FUTURE OF MICROGRIDS

RESIDENTIAL

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

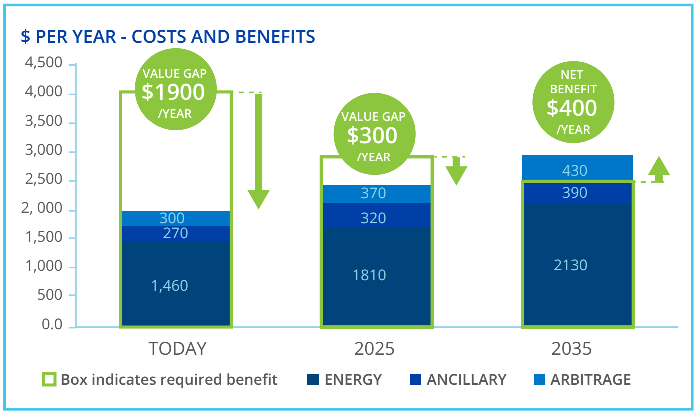
At its core, a residential microgrid consists of an advanced control system (or "controller") that integrates the customer's electrical loads, manages distributed resources such as solar PV and energy storage, and coordinates with the electricity transmission and distribution networks. A residential microgrid provides emergency power to critical circuits during power outages, and reduces a customer's dependence on centralized electricity supply. The microgrid controller transforms a residence into a flexible, dynamic and fast-acting network resource, capable of providing services to the electricity distribution and transmission network operators..

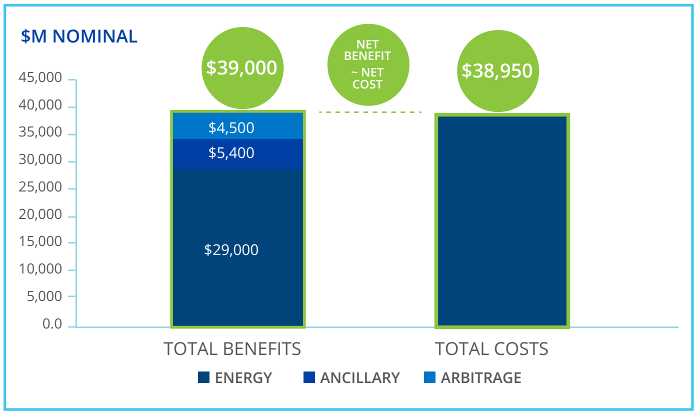
ASSUMPTIONS

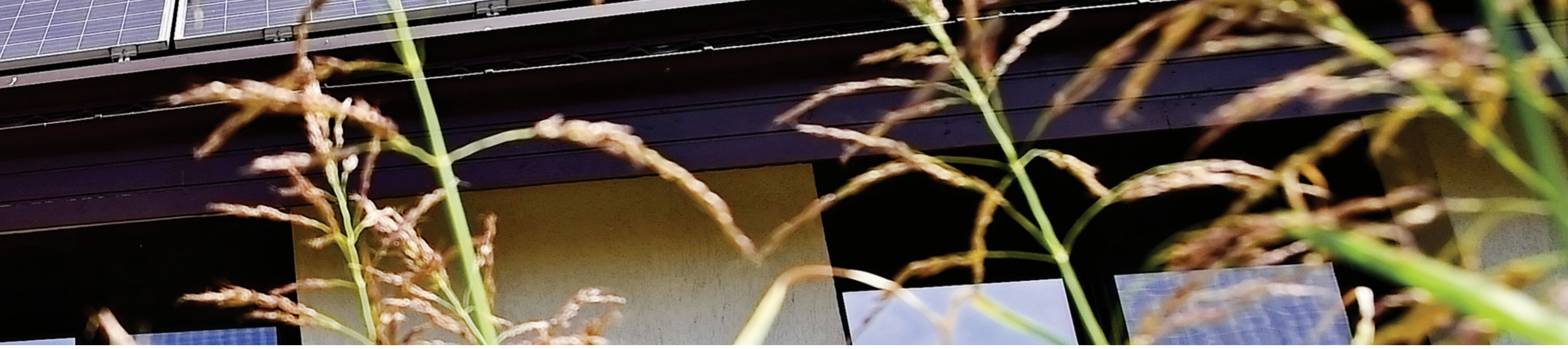
This analysis is based on a large residential customer with an annual consumption of 18,000kWh. The microgrid consists of a 5kW solar PV system coupled with 3kW (6kWh) Li-ion battery. The microgrid controller, the battery, and the microgrid's switchgear enable the residential customer to sustain power for critical systems during network outages. The battery is used to arbitrage energy rates (off-peak charging, and on-peak discharging), to participate in the operating reserve (OR) market administered by the transmission operator, and by a load-aggregator to provide demand response (DR) capacity. The electricity generated from the solar PV array offsets some of the customer's own electricity consumption, and during period of excess generation is sold back to the distribution network operator through a net metering arrangement.

