (TWAS), 2006.



## Keynote Speech

### **"Thermal Transport in Renewable Energy Systems"**

**Yogesh Jaluria**

Board of Governors Professor  
Interim Dean, School of Engineering  
Rutgers, the State University of New Jersey  
e-mail: [jaluria@soemail.rutgers.edu](mailto:jaluria@soemail.rutgers.edu)

## BIOGRAPHY



## **Education**

- **Ph.D., Mechanical Engineering, Cornell University**  
*May 1974*
- **M.S., Mechanical Engineering, Cornell University**  
*May 1972*
- **B.S., Mechanical Engineering, Indian Institute of Technology, Delhi**  
*May 1970*

## **Work Experience**

- **Interim Dean, School of Engineering, Rutgers, the State University of New Jersey**  
*July 2008 -*  
Mech. Engg. Dept., , Piscataway, NJ, 08854
- **Chairman, Rutgers, the State University of New Jersey, Department of Mechanical and Aerospace Engineering**  
*July 2005 -*
- **Board of Governors Professor, Rutgers, the State University of New Jersey, Department of Mechanical and Aerospace Engineering**  
*October 2001 -*
- **Professor II (Distinguished Professor), Rutgers, the State University of New Jersey, Department of Mechanical and Aerospace Engineering**  
*July 1991 -*

- **Visiting Professor, Indian Institute of Technology, Kanpur, Department of Mechanical Engineering**  
*September 1988 - June 1989*

### **Professional Affiliations**

- **Associate Fellow - American Institute of Aeronautics and Astronautics**  
*July 2005*
- **Member - The Combustion Institute**  
*July 1982*
- **Member - American Physical Society**  
*July 1981*
- **Fellow - American Society of Mechanical Engineers**  
*January 1981*

### **Awards and Honors**

- **Donald Q. Kern Award (2007) , American Institute of Chemical Engineers**  
*April 2008*  
Outstanding achievement in heat transfer or energy conversion
- **Classic Paper Award, Heat Transfer Division (2007) , ASME**  
*November 2007*  
Recognition of past exceptional papers and authors.
- **Hawkins Memorial Lecture (2006) , Purdue University**  
*October 2006*  
Annual lecture in Heat Transfer at Purdue University
- **Robert Henry Thurston Lecture Award (2003) , American Society of Mechanical Engineers**  
*November 2003*  
Lecture entitled "Buoyancy-Induced Flows in Nature and Technology," presented at IMECE 2003.
- **Max Jakob Memorial Award (2002) , American Society of Mechanical Engineers and American Institute of Chemical Engineers**  
*July 2002*  
Eminent achievement in the field of Heat Transfer

Session II: Renewable Energy Opportunities – Business and Research

**"Hydrogen Economy in Utility Power Generation"**

**Minking K. Chyu**

Leighton Orr Chair Professor and Chairman  
DOE-NETL Residence Fellow  
Department of Mechanical Engineering and Materials Science  
University of Pittsburgh  
Pittsburgh, PA 15261, USA  
Tel: 412-624-9784  
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BIOGRAPHY



**Dr. Minking K. Chyu** is presently the Leighton Orr Chair Professor and Chairman of Mechanical Engineering and Materials Science Department at the University of Pittsburgh. He received his Ph.D. degree in Mechanical Engineering from the University of Minnesota in 1986. He was a faculty member at Carnegie Mellon University for 14 years before joining the University of Pittsburgh in 2000. His primary research area lies in thermal and material issues relating to energy, power and propulsion systems. He has conducted research projects sponsored by a number of government agencies and industry. Since he joined Pitt, he has initiated a number of collaborative research programs in micro- and nanotechnology, fuel cells, and biomechanics. Professor Chyu is a recipient of four NASA Certificates of Recognition for his contribution on space shuttle program, Air Force Summer Research Fellow, Department of Energy Oak Ridge Research Fellow, and DOE Advanced-Turbine-System Faculty Fellow. He is a Fellow of the American Society of Mechanical Engineers (ASME), Associate Fellow of American Institute of Aerospace and Aeronautics (AIAA), and a US delegate to the Scientific Council of the International Centre of Heat and Mass Transfer (ICHMT). He was named the Engineer of The Year by the ASME Pittsburgh Chapter in 2002. In 2007, he was appointed as Institute of Advanced Energy Solutions (IAES) Residence Fellow by the National Energy Technology Laboratory (NETL), Department of Energy (DOE). He serves as an Associate Editor for the Journal of Heat Transfer, ASME, Advisory Board Member for the International Journal of Fluid Machinery and Systems, and a Foreign Editor for the International Journal of Chinese Institute of Mechanical Engineers. He has published more than 250 technical papers in archived journals and conference proceedings.

