



Clean Energy Research Centre's Fuel Cell Lab.

Moving Clean Energy Research Forward

UBC's Clean Energy Research Centre

Dr David P Wilkinson PEng

Many thought-leaders see energy as the single most important challenge facing humanity today. To quote Richard Smalley (1996 Nobel Prize in Chemistry): "Somehow we must find energy prosperity for the 21st century. We should assume that by the middle of the century we will need to at least double energy production from its current level, with most of it coming from some clean, sustainable, carbon dioxide free source. For worldwide peace and prosperity, it must be cheap."

Finding sustainable, clean energy solutions for the future will require a collaboration of thought-leaders who approach the challenge from various angles. A chemical engineer, a supply chain expert and an elected official will have broadly different perspectives on what is feasible and optimal, but all are required for successful solutions.

At the University of British Columbia, the Clean Energy Research Centre (CERC) brings together a number of experts dedicated to developing knowledge and solutions that help to reduce the environmental impact of energy consumption and improve energy sustainability. Chemical engineers join forces with mechanical, materials, electrical and computer engineers, sustainability leaders, economists and business professionals to develop solutions to one of the most critical challenges facing society today—clean energy.

UBC Clean Energy Research Centre (CERC)

CERC has existed in UBC's Faculty of Applied Science since 2000, but was officially opened in 2006 with the completion of a physical laboratory wing. Key areas of energy research at CERC include renewable

energy (hydro, wind, solar, geothermal, bioenergy), cleaner methods of utilizing non-renewable energy (oil and gas, gas hydrates and other unconventional gas resources), energy conversion (engines, fuel cells), energy storage (capacitors, batteries), energy materials, energy-related emissions (pollution control, CO₂ capture and removal), electrical transmission and control (power transmission, smart systems), energy efficiency and conservation (industrial, buildings/communities, transportation) and energy analysis (all aspects).

Clean energy, efficiency and conservation are essential components of the Province's new energy plan, *The BC Energy Plan: A Vision for Clean Energy Leadership*, to be energy self-sufficient by 2016 while taking responsibility for the natural environment and climate. This energy plan builds on the 2002 energy plan, *Energy for Our Future: A Plan for BC*, which lays out the provincial goal to be a net exporter of clean renewable energy and related technology, resulting in new job creation in areas such as research, development and production of innovative energy and conservation solutions. The BC energy plan has created up to 55 policy actions in the areas of energy conservation and efficiency, electricity, alternative energy, and oil and gas. Through the Clean Energy Research Centre and Sustainability Office, UBC is contributing to a number of these actions, particularly at the research and innovation stages.

Two recently signed collaborations are important to the support of the clean energy technology sector within British Columbia and Canada. The University of British Columbia (UBC), Powertech Labs (a clean energy subsidiary of BC Hydro) and the National Research Council Institute for Fuel Cell Innovation (NRC-IFCI) signed a letter of intent in November 2009, to work together in a new BC Clean Energy Technology Cooperative. This Cooperative will act as a unified critical mass of expertise and infrastructure for the clean energy sector, helping to advance clean energy commercialization. A new Memorandum of Understanding (MOU) is in place between NRC-IFCI and UBC, primarily involving Applied Science, the Clean Energy Research Centre (CERC) and the Centre for Interactive Research on Sustainability (CIRS). Collaboration arising from this MOU will mainly focus on fuel cell, hydrogen, and clean energy research and development, commercialization, and the training of highly qualified personnel in these areas.

From Research to Commercialization

On the alternative energy technology side a number of energy-related technologies have already been spun

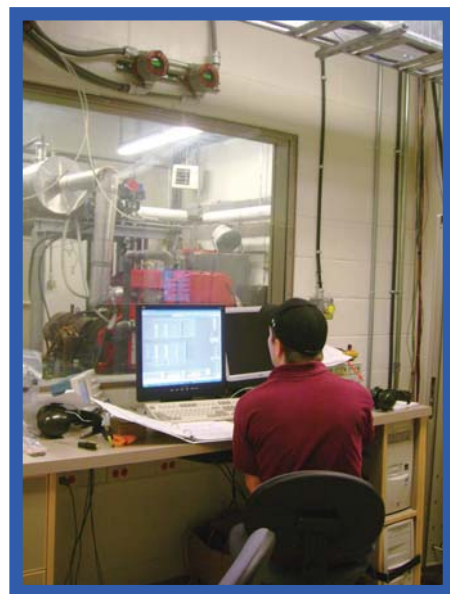
off, or are following a path from innovative university research to commercialization. Three examples follow.

Westport Innovations Inc, a UBC spinoff company, was formed in 1995 based on earlier research by Professor Philip Hill PEng and his graduate students in the Department of Mechanical Engineering. This technology focuses on high-pressure direct injection (HPDI) of natural gas to allow natural gas as a fuel in diesel engines. The result is to reduce emissions of nitrogen oxides (NO_x) and particulate matter that are harmful to the environment and human health, but at the same time preserve the performance advantages of the diesel engine. Engine research continues today at CERC in close collaboration with Westport. For example, glow plugs containing a ceramic heater within a silicon nitride body are being considered for hot surface ignition in natural gas direct injection engines. Another area of research looks at advanced fuel injector designs such as piezo actuator-based hydrogen injectors for hydrogen-based engine technology. Such research helps to maintain Westport Innovations as the leading Canadian developer of internal combustion engine technology based on clean-burning fuels such as natural gas, hydrogen and hydrogen-enriched compressed natural gas (HCNG).

