Part 1: Introduction to background, evolution, acronyms, and aspirations of microgrids.

By Dr. Art Hunter – CACOR member

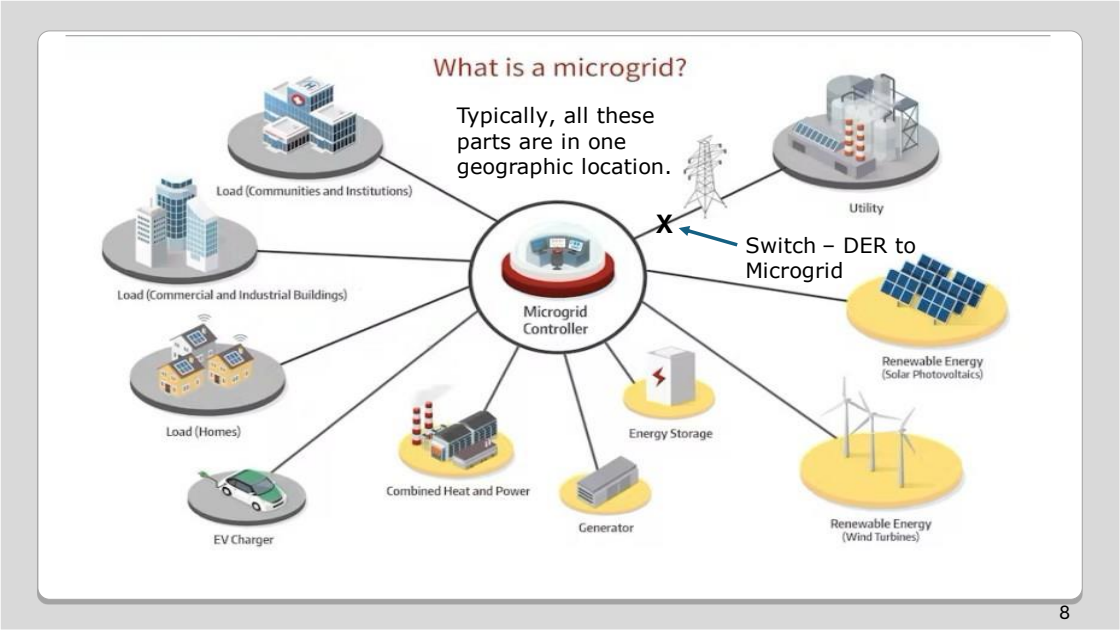
A microgrid is a small-scale power grid that operates independently or in conjunction with the area's main electrical grid. It's like a mini version of the larger grid but can disconnect and function autonomously, which is handy during emergencies. Microgrids can integrate various energy sources like solar panels, wind turbines, smart thermostats, and home batteries, providing localized, reliable energy. Picture it as a neighborhood with its own personal power backup!

A good graphical representation of a microgrid includes:

- Central Energy Source: Like a solar panel or wind turbine.
- Energy Storage: Batteries or other storage systems.
- Grid Connection: Highlighting the ability to connect to the main grid.
- Control System: Managing energy flows.
- Users: Residential or commercial buildings

Imagine a neighbourhood connected to various energy sources, with an on/off switch to illustrate its autonomous capabilities. These two busy graphics aid visualizations.

Or the below simpler illustration with energy sources, coupled with battery storage linked to energy loads all controlled by a command-and-control control center that links to the central power grid utility via an "island" switch.



The island switch ("X") is vital. According to this diagram, the microgrid can operate independently when this "island" switch is opened ("off") and there is no connection to the utility. In fact, from the perspective of the utility, the microgrid becomes invisible. When the island switch is closed ("on") the software in the microgrid controller starts to cooperate with the software in the utility control center under prearranged contractual terms and conditions. These terms and conditions normally give the utility the authority to deliver command instructions to both the loads (demands) and the generators (supplies) within the microgrid. Thus, the utility has an obedient resource that can be commanded to behave in ways to enhance reliability, affordability and resilience to the entire grid.

The microgrid then becomes a Distributed Energy Resource (DER). Many DERs then reduce the need for distant centralized generators (nuclear, hydro, gas turbines) and the transmission towers and distribution poles to connect local DER loads. This is done to decarbonize and modernize the grid. There are DERs that are only wind farms or solar farms or large grid scale Battery Energy Storage Systems (BESS) or home batteries. Some DERs simply control thousands of smart thermostats to control home heating or cooling loads during peak electricity demands.

The process of aggregating many DERs to operate as a system result in a Virtual Power Plant (VPP). Virtual Power Plants have been in existence for about 5 years, but they are deploying rapidly as utilities and building owners expand their understanding of their value in energy affordability, resilience and reliability.