RESULTS

The high costs of solar and storage technologies likely make the deployment of residential microgrids at scale cost-prohibitive today. However, rapid declines in the cost of solar PV and Li-ion battery storage is expected to drastically impact the economics and adoption of residential microgrids over the next two decades. The value gap required to make residential microgrids cost effective today is estimated at $1,900 per year, or $160 per month. By 2025, the value gap decreases to $300 per year (or $25 per month), and by 2035, the business case becomes positive creating a net-benefit of $400 per year (or $35 per month).







CONTINUED ANALYSIS

This analysis focused on high value opportunities, that is customers with characteristics that are favorable to the economics of a residential microgrid.

The results presented above are based exclusively on the direct economic benefits of a residential microgrid, and assessed based on a desired payback period of 8 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 costs of solar PV systems have decreased from $5.0/watt down to approximately $2.7/watt today. Solar costs are projected to decrease substantially over the next two decades down to $1.4/watt in 2035. The costs of Li-ion battery storage systems are also projected to decline rapidly, from $1,200/kWh today down to $400 in 2035.

RISING ELECTRICITY PRICES. Residential electricity rates in Ontario have steadily increased over the last five years. Since 2010, residential TOU rates have increased from ¢5.3/kWh (off-peak) and ¢9.9/kWh (on-peak) to ¢8.7/kWh and ¢18.0/kWh, respectively. As these trends continue, the economics of residential solar systems are becoming increasingly attractive as the costs of generating electricity from a solar PV array approach the retail cost of electricity. Another important characteristic of electricity rates in Ontario is the ratio between on-peak and off-peak rates (the "spread"). In Ontario, this ratio is currently fixed at approximately 2-to-1. Other jurisdictions in North America have more aggressive spreads, which lend themselves to higher economic value for a residential microgrid. Higher on-peak rates are favorable to residential microgrids because generation from a solar PV array generally coincides with on-peak and mid-peak periods, and because higher on-peak rates increase the value of energy arbitrage by the Li-ion storage system.

ELECTRICITY SECTOR EVOLUTION. The evolution of the Ontario electricity market and regulatory framework has the potential to create a more favorable environment for residential microgrids. Transmission and distribution utilities can draw significantly value by leveraging the capabilities and flexibility of microgrids to provide grid services. While a single residential microgrid may provide little value to a utility, the aggregation of strategically-located residential microgrids on a distribution network may provide significant value as an alternative to traditional poles-and-wires solutions. By reducing customer loads that would otherwise be served by the grid, microgrids can decrease local system peak demand and reduce electrical losses. In the long run, residential microgrids may enable utilities to defer or avoid costly reinforcement and system expansion.

Although the direct economic benefits are critical and significantly influence customer adoption, some attractive aspects of a residential microgrid -and perhaps the most important- are non-economic in nature.

THE IMPACT OF NON-ECONOMIC FACTORS. Power reliability, for example, can be a critical issue for some residential customers, particularly during major storms. For some customers, the risk of even a momentarily loss of power is not just a matter of inconvenience. In certain cases, and despite the high reliability of the electricity grid (>99.95% availability), the risk of losing power can drive residential customers to install emergency back-up generators to guarantee steady power supply during power interruptions. This illustrates that certain residential customers are willing to pay for increased grid reliability. Similarly, other residential customers will be attracted to microgrids by the environmental attributes of renewables adoption, by reducing their dependence on electricity grid, or simply by the fascination and wow factor of the technology. These customers will evaluate the adoption of a residential microgrid not only based on the direct economic benefits but also the non-economic benefits. Ultimately, residential customers that place a higher value on these non-economic factors (reliability, sustainability, grid-independence, and appeal) than the current gap in economic benefits -estimated at $170 per month- will be first movers and will lead the adoption of residential 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. With the increased adoption of electric vehicles and advanced demand-side technologies such as smart thermostats, load control switches, and home energy management systems, this capability is emerging as a major factor that can enhance the economics of residential 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 residential microgrids.

QUALITATIVE IMPACT OF DER AND OTHER FACTORS

↑ Smart DR & Load Control ↑ Smart EV Charging ↑ Increase in TOU Spread	↑ Declining Technology Costs ↑ 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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