AWARD

Smart Energy Innovation | Panasonic Eco Solutions Canada Inc.

NOMINEE

Panasonic Eco Solutions Canada Inc.

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NOMINATED BY:

Self-Nominated

Summary:
Set out a brief synopsis of the initiative (i.e. project, technology, service). This summary may be used during the event promotion.

University of Ontario Institute of Technology (UOIT) Micro-grid Research and Innovation Park is a fully integrated micro-grid project completed by Panasonic. The micro-grid encompasses an Energy Storage system and Solar PV generation system that are integrated to a natural gas Combined Heat and Power (CHP) generator. The micro-grid is configured as grid-forming, grid-tied and can will island during grid outages. The micro-grid utilizes a Lithium-ion battery configured in a unique electromechanical thermal management system, a Battery Management System (BMS) and an Energy Management System (EMS) that controls generation of a Solar PV system and an existing natural gas CHP system. This autonomous micro-grid will provide seamless backup power to a critical load during grid power faults or interruptions and intelligently manage Solar PV and CHP generations to charge batteries, provide peak-shaving arbitrage, black-start the CHP, has forecasting capabilities and will manage loads through a state of the art solid state switch and micro-grid controller and forecasting engine.

The UOIT campus is a designated emergency shelter and Panasonic's micro-grid now supports the campus to provide greater resiliency. The micro-grid also serves as a living laboratory for the university's electrical engineering faculty and students to conduct research on innovative techniques for developing new micro-grid standards.

Description:

Please provide as much detail as you can to describe the initiative. Simply provide a description of the project, technology, service, etc. being considered. Do not address here how it was done or what it achieved.

The key initiative and goal of this innovative project was to design and build an integrated system that would combine a 500kW/kWh Lithium-ion battery system and a 50kW Solar PV system that was to be integrated and seamlessly operate with an existing 2.4MW natural gas CHP generator to form a micro-grid. Panasonic, together with its partners, developed the integration parameters and use case scenarios to design and test the system.

Furthermore, another key objective of this project was to provide seamless power, measured in fifty milliseconds or less, to a critical load during grid faults or power interruptions, provide peak-shave arbitrage benefits to UOIT with an intelligent forecasting engine that takes historical weather and price data, gathers real-time weather, generation/storage data, Hourly Ontario Energy Price (HOEP) energy pricing to predict most economical battery charging/discharge times. This capability for a micro-grid did not previously exist and was developed as part of Panasonic's comprehensive micro-grid initiative at UOIT.

The micro-grid will provide emergency power to a critical load and also manage power to critical emergency lighting to designated emergency shelters.

1. **Innovative Approach: 25/100 points**
   Please describe which kind of innovation and creative approach that was used to achieve outstanding results. In what way has the initiative pushed the envelope of current norms, traditional results and standard approaches?

Innovative aspects of the project and how several challenges were overcome:

In the absence of global micro-grid standards, the UOIT micro-grid was designed and implemented using International Electrical Engineering Standard IEEE1547 on distributed generation. As battery storage systems work as a load during charging phase and become a generator when discharging, regulated power utility companies are apprehensive about implementing such energy storage systems with grid-tied connections.

In order for this initiative to achieve its aggressive performance goals, namely the seamless power transition, the UOIT micro-grid was designed with an innovative solid state fast switch to isolate the grid before islanding into micro-grid mode to support local critical load. It was also important to ensure that current backflow into the grid during the transition time was extremely low. This fast switch has enabled the micro-grid to transition energy storage power to critical load within 50 milliseconds from detecting grid faults (3 cycles). This achievement will be significant by way of establishing a key metric that can be referenced in defining "seamless" power transition for micro-grids. In ideal situations, the critical load, namely the Clean Energy Research Lab (CERL) at UOIT premises would only notice a slight flicker during power transition and not lose any of its important infrastructure during grid outages.

At the onset of the project, the system specifications were undefined as they were being studied prior to any engineering design. It was expected that several issues and challenges would need to be overcome to successfully complete the scope of the project, given that new power technologies that would be introduced with the design of the micro-grid, were to be developed and integrated to aging infrastructure on campus.

Another goad of the micro-grid was to provide maximum automation to facilitate autonomous operation and to accomplish this objective, select manual switchgear within UOIT's campus were replaced with motorized versions and integrated to the micro-grid controller.

During a grid outage, the CHP was expected to be started using the Battery Energy Storage System (BESS) to support critical loads on prolonged basis. This feature is defined as black-starting. The CHP plant was found to have no black-start capability, despite assurance by its owners, Oshawa Power Utilities Corporation that black-start function of the CHP existed and only needed to be tested through BESS. To overcome this significant hurdle, the CHP's schematics and protection schemes were extensively studied and modified by project engineers just too successfully implement black-start capability, which was not part of the projects initial scope but need to be implemented for the integrated micro-grid to operate as envisioned.

UOIT also has a General Motors Center for Automotive Excellence that has a significant electric wind-tunnel vehicle testing facility. This facility draws a 2.5MW of power, causing 90% power factor as a reactive load on the grid. As this load would surpass the total micro-grid's generation capacity, it was completely isolated during the micro-grid's islanding process using load breakers and an automatic transfer switch network. This was another key milestone for this initiative.

The local utility company Oshawa Power, originally required two transfer trips (one TT for each of the 2 feeders), which would have caused a significant budget overrun, thereby introducing a significant impediment to bringing the project to successful completion. Engineers were able to demonstrate to Oshawa Power that both feeders had single common coupling further upstream on the grid originating from the transformer substation site and that the tie-breaker modification will ensure the feeder connected to the micro-grid loop only required a single TT. This innovative approach saved the project more than a half-million dollars that a second transfer trip would have otherwise required.

Regarding fault-current sensing, only a single pole-mounted power transformer was implemented on a single phase, using a modeling built-into protection and control system that are tied into transfer trip tele-protection.

The state of the art, highly flexible micro-grid controller communicates with Battery Management System (BMS), Solar PV Generation, provides control hierarchy for autonomous operation and balances generation/storage and loads, allows black-starting CHP using the BESS while implementing a multi-layer complex protection and control system, while providing SCADA access reporting to utility.

Generation and storage sources are grid-tied and configured for grid-forming with a reliable inverter system with sufficient customized ride-through capability for islanded seamless power transition from the Battery Energy Storage System (BESS) to a critical load (120kW) and provide backup power for over 2.5 hours during grid power interruptions or power quality issues.

Almost 75% into the project timeline, it was discovered that the UOIT's science building with significant load was connected to the feeder that included the micro-grid, despite UOIT's electrical diagrams indicating that the science building was connected to the other feeder. Building automation settings were changed and extensive tests were carried out to ensure that CHP generator or BESS would not trip when science building loads were connected. Innovative engineering design changes were implemented including changes to unsupported load-shedding aspects of the system to be schemed through a second-phase islanding to the CHP plant.

Successful reconnection to the grid when power was restored was also imperative. The non-linear behavior of the BESS and its inverter, solar PV system and its inverters, solid state fast switch, coupled with a complex protection and control system will collectively synchronize phases extremely accurately with the grid sine wave thereby assuring a successful reconnection to the grid.

A state-of-the-art forecasting engine will read historical weather data, acquire real time weather data through micro-grid sensors, battery data, HOEP time-of-use pricing and determine the times to discharge the battery energy storage to enable peak shaving, optimize charging times, maintain power reserve in the batteries for emergency backup and black starting the CHP. This function is all orchestrated in an automated, autonomous sequence of operation.

2. **Economic Benefit: 25/100 points**
   Highlight the benefits, with a sense of financial benefit, cost savings, emission reductions or other directly attributable benefits of the initiative. Did this initiative deliver or exceed anticipated value, results and returns? If you include confidential and commercially sensitive information, it will be treated as such. Please ensure you note the following - do not publicize.

The UOIT micro-grid is a multi-fuel sourced micro-grid powered from solar PV, the grid and the CHP system. As such, there can be several economic benefits stemming from this multi-fuel sourced micro-grid:

1. Significant energy costs reduction for UOIT/CERL building during peak-shaving/arbitrage operation utilizing solar PV generation and low-peak time charging of the batteries.

2. Cost savings implemented during the project's design, engineering and construction process has enabled the project to be completed under-budget. Frugal procurement practices, quality equipment selection and innovative engineering design have helped the project avoid costly, unnecessary complexities and equipment. These lessons learned can be implemented when designing new micro-grids in order to help improve their economic feasibility and gain wider adoption of this technology.
3. Usage of the BESS during grid power quality variations or interruptions to provide back-up power to UOIT's CERL building will help reduce diesel generator usage for 2.5 hours for each occurrence. This reduced use of diesel generators will attribute a small but important reduction of GHG emission at UOIT.
4. The UOIT micro-grid, with its forecasting engine is equipped with intelligent algorithms to optimize Solar PV generation, manage battery storage operations and provide optimum economic benefit of lowered energy costs to UOIT.
5. A major economic benefit is the learning capability that the faculty and students will derive from the use case scenarios that they will be able to experiment utilizing the micro-grid as a "living lab". This will help develop the UOIT as a centre of excellence in Canada for this type of innovative technology, thereby attracting further resources to the university. This learning capability would not have been possible had the micro-grid project not been successfully implemented at UOIT.

3. Engagement: 25/100 points
In what way(s) did the nominee undergo meaningful stakeholder/customer engagement and how has it been incorporated into the design and execution of the initiative? Highlight the manner in which the initiative was communicated to promote the importance and benefits of solar energy while achieving business and stakeholder/client objectives. Demonstrate how the proponent listened to its audience and acted on the advice.

