

The Energy Transition:

How Microgrids Can Help Rebuild Ontario's Power Grid and Electrify Everything

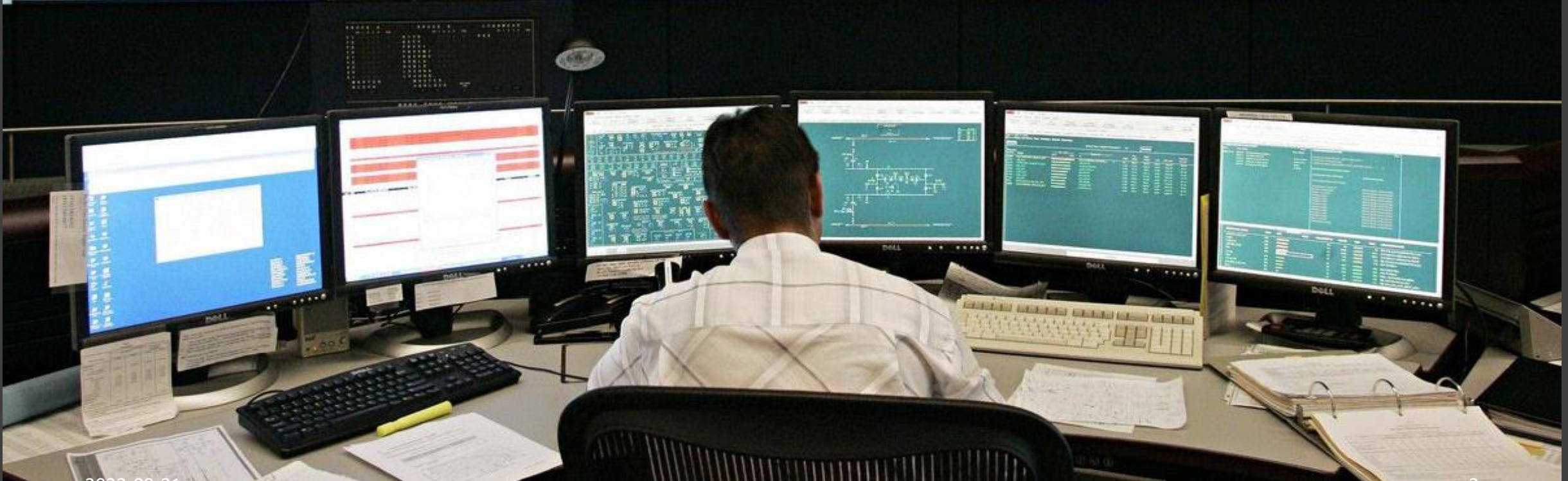
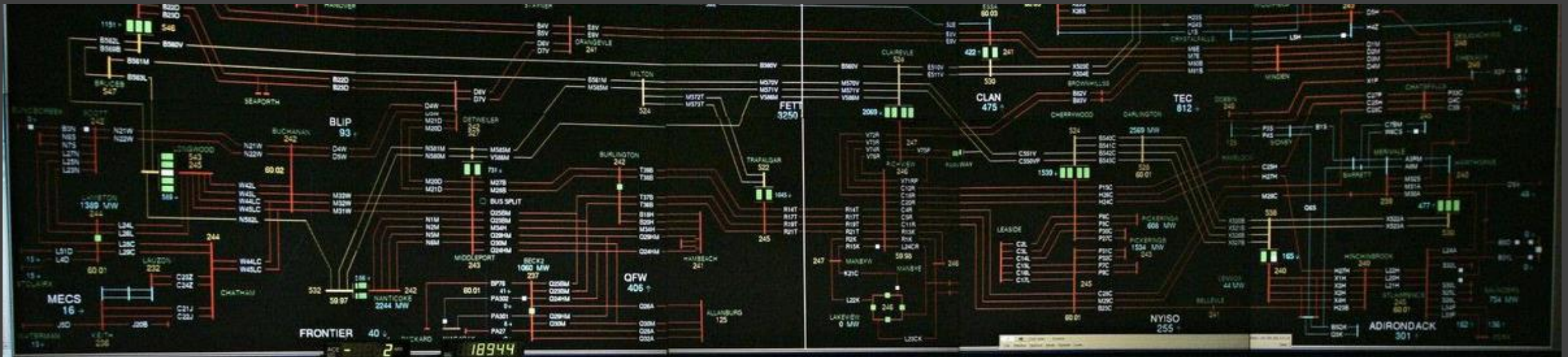
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McNeil Centre for Applied Renewable Energy

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The objective of this presentation is to introduce a fair and effective means to assist in climate change mitigation, adaptation and resilience while reversing the cost escalation of electrical energy for ALL Ontario consumers.

[MICROGRIDS NOW on Vimeo](#)



What is a Microgrid ?



Define a Distributed Energy Resource and a Microgrid

A Distributed Energy Resource (DER) in an electrical grid is:

“A resource that is directly connected to the distribution system, or indirectly connected to the distribution system behind a customer’s meter; and generates energy, stores energy, and/or controls load”

A microgrid can exist without a connection to the grid and becomes a DER when authorized and connected to the grid

A Non-Wired Alternative (NWA) means energy delivery without Transmission tower lines and high voltage transformers.



