Waterloo Institute for Sustainable Energy

THE YEAR IN REVIEW
MAY 1, 2008 – APRIL 30, 2009

CONTENTS

THE YEAR IN REVIEW 2008 – 2009 2

HIGHLIGHTS 3

Research 3

Education and Training 11

Outreach 13

WISE ORGANIZATION 16

Activities 19

LIST OF ATTACHMENTS 27

WISE brochure – The Full Spectrum of Research

A Proposal for WISE Courses and Training Program

B Media Related

C List of Regular Members

D Papers, presentations, conferences attended

WATERLOO INSTITUTE FOR SUSTAINABLE ENERGY

THE YEAR IN REVIEW 2008 – 2009

SUMMARY

THE WATERLOO INSTITUTE FOR SUSTAINABLE ENERGY (WISE) received formal approval at UW Senate in April 2008. More than 70 faculty members working as multi-disciplinary teams across faculties of Engineering, Science and Environment are involved in research studies with utilities, private sector partners and government agencies to develop improvements and alternatives to existing energy production and delivery systems, and to promote energy efficiency and environmental sustainability.

Our vision is to establish WISE as an internationally recognized centre of excellence and contribute to the development of energy policies that enhance the social, economic, and environmental performance of the energy system.

We recognize innovation will be the key driver to help transform the energy system required for long term sustainability. The emerging trends are for an increased role of renewable energy technologies and improvements to the efficiency of energy use. We focus on innovative research initiatives to provide solutions for timely implementation by our communities, businesses, government and industry.

WISE has enjoyed a successful first year of operation. We have organized ourselves as a presence on the campus. Our early efforts have been recognized by institutions outside the university and a number of major initiatives and projects are under way. In this report, we highlight some of our achievements but recognize that we are in the early stages of our journey. The path forward remains a daunting task because of the complexity of energy issues. However, we remain confident that a university-wide multi-disciplinary effort is the most promising approach.

The full spectrum of research undertaken at WISE is available in the institute's brochure and web pages at: http://www.wise.uwaterloo.ca/. A copy of the brochure is provided as an attachment.

Jatin Nathwanis
Executive Director

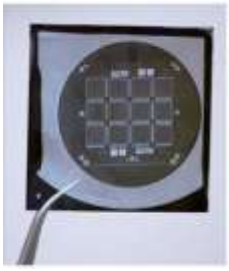
HIGHLIGHTS

OUR MISSION IS TO CONDUCT INNOVATIVE RESEARCH AND PROVIDE SOLUTIONS FOR TIMELY IMPLEMENTATION BY BUSINESSES, GOVERNMENT AND INDUSTRY.

RESEARCH

EXPERTISE OF WISE SPANS A WIDE RANGE OF DISCIPLINES AT UW: solar, wind and fuel-cell energy researchers, experts in conservation and efficiency, experts in power systems and public policy, and more. In 2007, prior to formal recognition as an institute, the wind energy research group launched a partnership with the city of Waterloo; the fuel-cell group received a $5.4-million grant; and public lectures for UW Energy Days brought researchers, policy makers and the public together on campus.

SIGNS OF THE GROWING CONCENTRATION OF SUSTAINABLE ENERGY RESEARCH ON CAMPUS



The Centre for Advanced Photovoltaic Devices and Systems (CAPDS) is housed in a new building. Photovoltaics – solar cells – convert sunlight directly into electricity. It is a clean form of renewable energy that does not require any fuel, decentralizes power generation, has no moving parts, almost no wear and tear, and requires minimal maintenance. Professor **Siva Sivoththaman**, electrical and computer engineering, is the director.

Research at the 14,000 square-foot facility ranges from basic work on semiconductor materials to testing ready-to-go grid-connectible modules to the development of advanced solar technologies to reduce cost and improve efficiencies dramatically.

The High Voltage Engineering Laboratory (HVEL) is a leading research and teaching lab in the field of insulation, applied electrostatics, nanodielectrics, pulse power applications, and power electronics. It is one of the most research-intensive facilities in North America and featurs state-of-the-art technology. Professor **Shesha Jayaram** of electrical and computer engineering is the director.

HVEL is also made available to industries as an independent university centre for testing and evaluation.

David Johnson, a professor of mechanical and mechatronics engineering is director of the world class UW Live Fire Research Facility, a large scale indoor wind generation facility. Research in wind turbines, structures and components takes place in this 5500 ft2 free span structure that houses a variable speed 600 hp fan system capable of delivering winds between 0 m/s and18 m/s over a 10mx20m area. The large enclosure can be configured for studies of many different wind profiles including shear and high turbulence. The labs and test areas are equipped with state-of-the-art monitoring and measurement instrumentation supported by a 380 channel, computerized data acquisition system.

The off-campus facility has been well equipped with state of the art test and analysis equipment.

Automotive research drives ahead

In 2007 researchers from chemical engineering launched new automotive projects. Professors Leonardo Simon and **Ray Legge** are currently working to replace the petroleum-based plastic used in cars and trucks with a biologically based plastic made from agricultural waste such as corn stalks. Professor **Mike Fowler** is leading efforts to make fuel cells more durable and more reliable for use in vehicles.

Making CO2 capture and storage more economical

Burning fossil fuels releases carbon dioxide. Carbon dioxide drives climate change. In a warming world, there's much to be gained by breaking that cycle. Chemical engineering professor **Eric Croiset** and fellow chemical engineering professor **Peter Douglas** are working to make capture and storage of carbon more economical. They are experimenting with techniques such as oxy-fuel combustion, where the fossil fuel is burned with almost pure oxygen. Another option is gasification, in which the coal is converted into hydrogen and carbon monoxide before combustion. Croiset and Douglas completed the first major examination of Ontario's carbon sequestration options with a study of the Nanticoke plant, North America's largest coal-fired generator. They concluded that the best option for Nanticoke would be to compress the captured gas into a liquid, pipe it to the centre of Lake Erie, and then pump it almost a kilometre below the surface, where the natural porous rock could absorb and hold it.

Ontario's Public Power Infrastructure is Aging

Ontario's electricity system, from hydroelectric dams to nuclear generation stations to the transmission and distribution system is showing its age. As the system components age, concern about the deterioration of the health and status of the infrastructure has led decision makers to focus on strategies for improving the integrity of the system. Blackouts, brownouts, safety and environmental emission are some of the concerns including the cost of replacing or repairing the multi-billion-dollar system. Professor **Mahesh Pandey** is leading a project to address these concerns. In 2007, the Ontario Research Fund awarded the civil and environmental engineering faculty member $1.4 million to support his work to maximize the efficiency of Ontario's existing energy system and to learn how to make smart decisions. When, for instance, a power plant develops a fault and operates at only half capacity, is it better to shut it down and try to repair it, or keep it running while a new one is built? To make decisions in such complex situations, public officials need to monitor the health of the power system, predict its decay, and make plans for its refurbishment. A model is needed to balance cost, safety and environmental concerns – all the while keeping the level of service unaffected. Prof. Pandey has developed mathematical models that take all the key variables into account and to develop actionable recommendations to help public officials and power engineers manage the risks in a cost-effective manner.

GREENING THE GRID

NEW ENERGY TECHNOLOGIES are required to help Ontario wean itself away from fossil fuels. The challenge is to ensure they can cope with the harsh climate and can be readily integrated into the existing system. A major investment from Ontario Centres of Excellence (OCE) in support of world-class research in clean energy options was announced in February 2008 for three signature projects at UW:

Decreasing Diesel Dependency in Remote Northern Communities

In an effort to reduce diesel dependency in remote Northern Ontario communities, this partnership aims to develop a low-carbon community energy system that combines new kinds of rugged wind turbines, specifically designed for extreme Northern climates, with a storage system that uses hydrogen and a fuel cell to generate electricity. This off-grid hybrid power system provides a lower-cost, environmentally friendly solution to alleviate the significant financial burden of diesel power systems on remote communities. Kasabonika Lake is part of the Nishnawbe Aski's 26 communities that rely on diesel – currently they use about 20 million litres annually. The new wind plants will cut that

consumption significantly and provide a renewable energy alternative for remote communities. The team at the University of Waterloo is led by professor **David Johnson** (Mechanical Engineering) (pictured at left) with professors **Mehrdad Kazerani**, **Xianghou Li**, and **Paul Parker** (Environment). Project partners include Hydro One Remote Communities Inc. Virilec, GE, Wenover, and Ontario Power Authority. OCE's funding is $3 million, with other partners providing $3.4 million.

Energy Consumption Management System Gives Consumers Control

The Energy Hub Management System, developed in partnership with the University of Waterloo, will enable Ontario homeowners and businesses to take ownership of their energy needs, while reducing costs and the impact on the energy grid. A smart web-based tool gives consumers control to change the way they use energy, like programming the system to switch away from the central energy grid at peak times, and move to on-site alternatives like solar and wind energy. The team at the University of Waterloo is led by professor **Ian Rowlands** (Environment) with professors **Kankar Bhattacharya**, **Claudio Canizares** (Electrical and Computing Engineering) and **Paul Parker** (Environment). Project partners include Hydro One Networks Inc. (Toronto), Energent Energy Solutions (Waterloo), Milton Hydro Distribution Inc. (Milton), and the Ontario Power Authority. OCE is providing $1 million, and other partners $1.45 million.

Connecting Solar Farms to the Grid

The University of Waterloo and the University of Western Ontario are developing comprehensive solutions to help grid operators incorporate large-scale solar farms on to their networks. By developing technologies to efficiently convert solar energy to electricity, and produce innovative software for making weather-based predictions to help manage unique weather challenges, the creation of a robust solar power integration plan has the potential to encourage utilities in Ontario and around the world to adopt solar technologies. Led by the University of Western Ontario and professors **Magdy Salama** and **Siva Sivoththaman** (electrical and computer engineering) at the University of Waterloo, project partners include Hydro One Networks Inc. (Toronto), OptiSolar Farms Canada (Sarnia), Bluewater Power Distribution Corporation (Sarnia) and London Hydro (London). OCE funding is $3million, with other partners adding $3 million.

Conservation and Energy Efficiency

Studies Promote Conservation

Waterloo researchers are studying ways to promote conservation of electricity as well as working to advance residential energy efficiency.

Ian Rowlands, of the Department of Environment and Resource Studies in the Faculty of Environmental Studies, is leading an Ontario Centre for Energy-supported project on conservation and demand management strategies in partnership with Milton Hydro.

The research involves investigations into the attitudes and behaviours of both industrial and residential customers. Included in this is a thorough analysis of how 'feedback mechanisms' - that is, increased information about energy consumption through conventional and electronic means of delivery - can empower people to manage their energy needs more sustainably.

Jennifer Lynes, a Waterloo Environment and Resource Studies professor, assisted high school students encouraging homeowners in Shelburne to save energy. Students from Centre Dufferin District High School's Environment Club arranged to have PowerCost monitors installed in 30 homes. The monitors display real-time household electricity consumption and cost.

Prof. Lynes guided the analysis of the results to see if providing households with immediate feedback helps to reduce their overall electricity consumption.

Teaching-Based Research Group (TBRG) Research Project and ***NSERC Centre for Research in Youth, Science Teaching and Learning (CRYSTAL) Research Program***

Christine Moresoli, a professor of chemical engineering is involved in two areas supported by NSERC: Industrial Chair related to energy efficiency building bio filters and working with municipalities on a project to deal with waste. She is also working with researchers in education to identify in school curriculums how energy saving ideas are being presented to children with an eye to also developing into an outreach program. As a member of NSERC CellNet Research Network, professor Moresoli's research activities focus on the establishment of strategies for the integration of membrane separation processes in the production of recombinant therapeutic proteins and immunoglobulins.

Doing All Your Cooking in One Pot

For 20 years, Professor **Flora Ng** in the chemical engineering department has been at the forefront of research into catalytic distillation. Catalysis speeds up the rate of chemical reactions while distillation separates out the chemical products you are interested in. Combining the two processes is more productive and uses less energy. When catalytic distillation processes were first developed in the 1980s, the fundamentals weren't well understood. Prof. Ng worked to both build that fundamental understanding and invent new processes. Prof. Ng has also always sought out opportunities for industrial collaboration. The process used by the 220,000-tonne chemical plant, for instance, was developed in collaboration with British Petroleum. More recently, her team has been at work on green energy processes, including one that creates biodiesels from waste oils. Currently, she is working to green the oil sands. Oil sands bitumen comes out of the ground as a tar-thick emulsion of oil and water. Right now surfactants are used to separate the bitumen from the water, then hydrogen is added to upgrade the bitumen into gasoline and diesel. Prof. Ng has developed nano-catalysts that react with the water to produce hydrogen, removing the water and upgrading the bitumen in a single step.

Biogas an Alternative Energy Source

Wayne Parker, a professor in the civil and environmental engineering department, and professor Ray Legge in chemical engineering, are conducting research to enhance the application of anaerobic digestion of farm, agricultural and municipal waste to produce biogas for heat and electricity generation. Anaerobic digestion and biogas products offer several advantages in terms of use of a renewable resource and providing a sustainable energy carrier. Anaerobic digestion promotes pathogen reduction, increased nutrient recovery and carbon return to the soil. Biogas combustion reduces methane emissions that would have otherwise occurred resulting in a net reduction in greenhouse gas emissions. This research provides a basis for the development of advanced biogas systems that are effective and economically viable in an Ontario context with significant energy generation, ecological and environmental benefits.

Renewable Solar Energy

Distributed Generation

Professors Y. El-Mabruk S. EL-Rayani, **K. Ponnambalam**, **M. Salama**, and **R. El Shatshat** have made significant advances to help integrate wind and PV based systems into the grid. The lack of ability to schedule DG units has been an impediment to wider adoption of DG resources because researchers have only applied traditional models. A detailed review of the incorporation of DG units into the operations of distribution systems was presented in IEEE GM09 Super Session -

Panel, Regulator and Public Challenges to Utility Enhancements on July 28, 2009. The work based on stochastic approaches was also presented in CORS-INFORMS International Meeting, Toronto June 14-17, 2009. Prof. Ponnambalam's team is working closely with Waterloo North Hydro Inc. to assist them with the challenges of integrating DG into the distribution network.

Integrating large-scale solar farms into grid networks

Professor **Magdy Salama**, PI, April 2008. The provincial government awarded the Faculty of Engineering $3 million to help power grid operators incorporate large-scale solar farms into their networks. The research team will design prototypes of new equipment that will help solar plants operate at maximum efficiency: weather sensors, power quality monitors, develop commercial software to keep the new plants running smoothly, and study problems of grid control and operation.

Collaborators include Ontario's public transmission company Hydro One, local distribution companies such as Bluewater Power and London Hydro, and Ontario's largest solar farm, OptiSolar Incorporated. The technology, software and equipment that this project will develop is needed wherever large-scale solar farms are built.

Mission to Develop Affordable Solar Energy

THE PROJECT VISION AND CONCEPT is to develop affordable energy services with minimum carbon footprint on a mass scale, thus making the services affordable by most of the world's population. Solar energy is part of the answer. Unfortunately, existing solar technologies come with a high cost of conversion, making solar energy deployment limited at present. The project vision is to deliver a robust and scalable technology to generate solar energy for widespread availability, at a cost that would be within reach of those who can't afford energy services today.

To make photovoltaic (PV) solar energy conversion commercially competitive with the depleting fossil fuels, radically different approaches for low cost, mass fabrication of PV modules and power distribution are required. Under this initiative, the goal is to develop novel materials and approaches to produce solar cells on a large scale at a much lower cost than the existing bulk semiconductor cells.

Canada-India Collaboration Project to Develop Affordable Solar Energy

Siva Sivoththaman and **Jatin Nathwani**, with external collaborators, are developing a proposal for a signature solar project to develop affordable solar energy. The collaborative project will deliver realistic solutions for a robust and scalable technology based on nano materials.

TRANSPORTATION AND STORAGE

Green Auto Power Train

Led by Professor **Xianguo Li**, mechanical and mechatronics engineering, the project involves researchers from the universities of Waterloo, McMaster, Toronto, and Windsor. Industrial sponsors include Ford, Chrysler, and Siemens. With a total budget of over $26M, one-third funding is from ORF-RE program.

PEM fuel cells for automotive applications

Professor **Li** is also working with leading automobile manufacturers, fuel cell developers and government researchers to develop the next generation PEM fuel cell technology as a viable solution for clean vehicles. The project has been awarded $1M by Auto21 and private partners including Ballard Power Systems.

Professor **Li** was awarded an NSERC Strategic Project Grant of $300K for the project "Water and thermal management in PEM fuel cells" co-sponsored by Chrysler. Professors Li and Pu Chen were also awarded an NSERC Strategic Project Grant Supplemental Competition for $200K. The project is titled "Liquid water removal through nano-creation of superhydrophobic surface properties in PEM fuel cells".

Building a greener automobile

There's more to a green car than what is under the hood. Cars are made mostly of non-renewable resources like metals and oil-based plastics. Professor **Leonardo Simon** in the chemical engineering department researches alternatives. For instance, the 100 kilograms of plastics in today's typical car or truck could be replaced with bioplastics or sustainable materials: plastics derived from renewable resources such as soybeans, canola or timber, or even waste like lignin or soy stems.

Exploring these alternatives is a new student team that Simon created: the Waterloo Team for Sustainable Automotive Material, known as the AutoBIOmobile. The students on the team will work together with the well-known UW Alternative Fuels Team to make UWAFT's "EcoCar" green to build as well as to run. The student team and the EcoCar are a real platform for trying out ideas – and more important, for demonstrating them. The goal is to get people thinking about what their cars are made of.