Session II: Renewable Energy Opportunities – Business and Research

**“Accelerate the Path to Renewable Energy by Business Model Innovation”**

**Conference Co-Chair**

**Sean Shao-Hwa Wang**

President, ITRI International Inc. (a subsidiary of ITRI)  
2880 Zanker Road, Suite #109, San Jose, CA 95134  
Tel: +1-408-428-9988 x12;  
e-mail: [seanwang@itri.com](mailto:seanwang@itri.com)

BIOGRAPHY



**Dr. Sean Shao-Hwa Wang** is the President of ITRI International (San Jose, California), which is ITRI’s presence in North America, beginning from June 2005. He joined ITRI as the General Director of IEK in July 2004. Before joining ITRI, for about 15 years, Dr. Wang was with SRI International/SRI Consulting (Menlo Park, California), where he developed and implemented international proprietary projects on technology evaluation, feasibility study, strategic planning, identification of new business opportunities, licensing strategy, buy-or-build issue, and new plant investment decision. He was the managing editor of *Process Economics Program (PEP) Yearbook*, which contains production economics for 900+ processes to produce more than 550 chemical products in the U.S., Germany, Japan, and China. He also authored 32 proprietary reports on the evaluation of technologies in the areas of energy, petrochemicals, and electronics chemicals and materials. Earlier, Dr. Wang was associated with M.W. Kellogg (now KBR) and Morgantown Energy Technology Center (now the National Energy Technology Laboratory) of U.S. Department of Energy.

Session II: Renewable Energy Opportunities – Business and Research

**“Enabling Technologies for Customer Demand and Budget Management in the Deregulated Environment”**

**Session Chair**

**Wei-Jen Lee**

Department of the Electrical Engineering  
Director, the Energy Systems Research Center  
The University of Texas at Arlington  
e-mail: [wlee@uta.edu](mailto:wlee@uta.edu)

ABSTRACT

Federal Government perceives the necessities of demand response for all customer classes including the real-time pricing for end-use residential consumers as stated in the Energy Policy Act (EPA) 2005 Section 1252 (a) (14) (A), 1252 (a) (14) (B), and 1252 (f). In addition, it is believed that the demand response and the real-time electricity pricing is an exit strategy to resolve electricity crises. According to DOE, the demand response is defined as “Changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized”.

The primary benefit of electricity demand response, as described in FERC’s Staff Report and the Department of Energy’s Report to the US Congress, is the enhancement of effectiveness and efficiency in utilizing the system’s overall resources both long-term and short-term. An effective demand response program can reduce or shift the electricity load consumptions away from the peak periods of near capacity limits and high marginal generating costs. The constrained or stressed power systems can be mitigated. The transmission networks, consequently, are not in at risk of overload, which can avoid forced outages or blackouts. Market failures and crises, such as California meltdown in 2000 and 2001 can be prevented. The expensive-to-run low efficiency peak generators do not have to be committed. Environmental benefit can also result since these low efficiency generators usually have highly polluted emission. Different load controls for demand response have been proposed and discussed previously. However, current demand response programs are utility-centered direct load controls, in which utilities disconnect or curtail loads for network security regardless of the end-use consumers’ discomfort. This presentation discusses the enabling technologies for customer demand and budget management in the deregulated environment.

BIOGRAPHY



**Wei-Jen Lee** (S'85-M'85-SM'97-F'07) received the B.S. and M.S. degrees from National Taiwan University, Taipei, Taiwan, R.O.C., and the Ph.D. degree from the University of Texas, Arlington, in 1978, 1980, and 1985, respectively, all in Electrical Engineering. In 1985, he joined the University of Texas, Arlington, where he is currently a professor of the Electrical Engineering Department and the director of the Energy Systems Research Center.

He has been involved in the revision of IEEE Std. 141, 339, 551, and 739. He is the Secretary of the IEEE/IAS, Industrial & Commercial Power Systems Department (ICPSD), the Committee Chairman of the Energy Systems Committee at ICPSD, and the associate editor of IEEE/IAS and International Journal of Power and Energy Systems. He is the project manager of IEEE/NFPA Collaboration on Arc Flash Phenomena Research Project.

Prof. Lee has been involved in research on renewable energy, power flow, transient and dynamic stability, voltage stability, short circuits, relay coordination, power quality analysis, demand response, on-line equipment protection, monitoring, and control system, and utility deregulation. He has served as the primary investigator (PI) or Co-PI of over seventy funded research projects. He has published more than one hundred sixty (160) journal papers and conference proceedings. He has provided on-site training courses for power engineers in Panama, China, Taiwan, Korea, Saudi Arabia, Thailand, and Singapore. He has refereed numerous technical papers for IEEE, IEE, and other professional organizations.

Prof. Lee is a Fellow of IEEE and registered Professional Engineer in the State of Texas.

Session II: Renewable Energy Opportunities – Business and Research

**“Patented Environmentally Friendly Technology for Low-Cost Solar-Grade Silicon Manufacturing”**

**Peter C Mei**

21-Century Silicon, Inc.  
1681 Firman Dr. Suite 103  
Richardson, TX 75081  
Tel: +1-214-5026711, Fax: +1-972-591-0731  
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ABSTRACT

21-Century Silicon, Incorporated (21CSi) was formed for the purpose of providing photovoltaic solar cell industry a low cost polysilicon product of high purity silicon material suitable for Solar Grade (SoG) silicon ingot/wafer manufacturers throughout the world. A patented, environmentally friendly, Carbothermal reduction technology, consist of scalability, flexibility and clusterability manufacturing attributes, which can produce low-cost solar-grade silicon in shorter time and much less capital.

SoG Silicon Industry was existed in the past only in concept. It is defined as a silicon metal product of purity around 99.9999% (6Ns) and good enough to make solar cells but not good enough to make electronic devices for semiconductor / computer chip industry. Therefore, SoG silicon normally means off-spec Electronic Grade (EG) silicon of purity originally for at lease better than 8Ns and can be as high as 14Ns.

In order to capitalize on the current extreme demand of polysilicon feedstock market, 21CSi has focused on its core competency of manufacturing SoG silicon from purer than SoG silica (silicon dioxide - a Determining Important Factor to Success, using the historically known of the lowest cost carbothermal silicon-reduction process.

BIOGRAPHY



Currently, Chairman/CEO of 21-Century Silicon, Inc., an innovative low-cost Solar Grade Silicon manufacturer for PV industry. Formerly President/CEO of an Innovation Materials & Technology Solutions, Fabless IC design. ExVP of Energy Saving Technology company and VP

Technical marketing and sales(Asia) of Globitech Inc. Managers of several Technology Transfer projects for TI & Infineon. Previously served as Member of Technical Staff for TI corporate R&D for Power device & IC. Mr. Mei have 25 years of technology R&D, engineering, IC design, and marketing experience. He holds eight patents (6 on LCD HV CMOS devices, 2 on future Si material) and has published 28 technical papers. He is also a Senior Member of IEEE.