Government and Other Positions on Renewables

- There is renewable policy support with:
 - The federal government [Clean Electricity Standard](#)
 - Most provincial governments
 - City governments
 - Healthcare providers
 - Citizen demands
 - Many Industries
- But the very profitable fossil fuel industry lobby is successfully pushing to go slow.
- We are more reliant on electricity than ever before, and our tolerance for outages is lower than ever -- A growing disparity

The Purpose of this Presentation

Links not Silos

- Electrical power generation, electrical vehicles, and microgrids are strongly linked into a system rather than 3 separate silos
- Hardware is already commercially available. The outstanding issues are regulations, appropriate business models, management, financial and scaling to deploy these existing technologies
- Microgrids are a pathway to deliver renewable energy to end users

Energy Transition to Electrify Everything

- The centralized, fragile and antiquated electricity grid is the main supplier of electrical energy
- Four main Energy sectors:
 - Traditional Electrical Grids with central power supply
 - Buildings (loads)
 - Heating and cooling
 - Lighting
 - Appliances and specialty demands
 - Industry – broad spectrum of energy loads
 - Transportation load for people and goods
- Microgrids can participate in all four categories at a community scale -- massive (> 100,000 homes)
- Microgrids will minimize distribution and transmission losses
- Two modes: Normal and grid outage survival modes

Energy Transition:

Massive Scale > 200,000
aggregation

Example

A USA builder plans 200,000 home microgrids using solar and batteries

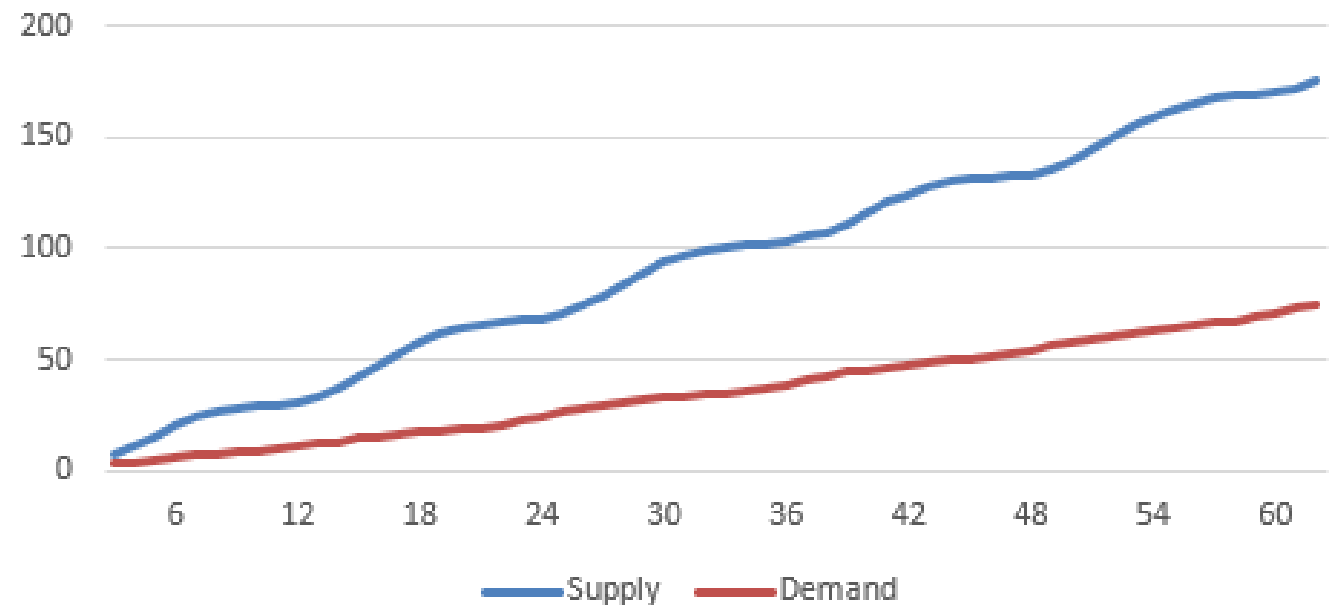
- Homes made from recycled plastic and no lumber with solar and battery storage
- Adds about \$20,000 to the cost of each house.
 - [Link to original article](#)
- The single home “Manotick Microgrid” Return On Investment after 60 months was USD \$21,318

Performance of the Manotick Microgrid

(solar, batteries, heat pump, EVs)

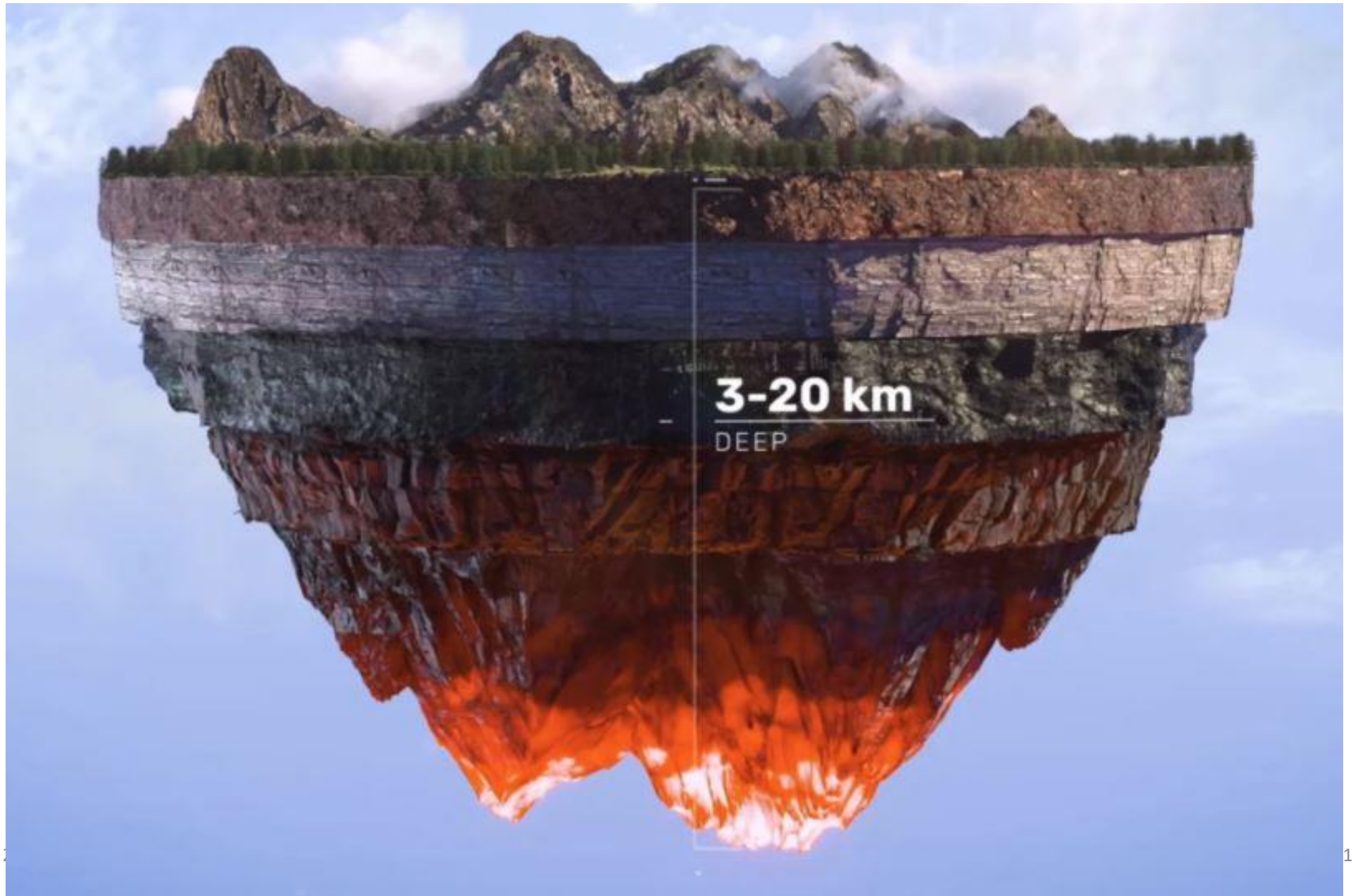
\$27,510 ROI

Manotick Microgrid Cumulative MWh of Supply and Demand for 60 months



North American Grids: energy sources

- Three North American independent grids in Canada, USA and Mexico
 - East
 - West
 - Texas
- Over the past 130 years proved fragile but stable
 - Repair Design Requirements based on last 20 years weather
- Now, solar and wind have matured to be the lowest cost electricity production
- Geothermal is least understood but cheapest heat source
- Tidal, wave, hydro, bio, fusion, fission and fast breeder Small Modular Reactors (SMR) are other competing power generating technologies



3-20 km
DEEP

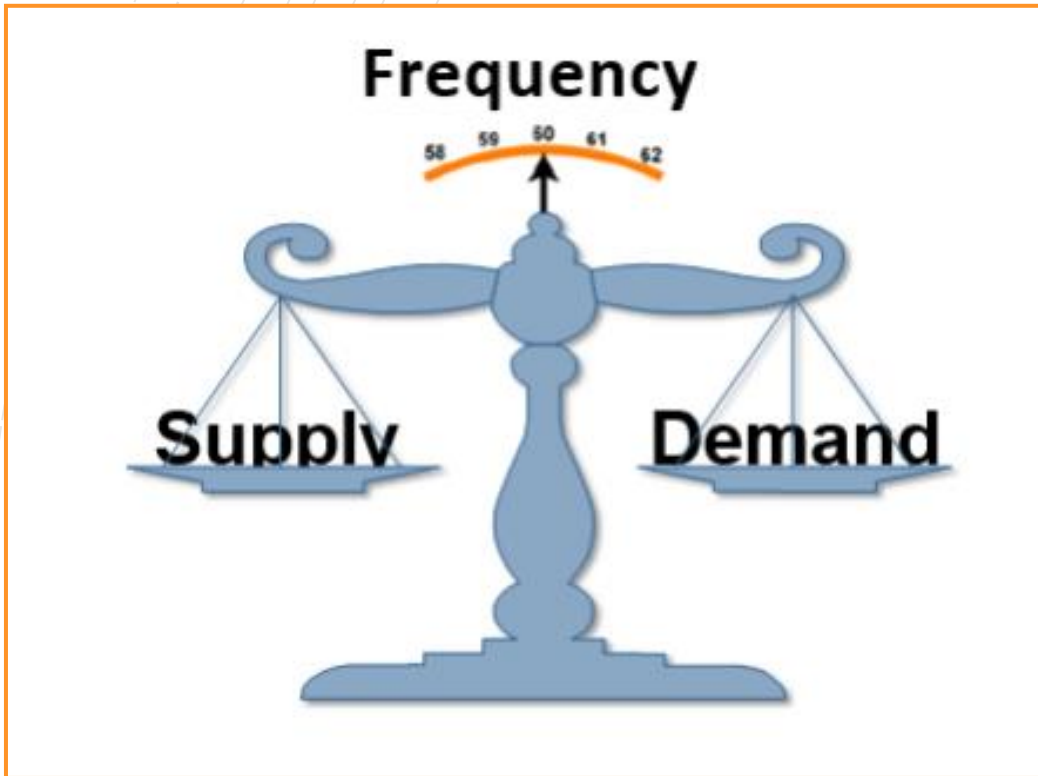
Thermal Battery – Svec Coil, May 2018.
Leda clay is an aquitard
– note vertical trench walls



Ontario Focus: How is the electrical grid managed?

- Ontario Energy Board (OEB) – Provincial regulator appointed by the Ontario government
- Ontario Power Generation (OPG) – build, maintain, operate all generating stations
- The Independent Electricity System Operator (IESO) – Grid manager - wholesale buyer from OPG using aging grid tower lines delivery to Local Distribution Companies
- Local Distribution Companies (LDC) – 38 in Ontario. Each has its own local management and transmission grid to its retail customers.

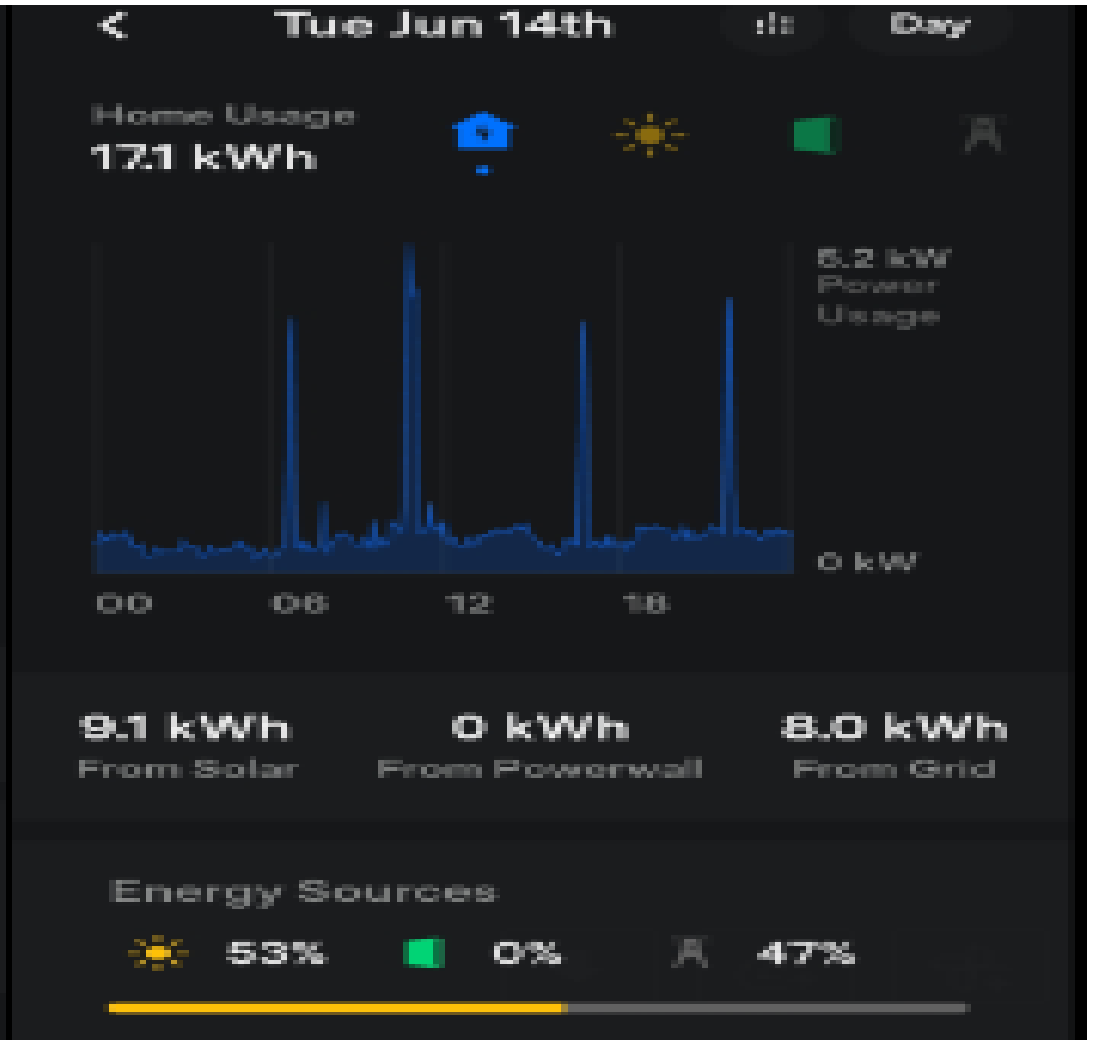
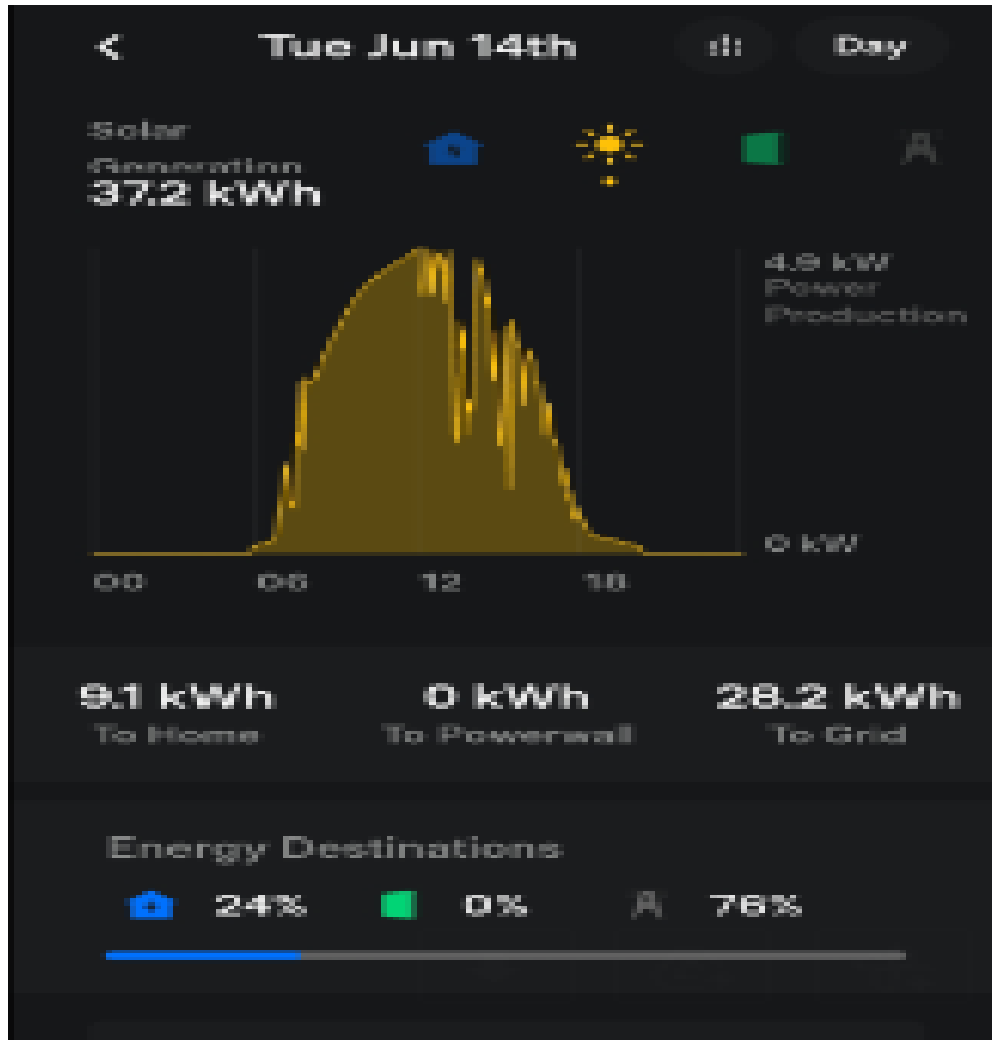
Grid Manager's Balancing Mandate



- Deliver to every corner of the grid
- Demand varies constantly by community and building
- Microgrids can work as a helpful tool to the IESO as ancillary services
 - Short term solution is to vary the voltage (millivolts)
 - Or to vary the local frequency (millihertz)

Solar Supply

Home Demand



Delivery Speed Flexibility



- Supply must keep up to demand but time delays are an issue
- Batteries have been verified to respond in fractions of a second
- Rate incentives to have customers use less during high demand
- [home-load-vs-microgrid-solar-supply standard](#)
- Special arrangements with big industry on phased start up or shut down (demand response)

IESO DER Roadmap

- **Modern DER Benefits:** These resources can provide more control and choice for energy consumers, additional revenue streams and sustainability opportunities for communities, and can help defer or avoid investments in new transmission infrastructure. DERs keep the provincial grid reliable and affordable
- **Contract Terms:** DERs currently participate in the IESO's wholesale market in a limited way. As a result, a DER Roadmap has been developed to set out the IESO's goal, objectives, initiatives and timing (2026) for modern DER integration (Aggregated Foundational > 1MW and Enhanced models)

Describe Microgrid Details – part 1

They are a Distributed Energy Resource – a Non-Wired Alternative

- Microgrids are energy systems that supply **LOCAL** loads and **MAY** deliver some excess electrical energy to the grid
- **May** have storage capacity
- **May** include geothermal
- **May** include air-to-air heat pumps
- **May** include EV charging and vehicle to grid (V2G) connectivity.
- **May** have a contract with a Local Distribution Company to sell or store excess power

Describe Microgrid Details– part 2

They are a Distributed Energy Resource – a Non-Wired Alternative

- May be R&D platforms
- Often Includes the ability to “island” - DER becomes a microgrid
- No such thing as only one microgrid configuration
- Many global (Japan, USA, EU) jurisdictions are well advanced in integrating microgrids with their grids
- Geopolitics of the EU – Russia energy adjustment is providing the political will to speed innovation and deployment
- [MICROGRIDS NOW on Vimeo](#)

Microgrid Benefits (1 of 16)

Supply Reliability

1. A reliable microgrid and an unreliable grid

- Microgrids keep the internal power flowing immediately by automatically disconnecting – or islanding – from the central grid when it begins to fail
- Often explained as “energy independence” or “self-sufficiency” or “energy security”
- Solar panels have just a 0.05% failure rate when it comes to reliability and lifespan.

Microgrid Benefits (2)

Resilience Hub

2. A microgrid enhances resilience/recovery

- Resilience describes the ability to avoid power outages and recover
- Deliver energy to emergency services using EVs and their mobile batteries
- Optimized interaction of EVs with the electric grid by tracking the connect time, power level usage and location of the EVs

Microgrid Benefits (3)

Lower Energy Cost

3. A microgrid can lower energy costs for consumers and the grid managers

- Microgrids deliver efficient management of supplied energy
- A microgrid can be utility owned and operated or community or other organization owner/operated
- Community ownership permits the community to decide on the next phase of system improvements

Microgrid Benefits (4)

Clean & Green

4. A microgrid improves the environment and promotes clean energy

- Green (GHG) power production and storage technologies are used
- Microgrids intelligently integrate renewables into the energy mix
- Microgrids provide the intersection of energy, behaviour and ecology in preparing for the future through community building

Microgrid Benefits (5)

Wireless Solution

5. A microgrid strengthens the central grid

- They act as an additional local supply resource that grid operators can call upon as required
- They avert the need to build more distant power plants and vulnerable transmission lines
- Most electrical energy is used almost immediately after it is generated into nearby loads (Roof panel to kitchen toaster)

Microgrid Benefits (5)

part 2

Local Virtual Power Plant

5. A microgrid strengthens the central grid

- Some studies aggregate microgrids to prevent building a nuclear, hydro or thermal plant as the “electrify everything” demand grows. Termed Virtual Power Plants (VPP)
- Elon Musk is working with the Texas and California grid regulators and managers to build out several VPPs – a separate utility

Microgrid Benefits (6)

Cybersecurity

6. *A microgrid bolsters cybersecurity*

- Experts are concerned about grid vulnerability. Microgrids can isolate from the grid and the Internet
- Effective cyber attacks on microgrids would be rendered increasingly difficult as target numbers increase (say 200,000 microgrids)

Microgrid Benefits (7)

Social value

7. A microgrid brings social value to society

- The microgrid community is not using power from a plant hundreds of kilometers away
 - A microgrid can be a local asset by keeping livability (comfort and convenience) costs low and providing local employment
- The objective is to make microgrids a “valued feature” in neighborhoods, not something separate and invisible to people as conventional energy tends to be
- It could become a local emergency transportation, food and communications hub

Microgrid Benefits (8)

Well-being

8. A microgrid improves community well-being

- The neighborhood microgrid becomes a place of refuge
- When all else fails, everybody in that local community can feel comfortable knowing that there is at least one place that they can go to where the power is always on, and they can communicate to their families and neighbours that they're OK.