The UBC spinoff company Membrane Reactor Technologies (MRT) has developed proprietary technology for hydrogen purification and recovery, and for generation of high purity hydrogen, with a number of advantages relative to steam-methane reforming of natural gas. The original validation of the fluidized bed membrane reactor concept for steam reforming was carried out in the Department of Chemical and Biological Engineering by Professors John Grace PEng and Jim Lim PEng and their graduate students. MRT works closely with CERC faculty researchers and NORAM Engineering to incorporate capture of carbon dioxide by chemical looping of calcium sorbents as an alternative or supplement to membrane hydrogen removal.

Another example of a CERC technology in transition is the development of direct methanol fuel cell (DMFC) technology for electronic and portable

Engine Test Cell Laboratory at the Clean Energy Research Centre.



devices. This technology is currently being considered as an alternative to incumbent battery technology in order to meet the consumer demand for higher performance with respect to runtime, recharge time and degradation. As part of a collaborative research initiative between the UBC CERC and the National Research Council – Institute for Fuel Cell Innovation, university researchers Professor David Wilkinson PEng, and Dr Alfred Lam,

have developed a patent-pending membraneless DMFC with novel operational methods that has shown scalability, fuel flexibility, higher efficiencies and operation at a single optimized condition. Under the Natural Sciences and Engineering Research Council of Canada Idea to Innovation (NSERC I2I) Program, the researchers are now building a prototype battery recharger based on the membraneless DMFC technology. This program allows

advancement of promising technologies to attract early stage investment and to build intellectual property.

Another important approach at CERC and UBC to help the energy sector advance commercialization is the UBC vision of the campus as “a living laboratory” of clean energy and sustainability innovation. This approach allows the accelerated development, demonstration and commercialization of clean energy technology for domestic use and global export. The UBC campus is a contained community, which allows better control and monitoring of installed clean energy technologies. This approach also provides faculty, staff and students with research and learning opportunities in the clean energy and sustainability sectors. UBC’s planned collaboration project with Vancouver-based, Nexterra Systems is a current example. The project will develop, plan and site, on the Point Grey campus, a new 2 MW combined heat and power (CHP) system, fuelled by biomass and housed in an advanced cross-laminate timber building. This innovative CHP solution will provide grid power and heat to the campus. It will reduce the campus’ natural gas consumption, lower net greenhouse gas emissions and will be used for research at the same time.

Educating Clean Energy Leaders

Equipping future leaders with the tools to make wise energy decisions is imperative. CERC has recently launched an innovative new Master’s degree program in Clean Energy Engineering—the first of its kind in Canada and one of only a handful worldwide.

The Masters of Engineering in Clean Energy Engineering is intended for those with an undergraduate degree in engineering (or related degree or experience) who are interested in advanced training related to environmentally advantageous energy efficient technologies—technologies that will help meet the global need for energy while reducing electricity consumption and greenhouse gases and other emissions. BC Hydro Power

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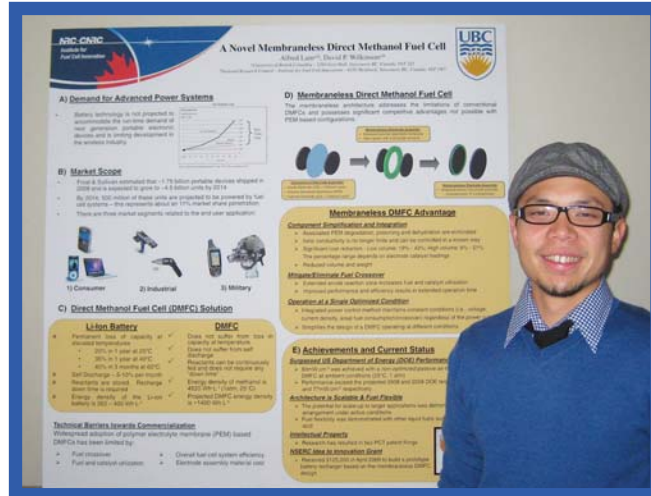
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Smart is an integral part of the new graduate program. It has provided funding to subsidize co-op work terms and an instructor, focused on energy conservation and efficiency.

With this special focus on energy conservation, social change concepts, efficient use of electricity and methods for comparing and evaluating alternative energy scenarios, students in the new program are investigating sustainable energy sources such as biomass, solar, wind and small-scale hydro. The program provides the unique opportunity for engineers to focus on areas such as management, business and leadership—areas where engineers can contribute to making a positive difference in our world. A required project course, allows the students to work on and gain experience with practical energy problems in the public and private sectors. Projects are expected to have practical utility for the host organizations.

Building on initial success, CERC and the University of British Columbia are on a path to be one of the world's leading academic research centres in clean energy solutions, for the benefit of both British Columbia and Canada. ☒

Dr David Wilkinson PEng is a professor and Canada Research Chair in the Department of Chemical and Biological Engineering at the University of British Columbia. He was recently appointed Director of the UBC Clean Energy Research Centre. To learn more about CERC and discover opportunities to connect, visit www.cerc.ubc.ca.



Top: Dr Alfred Lam with CERC display poster at BC Innovation Council's Connect '09 event.

Planned 2 MW biomass fuelled combined heat and power system on UBC campus.

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