FUTURE OF MICROGRIDS

INSTITUTIONAL

ADVANCED ENERGY CENTRE
MaRS Cleantech | Ontario, Canada

FUTURE OF MICROGRIDS SERIES OVERVIEW

Electricity distribution networks globally are undergoing a transformation, driven by the emergence of new distributed energy resources, including microgrids. However, with the majority of microgrids at the pilot and demonstration phase, this series will examine and forecast the commercial viability of microgrids right here in Ontario, and indicate factors that could result in deployment of these systems on fully commercial terms. The analysis, prepared with Navigant Consulting, also takes into account the non-financial factors affecting the overall business case for each microgrid use case, examined within the residential, institutional, utility, and commercial & industrial customer segments.

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OVERVIEW

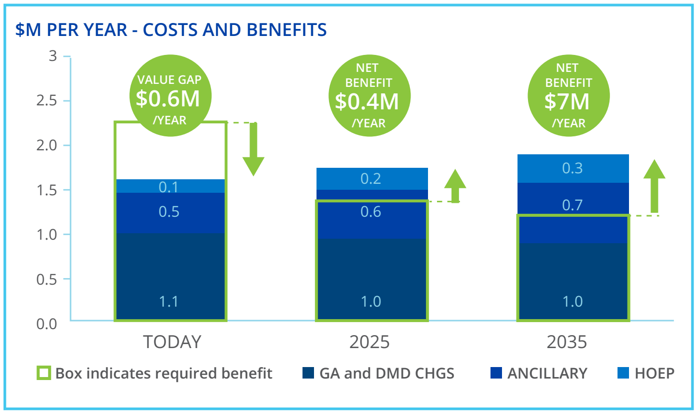
Institutional customers such as universities, colleges, and hospitals are uniquely positioned to pursue microgrids. These customers aggregate multiple buildings and on-site generation resources such as combined heat and power (CHP) and back-up generation systems. A microgrid enables them to take the next step and incorporate an advanced control system (or "controller") to become a dynamic and fast-acting network resource capable of responding to electricity price signals and providing services to the electricity distribution and transmission network operators. A microgrid also enables institutional customers to provide emergency power to critical circuits during power outages, and reduces a customer's dependence on centralized electricity supply.

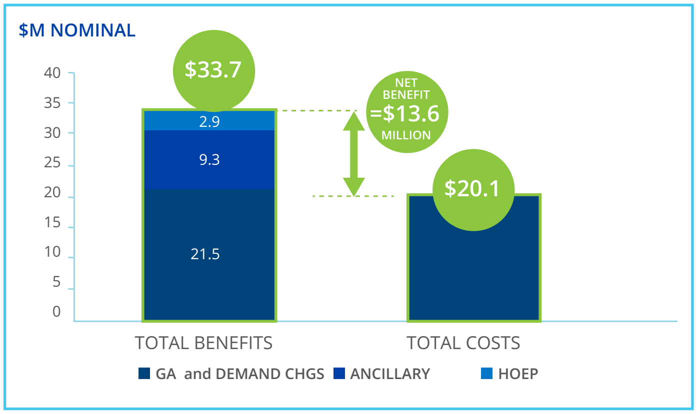
ASSUMPTIONS

This analysis is based on a Class A, medium-size university campus, composed of lecture halls, research and administrative buildings, and student residences. This university campus has an average load of 8 MW, and a 13 MW peak hourly demand. The microgrid consists of a microgrid controller, a 5MW (10MWh) Li-ion battery, and a 1.5 MW solar array. The microgrid controller, the battery, and the microgrid's switchgear enable the campus to sustain power for critical systems during network outages. This analysis assumes an existing CHP facility, allowing the microgrid to optimize its operation and ride-through long power outages. The battery is also used to reduce Global Adjustment (GA) charges, to participate in the operating reserve (OR) market, and to provide demand response (DR) capacity.

RESULTS

The relatively high costs of solar and storage technologies make the deployment of institutional microgrids at scale more difficult today. However, rapid declines in the cost of solar PV and Li-ion battery storage are expected to result in a strong and positive business case for institutional microgrids in the near and long term. The value gap (the difference between the direct costs and the direct economic benefits) required to make institutional microgrids cost effective today is estimated to be $600,000 per year. By 2025, the business case becomes positive creating a net-benefit of $400,000 per year, increasing to $700,000 by 2035.





CONTINUED ANALYSIS

This analysis focused on high value opportunities, that is customers with characteristics that are favourable to the economics of an institutional microgrid.

The results presented above are based exclusively on the direct economic benefits of an institutional microgrid, and assessed assuming that the desired simple-payback period is seven years.

ASSESSING THE IMPACT OF ECONOMIC FACTORS.