Microgrid Benefits (9)

Versatility

9. A microgrid has operational versatility

- MANY ways to optimize internal energy use. Versatility is vital to anticipatory adaptation and this in turn to graceful survival
- Intentional oversizing the generators and storage capacity provides internal and external operational versatility
- Live testing on the Manotick Microgrid of low energy demand scenarios have transformed into some “normal” procedural changes to eliminate waste

Microgrid Benefits (10)

Long-term

10. A microgrid brings long term economic value to owners

- 20% of Canadians live in energy poverty. A simple single solar panel microgrid reduces this cost and a properly designed microgrid will stop energy poverty
- Overdesigned microgrids mean they produce more than they consume
 - Sell to the main grid to participate in grid ancillary voltage and frequency services and support
 - produce Hydrogen which is also sold

Microgrid Benefits (11)

Energy Awareness

11. A microgrid greatly increases energy awareness

- Microgrid owners tend to pay closer attention to the factors affecting energy waste and conservation
- Some Microgrid owners consider energy quantities down to one kilowatt hour
 - Lifestyle adjustments, procedural change or home renovations often follow
- You can't manage what you can't measure

Microgrid Benefits (12)

Inflation Proof

12. A microgrid provides isolation from energy price inflation

- The direct impacts of energy price inflation are sharply reduced
- The real world consists of ever-increasing energy costs.
- Disconnecting from the inflating energy supply infrastructure is often an owner's primary objective
- Installation costs become an investment that can yield about 10% ROI

Microgrid Benefits (13)

Compatibility with Nature

13. Is operation of a Microgrid compatible with nature's energy flows?

- PV solar cells absorb solar radiation, convert it to electricity and that is then used in the shelter with the heat generated from lights and appliances returned to the atmosphere or soil. A time delay only
- Ground Source Heat Pumps absorb thermal energy from the soil that is then used in the shelter to warm the internal air and domestic water with the heat eventually returned to the atmosphere or soil. A time delay only
- The Manotick Microgrid energy systems are 100% compliant with natural energy flows

Microgrid Benefits (14)

Survival

14. How will a microgrid aid in survival

- **Ottawa Derecho of 21 May and CACOR advocacy**
- Ontario and Quebec grid failures of 25 May 2022, with a focus on Ottawa, resulted in CACOR advocating for microgrids on radio, TV and the print media
- 1. CBC TV [\(161\) Our Ottawa Manotick microgrid May 28, 2022 CBC ca 2022 05 30 – YouTube](#)
- 2. Newspaper [Ottawa storm 2022: Manotick man powers neighbourhood with ‘microgrid’ house | Ottawa Citizen](#)
- 3. National Post [Man powers his street with ‘microgrid’ house – Canadian Association for the Club of Rome \(canadiancor.com\)](#)
- 4. [CBC Radio As It Happens](#)
- 5. [Letter to the Editor](#)
- 6. [SMARTNet Alliance](#)
- Basic survival needs are shelter integrity, energy (heat, cool, appliances), food/water
- [Plan to Survive - Canadian Association for the Club of Rome \(canadiancor.com\)](#)

Microgrid Benefits (15)

Community Considerations

15. Platform and Community Dynamics

- A microgrid platform is a collection of parts operating as a system
- Ease of future growth to add new generating or storage capacity
- Technology advance and product upgrades are constant
- It is a learning platform
- A community of microgrids can have real time dynamic boundaries and connection pathways based on outage damage, location of demand loads, and individual microgrid production capacities
- Transmission and distribution resiliency planning methods are used to identify community microgrid placements, configurations and viable pathways along a feeder

Microgrid Benefits (16)

Repair Cost Avoidance

16. Asset Repair Cost Avoidance

- Retroactive adaptation to climate change studies considered two cases
 - Current business as usual GHG release
 - Reduced emission scenarios
- Benefit-to-Cost ratios of 9 to 1 through 38 to 1 have been published
- Ontario grid repair is still based on average weather conditions for the past 20 years
- Overlapping past event “repairs” and new weather event damage shall soon be unaffordable and outages will be very much longer than a few days

The objectives of Ontario Pilot Projects include: (part 1)

- Exploring models of coordination and interoperability between the IESO and a microgrid aggregators
- Demonstrating the interest of consumers in participating in and the potential for the creation of a reduced Local Energy Price
- Assessing the interest and ability of different DERs to compete to provide capacity and energy and reserve services through 5-minute dispatchable auctions
- Assessing the operational impact of DERs on the local distribution system to facilitate the maintenance of safe, reliable and efficient system operations

The objectives of Pilot Projects: (part 2)

- Identifying market and systems operations barriers to the use of DERs as NWAs and potential solutions
- Exploring how elements and benefits of the wholesale electricity market could be extended to the now modified distribution system
- Drive community engagement and development by enabling local solutions to meet local needs
- Assess the unique operational and reliability of DERs at the Transmission level

Aggregation Pilot Projects in Ontario

- On 1 April 2022, major Ontario pilot projects aggregating DERs and microgrids using AI-powered tracking to show how aggregating clean energy assets can
 - reduce energy costs
 - reduce carbon emissions
 - provide substantial economic, resilience and sustainability gains
 - integrate **EV charging** and use of **air-to-air heat pumps**

[New Project Exhibits Use of Aggregated Clean Energy for Utilities - Solar Industry \(solarindustrymag.com\)](https://solarindustrymag.com)

- One project office at the Oshawa Ontario Tech University campus. **Includes V2G**

[New Project Exhibits Use of Aggregated Clean Energy for Utilities - Canadian Association for the Club of Rome \(canadiancor.com\)](https://canadiancor.com)

