ALBERTA INNOVATES

CLIMATE CHANGE INNOVATION AND TECHNOLOGY FRAMEWORK

Awardee Summary

CCITF PROGRAM	Clean Technology Development
PROJECT TITLE	Next-Gen Modular Green Building Energy Systems With Optional Energy Storage
SECTOR	Low Carbon Electricity Green Buildings
ORGANIZATION	University of Alberta, Electrical and Computer Engineering Department
PROJECT LEAD	Ali Khajehoddin
AI PROJECT ADVISOR	Mehr Nikoo
GRANT AMOUNT	$600,000
START DATE	1/1/2019
END DATE	12/27/2021

PROJECT OBJECTIVE: To develop an intelligent green building energy system based on renewable resources and energy storage integration.

PROJECT PROFILE: The main objective of this project is to develop an intelligent green building energy system based on renewable resources and energy storage integration. The proposed technology has the following unique features: 1) The energy system performs as an improved and enhanced Virtual Synchronous Machine (eVSM) emulating existing grid generators. This way the converter does not introduce unfamiliar dynamics to the grid and existing knowledge of power system control and stability issues will apply. The proposed system facilitates parallel operations of distributed generators (DG) and will significantly reduce utility concerns regarding high penetration of renewables in the power grid. 2) The product will be scalable and modular, which enables subsequent expansion of the system in a plug and play fashion proportional to customer needs and affordability. This feature reduces maintenance and future expansion expense and will provide an opportunity for every user to start with a smaller renewable investment, which is specifically beneficial to people with limited budgets or for remote communities and first nations. 3) Without interruptions, the product can switch between three modes of operation; grid-connected, stand- alone, and grid-forming, that is, operation in parallel with other distributed energy systems while being isolated from the main grid. 4) The design is extremely durable as it uses optimum energy storage capacity with no other life limiting components such as electrolytic capacitors. 5) The energy storage is optional in all modes of operations. 6) The converters will use new wide band gap switches and advanced magnetic design to achieve the highest power density and efficiency possible. 7) Machine learning and artificial intelligent systems are employed to achieve optimum and adaptive energy management system with fault and health monitoring features.

Generally, the above features are missing in existing products in the market, and no product has all of the features described here. More specifically, there is no commercialized product that has the eVSM feature and in the most advanced distributed products only two of the operation modes are provided, not all three modes and when three modes are claimed, the converter system is centralized and lacks the second feature such that they are no longer modular and scalable.

Dr. Khajehoddin's research group has proposed novel methods to implement these features in a proof of concept and in this project all of them will be integrated and optimized in one product. We plan to achieve all these objectives through four main steps. First the novel eVSM controller is fine tuned for residential and commercial applications. The inverter hardware will also be updated according to targeted power density, physical size and specifications. Then all aforementioned features and performance characteristics will be integrated into the hardware product. In the end, comprehensive field testing will be conducted on the resulting alpha prototype to ready it for commercialization.

GHG EMISSION REDUCTION SUMMARY: