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Advancing the Performance and Stability of Hydrogen Fuel Cell-Based Combined Heat and Power Units: Paving the Way for Commercialization in Canada

Led by the University of Alberta, this project aims to develop a 0.5 kW hydrogen-fueled solid oxide fuel cell (SOFC) for use as combined heat and power (CHP) units in residential and commercial buildings in Canada. The objective of the project is to improve long term durability and minimize the power degradation. This technology can lower carbon emissions associated with buildings especially in Alberta's energy-intensive heating and power sectors. It also promises economic benefits, creating jobs and a growing market. The project supports Alberta's transition to green energy, helping build hydrogen communities, reducing power grid stress, and achieving a sustainable, low-carbon future.

UNIVERSITY OF ALBERTA

FUNDING DETAILS

RECIPIENT:
UofA – Mahdi Shahbakhti

PARTNERS:
NSERC
ATCO Gas

TOTAL BUDGET:
$2,184,687

AI FUNDING:
$950,000

PROJECT DATES:
JUL 2024 – MAR 2027

PROJECT TRL:
Start: 4
End: 6

APPLICATION

The SOFC technology developed in this project enables high-efficiency, low-emission combined heat and power (CHP) generation for residential, industrial, and commercial buildings. It is also applicable in stationary power systems, portable generators, as well as auxiliary power units for vehicles. SOFCs can operate on various fuels, including both hydrogen and methane and their blends. They can be especially valuable in hydrogen hubs like Edmonton, where hydrogen and natural gas infrastructure and expertise are already in place.

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PROJECT GOALS

- Develop a stable SOFC-based CHP prototype.
- Increase SOFC electrical efficiency to higher than 60%.
- Reduce SOFC operational temperature to 650 °C while maintaining high performance.
- Extend SOFC lifespan to over 10 years with less than 0.2% degradation per 1,000 hours.
- Optimize stack configuration using advanced multi-physics modeling.
- Apply artificial intelligence and machine learning for early degradation detection and real-time control.
- Techno-economic assessment of hydrogen fueled SOFCs for space heating in Alberta and Canada.

BENEFITS TO ALBERTA

- Advances Alberta's progress toward 2050 net-zero climate action goals.
- Enables transition from natural gas to 100% clean hydrogen.
- Supports development of Alberta's first demonstration-scale hydrogen SOFC technology.
- Reduces grid stress during Alberta's winter peak electricity demand periods.
- Improves reliability of Alberta's power supply in remote communities.
- Aligns with Alberta's economic diversification and sustainability development goals.
- Enables real-time SOFC monitoring through AI and smart electronics integration.

10 Publications

5 Students Trained

1 Patent

15 Project Jobs

40-50 Future Jobs

5 New Products/Services

1 Spin-off Company

2 Mt/yr 2035-2050 GHGs Reduced

CURRENT STATUS

MAY 2025

Key components, such as planar solid oxide fuel cells, have been fabricated, and advanced AI/ML models for fault diagnostics and stack control have been developed. Stack assembly, power electronics integration, and techno-economic assessments are under progress.