Materials and Capacities – New and Improved

Department of chemistry professor Linda Nazar's work on the Li-S battery has been under intense scrutiny for over two decades, as it offers the possibility of high gravimetric capacities and theoretical energy densities ranging up to a factor of 5 beyond conventional Li-ion systems. The feasibility to approach such capacities by creating highly ordered interwoven composites based on channel-structured mesoporous carbon was reported in ***Nature Materials*** (2009). In this cell, metallic lithium forms the negative electrode and sulfur forms the cathode. Intimate contact of the sulfur with the current collector – at the nano level – is critical for the reaction to proceed to completion. This was achieved by creating a nanoporous conductive carbon channel framework into which molten sulfur is imbibed via capillary forces. On cooling, the intimate contact "wires" up the sulfur fibres contained within, but allows ingress of electrolyte into the structure. The framework, further modified by hydrophilic polymers, constrains the intermediate reaction products so that full reduction to Li2S is facilitated. Capacities up to 8 times that of conventional lithium-ion intercalation materials are achieved. This work has received widespread attention. It was the subject of a CBC radio interview, the CBC news (May 18/09), and has been highlighted in scientific and technical publications including the MIT Technology Review; Energy Efficiency News (USA); Royal Society of Chemistry; EurekAlert! (AAAS); and the Swedish Technology News.

Prof. Nazar's group has also reported on a new 2-dimensional electrode material A2FePO4F (Nature. Matter, 2008) that may redefine the scope for new polyanion framework materials. The material has been patented by UW, and is the subject of an NSERC I2I award for further development of its commercial potential. The most important aspect is the ability to utilize a sodium iron phosphate directly as a cathode in a Li-ion cell. This offers significant advantages with respect to cost and lithium availability, and the possibility of developing viable Na-ion cells.

Bio-Logic Science Instrument:
MacPile II Galvanostatic/Potentiostatic Multichannel Analyzer

Education and Training

WISE Courses and Training Program

Sustainable Energy research at the University of Waterloo is already being carried out in several directions. Despite the importance and growing research activity and support in sustainable energy, there is a lack of structured inter-disciplinary academic programs.

Graduate Program Specialization in Sustainable Energy is a training program intended to address a WISE mandate for Education, Training, and Outreach. The courses available through the graduate program in sustainable energy attract students and strengthen the graduate studies at UW. See *Attachment A* for details of the elements of the training program.

New course: Earth 691/692

Professor **Maurice Dusseault** (Earth and Environmental Sciences) has developed a new offering based on expressions of interest from students. *Earth 691/692 Carbon Sequestration in Sedimentary Basins* is a reading course that will provide each participant with a series of basic background documents that will be treated as required readings and several assignments based on the required reading and on the material presented in a short series of lectures. Links for detailed information about this new course offering is available at the department web page: http://www.earth.uwaterloo.ca/graduate/courses/

New course: MSCI 760

Professor **Jatin Nathwani (**Management Sciences) is offering a course on *Energy Policies in the Context of Sustainable Development*. The goal of the reading course is to develop a comprehensive understanding of the drivers of energy policies and plans consistent with the long term desire for sustainable development. The course is offered at the Master's/PhD level.

Professors become students

When leaders at Mexico's premier technological university wanted to expand the school's entrepreneurship offerings, they looked north. In 2007/08, seven professors from the Monterrey Institute of Technology and Higher Education (ITSEM) put aside their teaching duties and became students again, enrolling in Waterloo's Master of Business, Entrepreneurship and Technology (MBET) program. CBET's director **Paul Doherty** is optimistic that the relationship between ITSEM and Waterloo can go further and plans to provide future courses in Mexico.

UW-linked solar house: a Student-led project

North House is an advanced solar-powered home being developed by Team North: http://www.wise.uwaterloo.ca/solar_marathon_jan24.html

Team North, which involves students and faculty at UW, Ryerson University and Simon Fraser University, along with industry partners, is one of only two Canadian entries selected to participate in the prestigious 2009 Solar Decathlon competition, sponsored by the U.S. Department of Energy and the National Renewable Energy Laboratory. Team North will develop North House — a marketable solar-powered home for people with active lifestyles. The team aims to combine green building, solar and interactive technologies in order to reduce energy demand, foster a conservation ethic and boost the quality of life for Canadians.

The decathlon will be held October 9-18 2009 in Washington, D.C., drawing 20 university teams with prototype solar homes from around the world. The teams will each build a full-scale house to compete in 10 categories measuring quality and performance.

OUTREACH

WISE SUPPORTS AND IS ACTIVE in a number of initiatives in the community to help enhance the understanding of energy sustainability issues.

WISE PUBLIC LECTURE SERIES

A lecture series has been established and is updated regularly on our website: http://www.wise.uwaterloo.ca/seminar.html

THIRD AGE LEARNING SERIES

Third Age Learning Kitchener-Waterloo is an independent organization that arranges lectures by university professors and community experts and offers “continuing education challenges for active, mature minds.” The lectures cover many areas of interest and help develop a sense of community gathering. Members are generally retirees interested in post-secondary learning experiences.

The recent lecture series with the theme “Sustainable Energy: What It Means for Planet Earth – and You” was offered in Fall 2008. Seven of the eight speakers taking part in this popular public outreach opportunity were WISE members.