DECLINING TECHNOLOGY COSTS. One of the key drivers of microgrid deployment is the cost of solar and energy storage technologies. Since 2010, the average costs of a large-scale solar PV system has decreased from $4.2/watt down to approximately $2.3/watt today. Solar costs are projected to decrease substantially over the next two decades down to $1.2/watt in 2035. Similarly, the average cost of a large-scale Li-ion battery storage system is also projected to decline rapidly, from $740/kWh today down to $230 in 2035.

MAGNITUDE OF GA CHARGES AND RESPONSE. Much like C&I microgrids, the largest economic benefit stream for an institutional microgrid in Ontario is avoided Global Adjustment (GA) charges. Class A institutional customers pay GA charges in proportion to their contribution to Ontario's top five system peaks. A customer able to decrease demand during those system peak hours can reduce their GA charges. A key implication of the way GA charges are calculated for Class A customers is that charges are determined based on a very small number of hours of the year. As a result, the financial incentive to reduce demand during each of the system peaks is substantial. In 2011, the financial incentive averaged approximately $220,000 per MW of demand reduction. Since then, the financial incentive has increased to close to $500,000 per MW. Forecasting the occurrence of system peaks is complex, given the inherent uncertainty of electricity consumption hour to hour and the added intricacy of a number of large customers reducing their consumption on expected peak days in an effort to reduce their GA charges. Most institutional customers hedge the risk of missing the peak by responding on more than five days and for several hours ahead of a potential system peak, and several hours after. This analysis is based on a battery size of 10 MWh and an average response of +/-2 hours –for a total response duration of 5 hours. In effect, the university is able to achieve a 2MW demand reduction during each hour.

DISTRIBUTION SYSTEM OWNERSHIP AND CHP. Microgrids have achieved great traction across university and college campuses. In many cases, universities and colleges own the substations, distribution lines, and equipment supplying the campus buildings with power. Single ownership and management over their distribution system, loads, and resources allows campuses the flexibility to pursue reliability improvements, energy efficiency projects, and major system investments – such as a microgrid. Another key reasons for the early microgrid adoption by universities and colleges is the pre-existence of CHP systems. For example, the cornerstone of the Princeton University microgrid is its 15 MW CHP plant. For over a century, Princeton has been supplying steam across campus with a district heating system. This infrastructure enabled Princeton to pursue a CHP system – which was later transformed into today's microgrids.

ELECTRICITY SECTOR EVOLUTION. The evolution of the Ontario electricity market and regulatory framework has the potential to create a more favourable market for microgrid deployment. An institutional microgrid has sufficient scale to deliver value to utilities. An institutional microgrid can be transformed into flexible and fast-acting resource, capable of decreasing local constraints and providing ancillary services such as voltage or power quality support to network operators.

THE VALUE OF IMPROVED RELIABILITY. One of the key drivers of microgrid adoption by universities and colleges is the prospect of improved reliability. Institutional customers can incur material losses - due to lost power to essential facilities and laboratory research – from power interruptions, and increasingly due to power quality issues, as a result of the increased use of sensitive research and power electronic equipment. Universities and colleges should evaluate the adoption of a microgrid not only based on the direct economic benefits but also on the value of improved reliability and power quality. Universities and colleges incurring annual interruption and power quality costs higher than the current gap in economic benefits –estimated at $600,000 per year– will be able to justify the investment and are likely to lead the adoption of C&I microgrids in Ontario.

THE VALUE OF INTEGRATING DIVERSE RESOURCES AND TECHNOLOGIES. One of the key characteristics of a microgrid is the ability to integrate multiple distributed energy resources and enabling technologies, including demand response, energy management systems, and distributed generation. This functionality has emerged as a major factor that can enhance the economics of institutional microgrids. This diagram shows a qualitative assessment of the impact of several key factors -including distributed resources, technology costs, and market transformation- on the business case of industrial microgrids.

QUALITATIVE IMPACT OF DER AND OTHER FACTORS

⬆ Smart DR & Load Control	⬆ Energy Management Systems
⬆ Smart EV Charging	⬆ Declining Technology Costs
⬆ CHP & DG Integration	⬆ Market Transformation
⬇ Anti-Islanding Provisions	⬇ Lack of Market Transformation

The Advanced Energy Centre is a independent non-profit catalyst for adoption of innovative energy technologies, hosted at the MaRS Discovery District in Toronto, Canada. We facilitate solutions-based approaches to addressing today's energy challenges, by collaboratively identifying systemic barriers with industry, and providing a linkage to Canadian energy technology entrepreneurs.

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FOR MORE INFORMATION, PLEASE CONTACT:

Aaron Barter
Program Manager, Buildings and Community Energy
Advanced Energy Centre
abarter@marsdd.com

Roisin Grimes
Associate
Advanced Energy Centre
rgrimes@marsdd.com

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