Starting in December of 2023, the IESO, under direction from the Ontario Energy Board (OEB) made available a new energy rate plan. [Ontario Launches New Ultra-Low Overnight Electricity Price Plan | Ontario Newsroom]

- The new optional Ultra-Low Overnight price plan provides:

    - Ultra-low overnight rate of 2.4 cents per kWh: everyday 11 p.m.-7 a.m.
    - Mid-peak rates of 10.2 cents per kWh: weekdays 7 a.m.-4 p.m. and 9 p.m.-11 p.m.
    - On-peak rates of 24.0 cents per kWh: weekdays 4 p.m.-9 p.m.
    - Weekend off-peak rates of 7.4 cents per kWh: weekends and statutory holidays 7 a.m.-11 p.m.
- The new optional third price plan is available to all eligible Regulated Price Plan (RPP) Time of Use (TOU) and Tiered consumers.

The ultra-low overnight rate will help reduce emissions by encouraging the use of more nighttime electricity, which is typically generated from clean, zero-emissions resources like nuclear, hydro and wind power.

This had proved to be very beneficial to early adopter homes, businesses and building owners that have paired solar power collection with battery storage. It permits energy trading (buy at low energy cost of $0.024/kWh and sell at high energy cost of $0.24/kWh) as well as time shifting loads to overnight for financial advantage. Time shifting can be accomplished with simple timers for daily use (e.g. Electric Vehicle charging) or using batteries to serve demand loads during high costs and then to recharge the batteries at low cost overnight rates. Energy trading and time shifting permits the buildup of energy credits that can be saved over the summer for use in the winter.

As Local Distribution Companies (LDC) adjust their policies and procedures the financial advantages are shared as described in https://canadiancor.com/wp-content/uploads/2024/10/Project-Payback-PEO-v2.0-fm-base-v7.3.pdf

The future of a decarbonized sustainable grid is in the rapid deployment of VPPs.

Part 2: Policy Proposal and Solutions

By Dr. David Head -- CACOR member

Microgrids-DER's positively affects affordability, reliability and resilience of the electrical system. The province should encourage their implementation throughout Ontario.

A direct step in doing so would be to establish a demonstration project in an Ontario municipality. The demonstration project would set up two microgrids operating in DER mode close to each other and join them as a Virtual Power Plant. One microgrid-DER would be in suburban domestic settings involving 20 to 50 homes. The second microgrid-DER would be in an institutional setting involving either several schools, or a hospital complex or an industrial park. These two microgrid-DERs should be served by the same transformer substation.

Following examples of aggregated microgrid-DERs in California, acting as a VPP, the domestic microgrid network could be set up and managed by the Local Distribution Company (LDC, e.g. Hydro Ottawa). The LDC would install solar panels on the homes and pair them with home batteries. The power generated would be sold back into the grid with the profit shared by the homeowners and the LDC until such time as the capital cost is recouped. Thereafter the homeowners would own the solar panels and batteries and earn the profit from the electricity sales.

An alternative funding arrangement could be demonstrated with the institutional microgrid-DER. The institutions would be subsidized in the purchase of solar panels and batteries and would enjoy a portion of the sales to the grid until the subsidy/loan is paid off. Thereafter the institutions would keep 100% of the profit.

The two microgrid-DERs would be aggregated by a Virtual Power Plant controller with its own Battery Energy Storage System (BESS) who would operate under contractual obligations to provide power and services to the LDC. The VPP would be designed to accept many more microgrid-DERs and BESSs once the pilot demonstration was verified.

To make this happen and be effective the Minister of Energy would direct the Ontario Energy Board to mandate and fund the project. The OEB can direct the involvement of IESO and the LDC, and the modification of any operational rules to ensure the project can run smoothly. Other LDCs in the province would be directed to establish a monitoring committee to evaluate the demonstration at least every 6 months on the factors of affordability, reliability and resilience. After the demonstration has been operated for 18 months the LDCs will be tasked to develop possibilities for establishing microgrid-DERs and VPPs in their area. A timeline goal for setting up local Microgrid-DERs would be placed on each LDC respecting its technical and financial situation.

Public communications would be issued concerning the project through the LDCs that featured the cost savings to individual homes/institutions and the increase in the ability of the system to deal with power interruptions and sell excess energy to the grid while reducing the cost of home electrical energy. The reduction in the need to build more generation plants and transmission lines could also be emphasized, particularly as this would diminish electricity cost increases for all Ontarians.

Implementation of microgrid-DERs and VPPs throughout the province would have strong economic benefits. Recent provincial and federal funding of battery manufacturing in Ontario could support these investments by establishing a robust market for batteries from these suppliers, thereby reducing or eliminating imports and supporting jobs in Ontario.