Commercializing clean energy technologies

The need for clean sources of energy to meet government targets for reducing greenhouse gas emissions has led researchers to investigate hydrogen fuel cells as an alternative, green energy source. Fuel cell research findings are used by researchers working closely with industry to develop practical applications for the technology.

The researcher

Simon Fraser University (SFU) researcher **Erik Kjeang** is an expert with over 20 years of experience in the field of fuel cell research and its application. He is a professor at the School of Mechatronic Systems Engineering and is also a Canada Research Chair in Fuel Cell Science and Technology Development. He is the Principal Investigator for the SFU Fuel Cell Research Laboratory (FCReL) and is an expert in electrochemical, hydrogen and sustainable energy systems.

Fuel cells use the **chemical energy of hydrogen to cleanly and efficiently produce electricity**, providing power for a wide range of applications, including transportation. This green technology creates water as its only byproduct, with no harmful emissions. Kjeang has worked on projects involving the design, fabrication and evaluation of new fuel cell technologies using cutting-edge research in materials design and electrochemistry. Before joining SFU, Kjeang worked as a research engineer for Ballard Power Systems, an industry leader in fuel cell development and manufacturing. This experience has helped build the SFU fuel cell research program and fostered a strategic research partnership with Ballard. Much of Kjeang's work focuses on the technology being developed for fuel cell electric vehicles, which are powered by hydrogen.

About the Canada Foundation for Innovation

Since its creation in 1997, the CFI has committed more than $10.5 billion in support of more than 13,000 research infrastructure projects in all disciplines at 174 institutions in 81 municipalities across Canada.

The research

Developing, testing and commercializing reliable and sustainable clean energy options is the mission of FCReL. More specifically, Kjeang and his team are working on reducing the cost and increasing the durability of fuel cells, electrolyzers (which use electricity to split water into hydrogen and oxygen) and energy storage solutions in collaboration with key industry partners such as Ballard Power Systems, Greenlight Innovation and Ionomr Innovations.

The research has developed new technologies including:

- A new method to improve electrochemical energy conversion and efficiency within batteries, fuel cells and electrolyzers
- A portable, disposable and easily mass-produced power source, using inexpensive, biodegradable materials
- A new imaging technique to visualize material degradation in fuel cells.

Kjeang's research projects supported by the Canada Foundation for Innovation (CFI) have resulted in four patent applications, extensive knowledge and technology transfer to industry and more than 100 peer-reviewed journal articles. The knowledge gained from these activities has been presented at more than 45 conferences, symposiums and workshops.

The research infrastructure

Between 2013 and 2019, the CFI awarded a total of $520,000 to two projects led by Kjeang, in addition to a $1.8 million project funded via the Automotive Partnership Canada Fund. Kjeang and his team noted that CFI funding has been a critical part of the lab success. The research infrastructure included, among several elements, a lab-scale process for manufacturing membrane electrode assembly devices used for fabrication and characterization of fuel cell components, and a facility for the electrochemical testing of fuel cells and batteries, and X-ray visualization of material degradation.

The impacts

CFI funding for the SFU fuel cell research projects has supported the development of innovative technologies. These technologies are being used by industry in their **manufacturing processes to improve products' durability, reliability and cost-effectiveness** to increase uptake within the heavy-duty transportation sector.

Helping industry be more competitive

Owing to the research team's expertise in fuel cell technology, they have been approached by industry to collaborate on developing applications for new commercial products. For example, the SFU research team has delivered technology to Ballard Power Systems to enhance the longevity of its heavy-duty fuel cell module in transit buses. The commercialization of this technology helps develop cost-competitive, zero-emission fuel cell vehicles for the automotive sector.

In conjunction with researchers at the FCReL, Ballard has helped develop a fuel cell research ecosystem. Along with developing talent and expertise in this field, Ballard also brought companies such as Daimler, Volvo and Mercedes-Benz to Canada to invest in fuel cell technology research. As an example, the international hydrogen fuel cell company Cellcentric, a joint venture between Daimler Truck AG and Volvo Group, opened a state-of-the-art facility in Burnaby, B.C., in 2022. This facility is key to these two automotive companies' global research and development, manufacturing and commercialization activities for fuel-cell systems within the heavy-duty trucking sector. The Cellcentric facility's location was chosen for its close proximity to the fuel cell technology and expertise that exists within institutions such as SFU and companies like Ballard.

Developing sought-after skills

SFU researchers gain valuable technical expertise by working alongside other highly skilled professionals and by training on highly specialized state-of-the-art equipment. The research team's engagement with industry partners has also helped to build professional networks and employment opportunities, as well as to develop relevant skills for employment in the private, non-profit and academic research sectors.

Current and previous students working under Kjeang highlighted the privilege of working in state-of-the-art research and analytical facilities. In so doing, they can leverage this infrastructure and these resources along with their technical expertise to work with industry partners in relevant research. This has enabled them to advance their careers in the clean energy sector. Kjeang's partnership with Ballard Power Systems has provided first-hand experiences for more than 50 students over the last 10 years. Many are now employed by Ballard or other clean-technology industries.

Forming partnerships

The research team has partnered with leaders in the field, such as Ballard Power Systems, Greenlight Innovation, Mercedes-Benz and Indian Oil Corporation. This provides the research team with business perspectives and feedback to ensure that their research is relevant, readily transferable and adoptable by industry. In turn, **industry gains access to research that allows it to tap into the huge potential of fuel cells as a clean energy supply.**

Another firm that the research team collaborates with is Hydrogen In Motion, a local manufacturer of hydrogen storage solutions. The SFU fuel cell research team partnered with this firm to undertake foundational scientific research, and in so doing has helped this company develop key intellectual property for the technology used in its hydrogen storage solutions.

Collaborating across disciplines to create a successful spinoff

In addition to key industry partnerships, complementary and multidisciplinary expertise in fuel cell research and technology is essential for maximum impact. For example, Kjeang collaborates with fellow SFU and CFI-funded researcher Steven Holdcroft, Professor of Chemistry and Canada Research Chair (Tier 1) in Electrochemical Materials, on research on fuel-cell membranes degradation and durability. Through research such as this, a successful spinoff company, Ionomr Innovations, was founded by Holdcroft and his former PhD student Ben Britton. Ionomr develops and markets advanced materials for clean technology solutions including fuel cells, hydrogen production and a range of energy storage applications. Ionomr generates revenue by selling its membrane film to original equipment manufacturers. Currently the firm has over 50 employees and has raised approximately $50 million in equity. It has three offices, including a 925-square-metre facility in Vancouver, along with a 925-square-metre hydrogen test lab and a 375-square-metre wet lab. Ionomr continues working with Kjeang's team to improve its membrane durability.