October 14: Energy, Environment, Economy: Cross-currents

How do we provide reliable, accessible and affordable energy services that will endure and improve our lives? ***Dr. Jatin Nathwani****, Ontario Research Chair in Public Policy and Sustainable Energy Management; Executive Director, Waterloo Institute for Sustainable Energy; Professor, University of Waterloo*

October 21: The Hydrogen Economy: Alternative Fuel of the Future

How hydrogen and fuel cell technology will contribute to transportation energy and facilitate the integration of renewable power sources such as wind and solar. ***Dr. Mike Fowler****, Assistant Professor, Chemical Engineering, UW*

October 28: Electricity Conservation and Demand Management Strategies in Ontario: Powerful Choices that make Cents

Key programs to reduce electricity demand and load. ***Dr. Ian Rowlands****, Associate Professor, Environment & Resource Studies, and Associate Dean of Research, Faculty of Environment, UW*

November 4: Biological Solutions to the Energy Problem

How ***do*** microbial fuel cells create biogas and biofuels? ***Dr. Raymond Legge****, Professor, Chemical Engineering, UW*

November 11: Getting "Energy Smart" through Solar Electricity

How solar energy is fast becoming a reality to the community and industry. ***Dr. Siva Sivoththaman****, Professor, Electrical & Computer Engineering, and Director, Centre for Advanced Photovoltaic Devices & Systems, UW*

November 25: Feel the Breeze: Wind Energy takes Root in Canada

The history of wind energy, current issues and future prospects of this expanding renewable technology. ***Dr. David Johnson****, Associate Professor, Mechanical & Mechatronics Engineering, UW*

December 2: Carbon Capture and Storage: From the Boiler to the Fleet

How can Ontario reduce carbon dioxide emissions from its electric generating stations over the next20 years? ***Dr. Peter Douglas****, Professor, Chemical Engineering, and Associate Dean of Graduate Studies &International Agreements and of Computing, UW*

High interest was expressed, feedback was very positive and all of the lectures enjoyed full-capacity attendance. The brochure is available for viewing here: http://www.wise.uwaterloo.ca/new_2008.html.

Current activities of WISE members and articles of interest can be found at the WISE "What's New" WISE website: http://www.wise.uwaterloo.ca/new.html.

Sustainable Waterloo

Sustainable Waterloo guides corporations in Waterloo Region towards a more environmentally sustainable future by facilitating collaboration between industry, local government, academia, and non-governmental organizations. The goal is to ensure that Waterloo Region is more environmentally sustainable as a result of its efforts in environmental leadership. Jatin Nathwani is currently on the Advisory Board.

UW's Energy Days event explored a sustainable energy system for Ontario

The University of Waterloo's Energy Days event was held Oct. 23-25, 2007 to explore the challenges involved in building a sustainable energy system in Ontario.

The public event, sponsored by UW and coordinated by the faculty of environment and faculty of engineering, drew on the expertise of campus and guest researchers to offer a series of lectures, discussions and displays. A related event, the third annual green energy youth conference for middle- and high-school students, was also held on the UW campus on October 21. The event was organized by the faculty of engineering and the Association for Bright Children to teach students about the feasibility of self-sufficient or partially self-sufficient homes and buildings.

Organizations supported

Clean Energy Classrooms: A one-stop resource portal to training and education options in Canadian sustainable energy. Clean Energy Classrooms is also featured in the 2009 Canadian College Guide and Canadian University Guide. WISE, University of Waterloo can be accessed at: http://www.cleanenergyclassrooms.ca/schools-programs/detail/university-of-waterloo/

MEDIA RELATED

GROWING NATIONAL PUBLIC INTEREST in the pressing issues of sustainable energy is clear from the frequent requests for the expert opinion of the Executive Director from radio, television and national newspapers. Three major OP Ed publications were published in the Globe and Mail during 2008, one on the public controversy on the safety of the medical isotope reactor at Chalk River, one on the issue of independence of regulatory agencies and one on the subject of promoting sustainable mobility through convergence of the power and the transport sectors.

The following sampling includes newspaper articles with links to all of the publications at: www.wise.uwaterloo.ca/communications.html. A representative (but not exhaustive) sample of opinion pieces and other relevant newspaper articles can be found in Attachment B.

Loss of isotope supply will hurt in long run


thestar.com

Loss of isotope supply will hurt in long run

June 18, 2009

JATIN NATHWANI

The shutdown of the NRU reactor at Chalk River has again brought into sharp focus the critical need for a consistent supply of isotopes to our hospitals. The most compelling and difficult issue is the reliability and safe operation of a single aging reactor on which the well-being of so many depends, both in Canada and globally.

To outside observers, the realization of such extreme dependency on a single source is shocking.

The shutdown of the NRU reactor at Chalk River has again brought into sharp focus the critical need for a constant supply of isotopes to our hospitals. *By Jatin Nathwani. Published: June 18, 2009 in The Toronto Star.*

THE GLOBE AND MAIL

Report on Campus Innovation: ALTERNATIVE ENERGY


Report on Campus Innovation: ALTERNATIVE ENERGY

Waterloo scientists pursue the elusive dream: efficient solar power
Mission of new research centre: Make electricity generated by sunlight more affordable

October 28, 2008
Grant Buckler
Special to The Globe and Mail

Like a vision in the desert, economically feasible solar power has always seemed just out of reach. Given technological advances we should be able to harness the sun's huge energy output to replace increasingly scarce and polluting fossil fuels. But even with recent leaps in oil prices, solar can't compete in most of the world.

In Canada, electricity costs five to seven cents a kilowatt hour, says Siva Sivoththaman, a professor of electrical and computer engineering at Ontario's University of Waterloo. Electricity generated from solar panels costs three or four times as much.

Waterloo scientists pursue the elusive dream: efficient solar power. Mission of new research centre: Make electricity generated by sunlight more affordable. *Published: October 28, 2008 Siva Sivoththaman special to The Globe and Mail.*

Plug-in vehicles part of the solution

Re: Reality for plug-in cars could be a shock, Feb.10. *By Jatin Nathwani and Claudio Canizares. Published: February 17, 2009 in the Ottawa Citizen.*

Smart grid reduces carbon footprint and drives economic growth

The current global financial crisis provides an unintended but timely opportunity to change the lens through which we view Ontario and Canada's power sector. *By Jatin Nathwani. Published: February 6, 2009 in The Toronto Star.*

WISE ORGANIZATION

Executive Director

Jatin Nathwani, Ontario Research Chair in Public Policy for Sustainable Energy Management, accepted the position as the Executive Director. Iris Strickler, University of Waterloo staff member, was appointed as the Administrative Assistant. The position of Director is expected to be confirmed during 2009/2010. The primary role of the Executive Director is to develop the focus and programs for energy research at the University of Waterloo and to ensure WISE is recognized nationally and internationally. A key aspect is to assist, work with and provide leadership to faculty members across diverse disciplines, and to help shape proposal development and initiatives with industry and government agencies. Maintaining a strong external presence and bringing the expertise of university to business and industry is another aspect of the role.

Board of Management

The WISE Board of Management met twice in 2008/09 and comprises:

Researcher	*Position*
Jatin Nathwani	Professor, Management Sciences/ Civil & Environmental Engineering Ontario Research Chair in Public Policy for Sustainable Energy Management Executive Director, Waterloo Institute for Sustainable Energy
Claudio Canizares	Professor, Electrical & Computer Engineering Associate Director WISE
Ian Rowlands	Professor, Environment & Resource Studies Associate Dean, Research, Faculty of Environment Associate Director, WISE
David Johnson	Professor, Mechanical & Mechatronics Engineering Director, Wind Lab
David Fuller	Professor, Management Sciences
Linda Nazar	Professor, Chemistry
Mahesh Pandey	Professor, Civil & Environmental Engineering
Mike Fowler	Associate Professor, Chemical Engineering Director, Hydrogen Lab
Magdy Salama	Professor, Electrical & Computer Engineering University Research Chair
Peter Douglas	Professor, Chemical Engineering Associate Dean of Engineering (Computing) Associate Dean of Engineering (Graduate Studies)
Siva Sivoththaman	Professor, Electrical & Computer Engineering Director, Centre for Photovoltaic Devices and Systems (CAPDS)
Xianguo Li	Professor, Mechanical & Mechatronics Engineering

Prof. **Claudio Canizares** accepted the position of WISE Associate Director (Engineering) effective September 1, 2008.

Prof. **Ian Rowlands** accepted the position of WISE Associate Director (Environment) effective January 1, 2009.

COMMITTEES OF THE BOARD OF MANAGEMENT

Board Advisory Council

The Executive Director and Associate Directors intend to seek guidance and advice of senior executives in government and industry to help shape the future agenda and activities of WISE.

The Executive Director envisions the Board Advisory Council will include 7 – 10 executives and expects to establish this council during 2009/2010.

Board of Directors

Executive Director
Deans of Engineering, Environment and Science or their delegates

MEMBERSHIP

WISE membership has grown from 60 to over 70 researchers across three faculties. Four WISE meetings were held in 2008/09: October 1 and December 3, 2008 and January 27 and March 25 2009. A membership list is included in *Attachment C*.

FACILITIES

WISE has eight offices and includes a conference room for 8 – 10 available for all WISE members. In addition to administrative offices, additional offices are set up to accommodate students and visitors. The suite of offices is located in CPH 3611.



ACTIVITIES

A REPRESENTATIVE SAMPLE OF VISITORS from Industry and academia hosted by WISE members in 2008 and 2009 follows.

VISITORS FROM INDUSTRY AND ACADEMIA IN 2008 – 2009

Xianqi Li, Chinese Scholar – Stability analysis of power system with significant DG generation. Claudio Canizares supervisor

Hosein Haghighat, Postdoctoral Fellow – Reactive power markets. Claudio Canizares and Kankar Bhattacharya supervisors

Tarek El-Fouly, Postdoctoral Fellow - Conservation and Demand Side Management (CDM) and price forecasting. Claudio Canizares and Kankar Bhattacharya supervisors

Juan Miguel Gonzalez, Mexican PhD Scholar - FACTS matrix converter modeling, simulation, analysis and control. Claudio Canizares supervisor

Behnam Tamimi, Iranian Scholar, University of Tehran - OPF application in voltage stability and reactive power control. Claudio Canizares supervisor

Claudia Battistelli, Italian Scholar, University of Naples - Probabilistic OPFs and congestion studies. Claudio Canizares supervisor

José Rafael Avalos-Muñoz, Postdoctoral Fellow - Conservation and Demand Management (CDM). Claudio Canizares and Kankar Bhattacharya supervisors

Alfredo Vaccaro, Visiting Professor, University of Sannio, Benvenuto, Italy. Power systems' security using probabilistic analysis techniques. UW host: Claudio Canizares

Gustavo Araujo, Venezuelan Scholar (Universidad Nacional Experimental Politécnica Antonio José de Sucre, Barquisimeto, Venezuela) - On-line detection of voltage instabilities. Claudio Canizares supervisor

Geraldo Torres, Associate Professor on sabbatical leave from the Federal University of Pernambuco, Recife, Brazil. Research: Voltage stability constrained optimal power flows. UW host: Claudio Canizares

Kamahldin Haghbeen, Research Associate - Development of Novel Sol-gel Materials for Enzyme Immobilization. Ray Legge supervisor

Subhash Mojumdar, Research Associate - Development and Analysis of Protein-based Thin Films. Ray Legge co-supervisor

Professor Emeritus, Niels Lind, UW host: Jatin Nathwani

Supaporn Douglas of Patumporn Manpong and Photchanathip Imsanguan - Supercritical Fluid Extraction (Supervision in progress) UW Host: Peter Douglas

Bio-en power inc, Earl Brubacher, UW participants: Jatin Nathwani, Wayne Parker, Ray Legge

Investeco Capital, Michael Curry, UW participants: Jatin Nathwani, Paul Parker, Wayne Parker, Ray Legge

Ontario Power Authority, Peter Love, UW participants: Claudio Canizares, Siva Sivoththaman, Mike Fowler, Shesha Jayaram, Jatin Nathwani, Ian Rowlands, Paul Parker, Geoff Lewis.