Engagement with Stakeholders and Collaborators
1. The clear expectations of the Ministry of Energy (MoE) in terms of setting goals for this project as well as learning the capability of other collaborators on the project contributed to clearly defining and refining the project's expectations, both technological and budgetary, as well as delivery of performance metrics from concept to implementation to final testing.
2. Benefits of solar PV + BESS storage in a micro-grid environment were understood by all collaborators and the MoE. Continued discussions and close collaboration were quintessential to merge design objectives into an agreed single system design to build the project. From component level to equipment level, multiple layers of engineering and logistical details were discussed and agreed upon to ensure project objectives were successfully met.
3. Regular weekly meetings and discussions were conducted during design phase to ensure every possible issue, problem, regulatory issue, permit delays, etc. were captured, actioned and resolved on a timely basis.
4. When faced with technical or regulatory challenges, meetings with the MoE together with other collaborators were conducted to resolve differing viewpoints on regulatory issues, delays in getting power outages scheduled from UOIT for micro-grid testing, design/scope variations to resolve challenges and equipment calibration.

5. Weekly meetings were mandatory in-person discussions and urgent conference calls were conducted to communicate and resolve any equipment issues with overseas suppliers.
6. All contractors were required to submit bi-weekly progress reports to monitor works in progress and synchronize with project timeline.

4. Corporate and Sustainable Responsibility: 25/100 points

Describe the environmentally conscientious approach during the design and execution of the initiative. Give concrete examples of how your initiative has benefited the environment (ex: saved X amount of CO2 emissions, reduced X amount of GHG, etc.) Explain the ways and manners by which this initiative was undertaken with the intent of demonstrating true corporate responsibility.

Environmental responsibility:

1. To minimize the environmental impact during construction phase, helical screw piles were drilled into the ground to anchor the integrated BESS container to the ground, instead of removing earth and trenching to pour large concrete. This approach would also help facilitate site restoration in the future with minimal disruption to the environment.
2. To minimize environmental noise, particularly since this was a university setting, BESS design was incorporated with a quiet HVAC system and liquid cooled inverter integrated inside the battery container, thereby minimizing the system's environmental noise footprint.
3. No plants or trees were removed during the entire project. Utilized an available empty, gravel yard belonging to UOIT that was close to the critical load supported by the system.
4. No real time data is available for GHG reduction at this time but will be available in the future as further data is captured and analyzed.

Corporate responsibility:

1. The micro-grid will contribute and compliment UOIT being designated as an emergency shelter, with its reliable, multi-fuel sources that will provide uninterrupted power for several days. This is an important contribution and benefit to the university and local community.
2. The BESS provides clean, renewable energy stored from solar PV generation to the CERL building, which will help reduce Green House Gas (GHG) emissions from the natural-gas powered CHP during islanded peak-shaving mode of the micro-grid's operation.
3. The system enables a "living laboratory" for UOIT's electrical engineering students and professors to help develop local talent in Ontario/Canada and establish a centre of excellence for this new and innovative technology.
4. Panasonic will initially own the project but will donate it to UOIT after 5 years for their own further development of engineering innovation in renewable energy generation, energy storage and micro-grid environments.

PHOTOS

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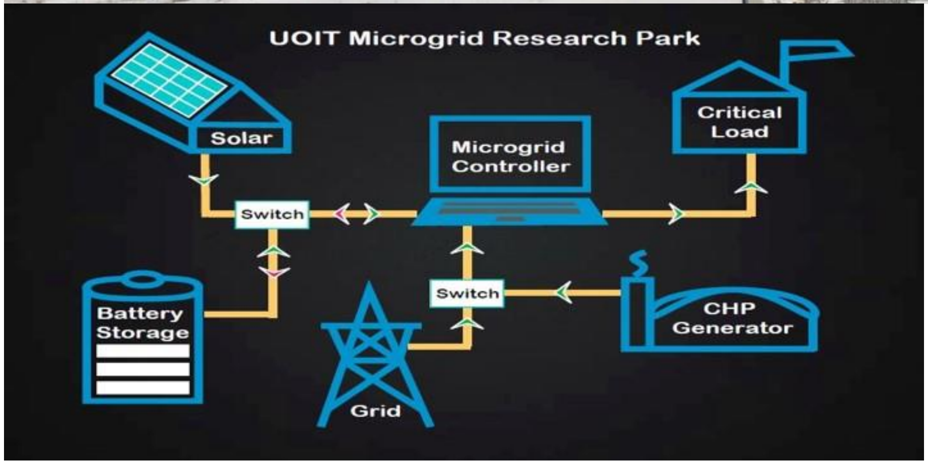
UOIT Microgrid Research Park
Solar
Microgrid Controller
Critical Load
Switch
Switch
Battery Storage
CHP Generator
Grid