## Session III: Renewable Energy Innovations – Generation, Storage, and Use

### **Session Chair**

### **Jen-Yao Chung**

Senior Manager  
Industry Technology and Solutions  
IBM T. J. Watson Research Center  
Tel: (914)945-3422  
e-mail: [jychung@us.ibm.com](mailto:jychung@us.ibm.com)

#### BIOGRAPHY



**Jen-Yao Chung** received the M.S. and Ph.D. degrees in computer science from the University of Illinois at Urbana-Champaign. He is the senior manager for Industry Technology and Solutions, IBM T. J. Watson Research Center, responsible for identifying and creating emerging solutions with focus on "Green Computing and Business". Before that, he was Chief Technology Officer for IBM Global Electronics Industry. Before that, he was senior manager of the electronic commerce and supply chain department, and program director for the IBM Institute for Advanced Commerce Technology office. Dr. Chung is co-Editor in Chief of the International Journal of Service Oriented Computing and Applications (published by Springer). Dr. Chung is the co-founder and co-chair of the IEEE technical committee on Electronic Commerce. He has served as general chairs and program chairs for many international conferences. He has authored or co-authored over 160 technical papers in published journals or conference proceedings. He is a Fellow of IEEE and a Distinguished Engineer of ACM.



## Session III: Renewable Energy Innovations – Generation, Storage, and Use

### **"Development of a Passive Micro Direct Methanol Fuel Cell"**

#### **Chin Pan**

Dean, College of Nuclear Science  
Director, Energy and environmental Research Center  
National Tsing Hua University  
Hsinchu, Taiwan, Republic of China  
e-mail: cpan@ess.nthu.edu.tw

#### BIOGRAPHY



**Dr. Chin Pan** is a professor of the Department of Engineering and System Science and the Dean of the College of Nuclear Science of the National Tsing Hua University (NTHU). Dr. Pan received his BS degree in nuclear engineering from National Tsing Hua University in 1979, MS and Ph.D degrees in nuclear engineering from University of Illinois at Urbana-Champaign (UIUC) in 1983 and 1985, respectively. After receiving his doctoral degree, Dr. Pan served as a visiting research assistant professor at UIUC before joining NTHU as an associate professor in 1986 and promoted to full professor in 1990. From August 1992 to August 1993, Dr. Pan conducted research and served as a Visiting Professor of the Department of Nuclear Engineering of UIUC with a fellowship from the National Science Council of Taiwan, ROC. In the summer of 1998, he conducted microchannel boiling studies in the Department of Engineering Science of the University of Oxford as an academic visitor with a visiting fellowship from Engineering and Physical Sciences Research Council, UK. In the next summer, he conducted researches on multidimensional modeling of two-phase flow in the Rensselaer Polytechnic Institute as a visiting scholar with a fellowship from the National Science Council of Taiwan, ROC. He served as the Chairman of the Department of Engineering and System Science of NTHU from February, 2001 to January, 2004 and the director of the Center for Energy and Environmental Research from December 2003 to July 2008. He served as the chairman of the academic committee for joint projects of Atomic Energy Council and National Science Council from 2001 to 2005. He is now serving as the chairman of the Advisory Committee of Nuclear Safety in the Atomic Energy Council. Dr. Pan has been serving as the Dean of College of Nuclear Science since August, 2005.

Dr. Pan's research activities for the past two decades have been in the areas of two-phase flow, boiling heat transfer and energy engineering with a special focus on transition boiling, nucleate boiling near CHF, nuclear reactor thermalhydraulics, two-phase flow instability with or without nuclear coupling, two-phase natural circulation loops, microchannel two-phase flow, microchannel boiling, microchannel heat sink, microchannel reactor, and thermal-fluid transport in fuel cell systems, especially micro direct

methanol fuel cells. He published a book in Chinese entitled “Boiling Heat Transfer and Two-phase Flow” in 2001. He authored and co-authored about 60 SCI journal papers and 80 conference papers. He received a distinguished research award in 1998 and three excellent research awards earlier from the National Science Council of Taiwan, ROC. He also received an distinguished industry – academia collaboration award from the Ministry of Education of Taiwan, ROC in 2003.