- Another project is run by Toronto area business Enel X

[Toronto area businesses to engage in 77MW distributed energy aggregation - Canadian Association for the Club of Rome \(canadiancor.com\)](https://canadiancor.com)

IESO Demonstration 2021 and 2022

- York Region Pilot Project Objective: Explore how to use Distributed Energy Resources (“DERs”) to help meet electricity system needs
 - help meet local system needs by managing local peak demand
 - When used as NAWs, the DERs are expected to be available to support grid needs
- DERs can offer services to defer, reduce, or avoid capital and operating costs associated with the distribution network
 - Avoiding new expensive centralized generating infrastructure (nuclear, hydro, diesel) single points of failure

EV Aggregation in Ottawa

- Artificial Intelligence Pilot to Support EV Electricity Demand in Ottawa
 - Collaboration between the IESO, OEB, BluWave-ai and Hydro Ottawa
 - Use artificial intelligence (AI) to manage EV charging during peak demand periods,
 - Create an online service for EV owners to smooth out demand peaks using V2G
 - Projects like EV Everywhere leveraging AI to shift EV charging to off-peak periods
 - Defer or reduce the need for capital infrastructure upgrades
 - "Working with BluWave-ai and Hydro Ottawa creates an amazing opportunity to increase EV adoption. By adding energy storage to the grid, we can solve many problems the grid would otherwise experience as EV adoption increases."
 - [EV Everywhere](#)

The IESO intends to use the results of the Pilots for the following purposes

- To establish the case for DER integration in IESO's wholesale markets
- To inform wholesale market design priorities to capture services from and eliminate barriers to cost-effective DERs
- To identify circumstances where DERs prove cost-effective and/or where adoption would likely occur
- To provide estimates of resource potential and cost savings
- To identify cost-effective carbon emissions reduction opportunities
 - Electrifying Everything

Microgrid Value to the Grid Owners

supply = demand

- Demand (Consumption) reduction with a flexible load.
 - Can remain off-grid if solar generation and storage are properly sized.
 - Could charge EV during Off-Peak times or fully from solar generation.
 - Could charge batteries at peak solar power generation and discharge into grid at peak demand (4 p.m. to 9 p.m.)
- Supply addition with Solar generation
 - Remove need for gas turbine or diesel use for peak loads
 - Remove need for >1 MW utility grade solar farms
 - Remove need for utility grade megapack batteries
 - Remove need for imports from neighbouring grids (Quebec, Manitoba, New York, Michigan)
- The reduction in demand is valued at twice the supply addition

Business Model Development

- Requires Grid side software to command and control the VPPs.
- Requires use of VPP aggregator software to monitor and respond to grid commands and provide accurate measurement of deliverables in real time
 - Software Command and Control of Microgrid Building Management Systems
 - Control Smart thermostat settings for heating and cooling levels
 - Control EV and building battery charger time of use
 - Control time and duration of EV and building battery power delivery to grid
 - Control power to water pumps, rotating motors and large commercial refrigerators
 - Control of roving EV batteries no matter their location when connected to a participating charger.

Business Model Challenge

- What is just, fair and reasonable value of microgrid supply and demand contributions?
 - The grid has saving by NOT having to build and maintain Generating and Peaker stations, transmission and transformer networks. Avoids resistive losses over long wires. Not responsible for fragile grid repairs in an emergency. \$Billions in savings.
 - The VPP should be compensated not only for meeting energy delivery commands but for being on standby (like a spinning turbine at no load) and ready to supply energy nearly instantaneously.
 - VPP compensation should include daily standby not just for peak times. Emergencies can occur without warning.
- Savings should be shared by the supporting microgrids (via the VPP), the grid owners and ALL grid retail customers (estimated 50% to 85%).

Reliable Microgrid Summary

- **Investment Main features**
 - Efficient, Sustainable, Resilient, Profitable, Distributed, Scalable, community oriented, nature friendly
- **Provides fossil fuel free energy supply:**
 - Highly flexible critical operational uses
 - Provides for community interface and management
 - Long Term Business profit centre
 - Energy to customers, storage and power to the grid, grid stability services
 - EV charging and V2G connection

The Electrify Everything Transition

- Many market studies and some pundits are predicting
 - Massive investments from fossil fuels to renewables in the next decade
 - One pundit even suggested \$150 trillion in a “Great Market Distortion” starting soon
- Community adaptations using microgrids are encouraged.
- The microgrid solution is an important shining star in the energy transition’s bright future

- The objective of this presentation has been to introduce a fair and effective means to assist in climate change mitigation, adaptation and resilience while reversing the cost escalation of electrical energy for ALL Ontario consumers

A Canadian Association for the Club of Rome (CACOR) outreach topic seeking reduction in the demand for fossil fuels in the electrical power and transportation sectors.

- Primary references
 - [Microgrid-EV-and-grid-IESO-20220622](#)
 - [G78-Climate Legacy Brief on Adaptation and Seniors for Climate Action Now - Canadian Association for the Club of Rome \(canadiancor.com\)](#)