Peter Love, Ontario Power Authority and Ian Rowlands, 2 October 2008

General Electric delegation, UW participants: David Johnson, Mehrda Kazerani, Xianguo Li, Pal Parker

Canada's Technology Triangle Inc., Catherine Gerhard, UW host: Ian Rowlands

Joe Barnes, Rice University, J. Sumner and C. Cole US Consulate General Toronto (hosts), UW host: Ian Rowlands

Burlington Hydro, Dan Guatto, UW participants: Claudio Canizares, Shesha Jayaram, Isaias Ramirez-Vazquez (PhD student), Mike Fowler, Kankar Bhattacharya, Mehrdad Kazerani, Ian Rowlands, Ross McKenzie (WatCAR)

*Delegation of Indian Journalists, Debbie Kemp, Department of Foreign Affairs and International Trade Canada (host), UW host: Claudio Canizares, Ian Rowlands. Tours hosted by Andrei Sazonov (G2N Lab), Siva Sivoththaman (Solar Lab), David Johnson (Wind Lab)**

*Delegation of diplomats from India: Mr. Deepak Gupta, Secretary, Ministry of New and Renewable Energy India, Mr. Debashish Majumdar, Chairman and Managing Director, Indian Renewable Energy Development Agency Limited, Dr. Bhargava, Senior Scientist, Ministry of New and Renewable Energy India, Mr. Pradeep Chaudhry, Vice Consul, Consulate general India, Toronto, UW host: Ian Rowlands, Meg Beckel, Arthur Carty**

Visit by scientists and Secretary, MNRE India, 15 April 2009 at Centre for Photovoltaic Devices and Systems Lab (CAPDS

** These visits are in response to ongoing discussions on international cooperation for solar energy projects. David Johnson visited India in December 2008 to reactivate interaction on clean energy technologies. Jatin Nathwani made follow-up visits in March 2009 to maintain momentum on discussions on behalf of UW.*

SEMINARS AND CONFERENCES HOSTED

In July 2008 WISE hosted a visit from S. Sreenivasa Murthy, an international collaborator from the Indian Institute of Technology. His seminar presentation was entitled "Future Energy Scenarios & R&D: India/Canada Collaboration Potential".

'Distributed Generation and the Future of Ontario's Electricity Grid' was held on October 26 and 27, 2008 at the Waterloo Inn. Ontario Energy Minister George Smitherman presented a keynote address on the challenges of incorporating new and developing generation systems into Ontario's electricity grid. The conference was hosted by Queen University's Institute for Energy and Environmental Policy, Council for Clean and Reliable Electricity and the University of Waterloo Institute for Sustainable Energy.

THE HONOURABLE GEORGE SMITHERMAN
Deputy Premier of Ontario and Minister of Energy and Infrastructure

Presentations were from an array of experts who discussed the future of the electricity grid as it adapts to smaller, more environmentally-sensitive generation systems. John Kim Bell was also a keynote speaker: http://www.queensu.ca/qieep/events/distributedGeneration.htm.

JOHN KIM BELL
President & CEO, Bell and Bernard Ltd.

John Kim Bell serves as an Intervenor on behalf of the Assembly of First Nations and the National Chief's Office in the Integrated Power System Plan (IPSP) review process that will lay out the plan for energy production in Ontario for the next 20 years.

WISE and INAE International Conference – October 2009

In collaboration with the Indian National Academy of Engineering, WISE will host an international conference on "Research Policy for Sustainable Energy" in October 2009, Delhi, India. An exhibition is also planned aimed at showcasing the systems, sub-systems, models and photographs relevant to the theme of the conference and is intended to provide an opportunity for business interaction with the audience from academia, R&D and industry.

External Service

Executive Director, J. Nathwani

- *Chair, Board of Directors, UNENE: University Network of Excellence in Nuclear Engineering*
- *Member, Council for Clean and Reliable Electricity: Encourages appropriate provincial action regarding generation, transmission and distribution of energy*
- *Member, Ontario Smart Grid Forum: Convened by Independent Electricity System Operator IESO*
- *Board Member, Ontario Centres of Excellence: Ontario Centres of Excellence Energy*
- *Member, Advisory Board, Sustainable Waterloo: Council for Clean and Reliable Electricity*
- *A senior contributor and co-author, the Ontario Integrated Power System Plan (IPSP) on the subject of Environment and Sustainability for the Ontario Power Authority (OPA). Prepared expert testimony and background for the Ontario Energy Board Hearings on the IPSP (throughout August 2008)*
- *As Member of the Ontario Smart Grid Forum, and the only university member invited to participate. Provided the key input into the role of innovation in modernizing the Ontario Grid of the future. This was a formal report submitted to IESO. The major report findings were immediately included in the legislation that is now the Ontario Green Energy Act. In addition, the Government has committed $50 million in the budget for implementation of smart grid initiatives.*
- *Representing UW for the signature solar project actively in process as part of the interaction on clean energy technologies as intended by the IIT Delhi/UW agreement.*

C. Canizares

- *The Powercar project is attracting interest from industry, such as Hydro One and other utilities.*

P. Douglas

- *Referee for the Polish-Norwegian Research Fund*
- *Conference Chair, CSChE Conference, Ottawa, Ontario; 2 sessions on Clean Coal and Carbon Capture, 10 hours 2008*
- *Conference Chair, GHGT-9, Washington DC, one session, 5 hours 2008*

R. Legge

- *MSc Committee Member, M. Arif, Dept. of Plant Agriculture, University of Guelph*
- *2008, Reviewer, USDA, Small Business Innovation Research Program*
- *Member, Board of Directors, Ontario BioCar Initiative*

J. Lynes

- *Invited guest to strategic planning session, Reduce the Juice Foundation, December 2008*

X. Li

- *Steering Committee member for the Canadian Hydrogen and PEM Collaborative Initiative*
- *Member of the Advisory Board Technical Sub-committee for NRC Institute for Fuel Cell Innovation*

L. NAZAR

- *Member, NSERC Discovery Grant Committee*
- *Member, NATO Science (Chemistry, Biology and Physics) Committee, Brussels, Belgium – met three times in 2008, approx. 40 proposals to review each time. Chair of the committee in 2009*
- *Advisor to the Energy Frontiers Research Centre application, University of California, Berkeley*
- *Member, Scientific Board for the International Lithium Battery Meeting, IMLB-2010, and conference co-organizer*
- *Expert Witness/Technical Expert on two USA lawsuits involving cathode materials in Lithium-Ion Batteries*
- *Editorial Board member, Chemistry of Materials; and Journal of Materials Chemistry*

AWARDS

THE FOLLOWING MEMBERS HAVE RECEIVED PRESTIGIOUS AWARDS AND HONOURS IN THE PAST YEAR:

Miguel Anjos

Humboldt Research Fellowship for Experienced Researchers, to support his work in the development of mathematical optimization models and algorithms for a class of problems in science and engineering known as the maximum-k-cut problems. The fellowship allows foreign researchers to carry out long-term projects with German colleagues.