Session III: Renewable Energy Innovations – Generation, Storage, and Use

**"Sensor-related Energy Saving Technologies"**

**Ping-Hei Chen**

Distinguished Professor  
Department of Mechanical Engineering, National Taiwan University  
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BIOGRAPHY



**Prof. Ping-Hei Chen** was born in Taichung county, Taiwan on Aug. 31<sup>th</sup>, 1958. He received bachelor degree in mechanical engineering from National Taiwan University in 1980. After completing his military service, he went to U. of Minnesota for his graduate study. He received his master and Ph. D. degree in mechanical engineering from U. of Minnesota in 1984 and 1988, respectively.

In 1988, he joined the Dept. of Mechanical Engineering of National Taiwan University as an associate professor. He was promoted to full professor in 1996. He had served as the chairman of the Department of Mechanical Engineering of National Taiwan University from 1998 to 2001. He was awarded as a distinguished professor by the National Taiwan University in 2008. He is serving as the program director of thermal, fluid, and energy division of NSC. His major research areas are in MEMS, Biomedical devices, nanotechnology, energy harvesting chips, and sensors.

Prof. Ping-Hei Chen is a member of ASME, CSME, CIE, CSNM, CSAAE, and CSAT. He was awarded with the excellent engineering professor award by CSME in 2002, the excellent engineering professor award by CIE in 2006, and the distinguished research award by NSC in 2008. He has published more than 100 journal papers, 130 conference papers, two books, and 14 patents.

Session III: Renewable Energy Innovations – Generation, Storage, and Use

**“Third Generation Solar Cell”**

**Wei-Fang Su**

Professor, Department of Materials Science and Engineering  
National Taiwan University  
Tel: \*886-(02) 3366-4078  
e-mail: suwf@ntu.edu.tw

BIOGRAPHY



**學歷:** 美國麻州大學高分子化學博士

**Education:** 1978 Ph.D. University of Massachusetts

**現職:** 台灣大學材料工程與科學研究所教授(1996 迄今)

**Position:** Professor of National Taiwan University (1996 to present)

**經歷:**

**Experience :**

瑞士理工學院洛桑分校客座教授(2004)

2004 Swiss Federal Institute of Technology, Lausanne, Switzerland

美國西屋科技中心 Fellow Scientist (1980-1996)

Fellow Scientist, Westinghouse Science and Technology Center, Pittsburgh, PA, USA

日本三菱電機材料與元件研究中心客座學者(1990-1991)

1990-1991 Visiting Scientist, Electronic Materials and Device Laboratory of Mitsubishi Electric Corporation, Osaka, Japan

美國西北大學材料研究中心博士後研究員(1978-1979)

1978-1979 Postdoctoral Fellow, Materials Research Center of Northwestern University, Evanston, IL, USA

**專長:** 光電高分子及電子陶瓷材料、奈米材料、薄膜製程、太陽能電池。

**Expertise:** Polymers, electroceramics, nanomaterials, thin film processing, solar cell

## Session III: Renewable Energy Innovations – Generation, Storage, and Use

### **“Biomass-Ethanol Conversion: A Renaissance of Fermentation Technologies”**

**J.H. David Wu**

Professor, Department of Chemical Engineering  
University of Rochester  
Tel: +1-585-275-8499, Fax: +1-585-273-1348  
e-mail: [davidwu@che.rochester.edu](mailto:davidwu@che.rochester.edu)

#### ABSTRACT

Biomass conversion to ethanol as a liquid fuel offers a potential partial solution to the problem of the world's dependence on petroleum for energy.

Of the total gasoline usage in the U.S.A. as a transportation fuel and by industry, about half has to be imported. On a worldwide basis, terrestrial plants produce  $1.3 \times 10^{10}$  metric tons (dry weight basis) of wood per year, which is equivalent to about two-thirds of the world's energy requirement. Furthermore, tremendous amounts of cellulose are available as municipal and industrial wastes, which today contribute to our pollution problems. Thus, great interest exists in the use of cellulosic biomass as a renewable source of energy via breakdown to sugars that can then be converted to liquid fuel. Neat (unblended) ethanol burns cleaner, has a higher octane rating, can be burned with greater efficiency, is thought to produce lower amounts of ozone precursors, thus decreasing urban air pollution, and is particularly beneficial with respect to low net CO<sub>2</sub> put into the atmosphere. Furthermore, ethanol by fermentation offers a more favorable trade balance, enhanced energy security and a major new crop for a depressed agricultural economy. Ethanol is considerably less toxic to humans than is gasoline (or methanol). Ethanol also reduces smog formation because of low volatility; its photochemical reactivity and that of its combustion products are low. With the current and impending phase-out of methyl *tert*-butyl ether (MTBE) as an oxygenate in many states in the U.S.A., ethanol will fill the void.

The potential quantity of ethanol that could be produced from cellulose is over an order of magnitude larger than that can be produced from corn. In contrast to the corn to ethanol conversion, the cellulose to ethanol route involves little or no contribution to the greenhouse effect and has a clearly positive net energy balance (5 times better). As a result of such considerations, microorganisms that metabolize cellulose have gained prominence in recent year. The rate-limiting step in the conversion of cellulose to fuels is its hydrolysis, especially the initial attack on the highly-ordered, insoluble structure of crystalline cellulose.

The presentation will review the need for a consolidated cellulosic ethanol fermentation process and discuss the industrial bioprocess of biomass-ethanol conversion.

## BIOGRAPHY



**Professor Wu** was born in Taiwan. He received a BS and MS degrees in Biochemical Science and Technology (formerly known as Agriculture Chemistry) from the National Taiwan University in 1976 and 1980, respectively. He earned his MS and PhD degrees in Biochemical Engineering from MIT in 1982 and 1987, respectively.

He is a *Professor of Chemical Engineering and of Biomedical Engineering* at the University of Rochester in Rochester, NY. He is a leader in studying the biomass-degrading enzyme system of *Clostridium thermocellum*, a key bacterium in “onsolidated Processing” leading to bioethanol production. He directs a DOE-funded consortium to develop biomolecular strategies toward biofuel production employing this bacterium. His work has led to the discoveries of the modular structure of the now well-known cellulosomal scaffolding protein, the unique Family 48 of glycosyl hydrolases, the novel 3-D structure of the cellulosomal dockerin, and the first cellulase transcriptional regulator and operon in *C. thermocellum*. At the University of Rochester, he developed a novel 3-D bone marrow culture system conducive to multi-lineal blood cell differentiation. The 3-D culture system is being used as a model in three NIH- or BARDA-funded centers on developing countermeasures against bioterrorism, including vaccines and anti-radiation drugs. His research group continues to investigate the cellulosome mechanism, and transcription regulation concerning biomass degradation and bioethanol fermentation at the genome scale as well as molecular events governing blood cell formation.

Professor Wu is a Fellow of *the American Academy of Microbiology (AAM)*, a Fellow of *the Society for Industrial Microbiology (SIM)*, and a recipient of the SIM Waksman Outstanding Educator Award. He has twice won the awards for excellence in teaching from the Undergraduate Engineering Council of the University of Rochester. He is currently an editor for *Industrial Biotechnology* and served on the editorial boards of *the Journal of Bioscience and Bioengineering* and *Applied Microbiology and Biotechnology*. He is also an editor for *the ASM Manual of Industrial Microbiology and Biotechnology* (Second Edition). He served as the ASM Div. O Chair in 1997/1998 and was the Divisional Lecturer in 2002. He has served as a reviewer for various federal programs on bioenergy or tissue engineering, including those of DOE, DOE-GTL, NSF, NIH, and NREL. He also served as a Scientific Advisor to NYSTAR (the New York State Foundation for Science, Technology & Innovation), and a Program Co-Chair for the SIM Annual Meeting.