C.P. Chou

Canada Research Chair - Tier 2, Novel Strategies for High-Level Recombinant Protein Production

Peter Douglas

2008 Faculty Advisor to **Colin Alie** who was selected as one of 50 researchers worldwide to represent Canada at the International Energy Agency's research program for young scientists that was held in Vancouver, Canada.

Ehab El-Sadaany

Canada Research Chair - Tier 2, Chair in Energy Systems

Ray Legge 2007 UW Faculty of Engineering Teaching Excellence Award Sandford Fleming Foundation Faculty of Engineering Teaching Excellence Award

Xianguo Li Awarded Fellow of the Engineering Institute of Canada in 2008

Jatin Nathwani 2007 Ontario Research Chair in Public Policy and Sustainable Energy Management

Linda Nazar Moore Distinguished Scholar, California Institute of Technology (to be taken up in the fall of 2009)

Electrochemical Society International Battery Division Award for 2009 (official presentation in Vienna fall 2009)

Flora Ng

University Research Chair

2008 Chemical Institute of Canada Catalysis Award

2008 Given the University of Waterloo's highest academic honour, University Professor

Mahesh Pandey NSERC Industrial Research Chair

Wayne Parker The First Director of the Centre for the Control of Emerging Contaminants based at Waterloo. The Ontario government provided $4.8 million toward the founding of the centre in 2008.

Ian Rowlands

2009 Distinguished Teaching Award, to recognize outstanding professors and instructors nominated by their students, colleagues and alumni

Garry Rempel NSERC Industrial Research Chair

Magdy Salama 2004 University Research Chair – UW recognizes exceptional achievement and pre-eminence in a particular field of knowledge with this designation.

Siva Sivoththaman ComDev Associate NSERC Industrial Research Chair (IRC).

Michael Worswick Canada Research Chair – Tier 1

National/International Collaboration Initiatives

The provincial and federal governments have confirmed a long-term view of the importance of energy to the economy and its overall environmental performance. Some active collaboration initiatives are as follows:

MOU – UW and Hydro One

A Memorandum of Understanding to advance effective collaboration and timely initiatives to foster a sustainable energy future for Ontario and to address the emergence of new and distributed sources of clean energy developments. UW in partnership with Hydro One will undertake specific research projects to address mutual interests in:

- Smart networks and emerging industry infrastructure
- Existing transmission and distribution systems
- Policies and planning

MOU – UW and University of Petroleum & Energy Studies (UPES)

A Memorandum of Understanding for Educational and Scientific Cooperation between University of Petroleum & Energy Studies, India (UPES) and the University of Waterloo to explore the potential for cooperation and active collaboration to foster exchanges in education, training and research. Both institutions will encourage institutional facilitated contact and cooperation between their faculty members, departments and research institutes under provisions of this Memorandum.

In March 2009, the Executive Director was invited to visit the UPES campuses in Dehradun and Delhi to meet with the Chancellor and Vice Chancellor.

The Executive Director met with Senior officials of UPES at the corporate offices and research facility in Delhi to explore common areas of research between WISE and UPES-CAER and to develop the Nuclear Technology Training Program.

MOU – UW and Process Research Ortech Inc. (PRO)

A memorandum of Understanding to work on joint projects associated with affordable solar energy between Process Research Ortech Inc. (PRO) and UW was signed by the Executive Director in January 2009.

Canada-India Scientific and Technological Cooperation

This partnership development proposal submitted in September 2008 was approved. A formal proposal has subsequently been submitted for an Indo-Canada event. A two-day Workshop is planned with the theme: 'Indo-Canada Workshop on Electricity Generation Using Renewable Energy'. The workshop will be hosted in India (Delhi or Bangalore) 12-13 October 2009 under the Partnership development activities of ISTP (Canada) and GITA (India). Partners in India will include Prof. S. Sreenivasa Murthy, CEA Chair, Department of Electrical Engineering, Indian Institute of Technology, New Delhi.

A Canada-India Collaboration Project

A proposal is in process for 'Mission to Develop Affordable Solar Energy' Canada and India. The research project is to be carried out as a partnership between academia, industry, and government sectors from Canada and India. University of Waterloo will take the scientific lead of the overall project and will work closely with the Canadian and Indian partners. The Waterloo team will comprise of professors **Jatin Nathwani** (Executive Director, WISE), **Siva Sivoththaman** (Director, CAPDS), and Arthur Carty (Executive Director, WIN), along with other researchers at the University of Toronto and the University of Western Ontario and Canadian industry partner, Process Research Ortech Inc.

PAPERS, PRESENTATIONS AND CONFERENCES ATTENDED

A REPRESENTATIVE SAMPLE of publications, presentations and important conference attendance by WISE members are available in *Attachment D*.

LIST OF ATTACHMENTS

WISE brochure – The Full Spectrum of Research
A Proposal for WISE Courses and Training Program
B Media Related
The Toronto Star, June 18, 2009
The Ottawa Citizen, February 17, 2009
The Toronto Star, February 6, 2009
The Globe and Mail, October 28, 2008
C List of Regular Members
D Papers, presentations, conferences attended

Contact Us

Waterloo Institute for Sustainable Energy (WISE)
University of Waterloo
CPH 3611
200 University Avenue West
Waterloo, ON Canada N2L 3G1
Phone: 519.888.4618
Fax: 519.888.4359
WWW.WISE.UWATERLOO.CA