

Welcome to this week's presentation and conversation
hosted by the
Canadian Association for the Club of Rome,
a Club dedicated to intelligent debate and action on global issues.

The Energy Transition: How Microgrids Can Help Rebuild Ontario's Power Grid and Electrify Everything

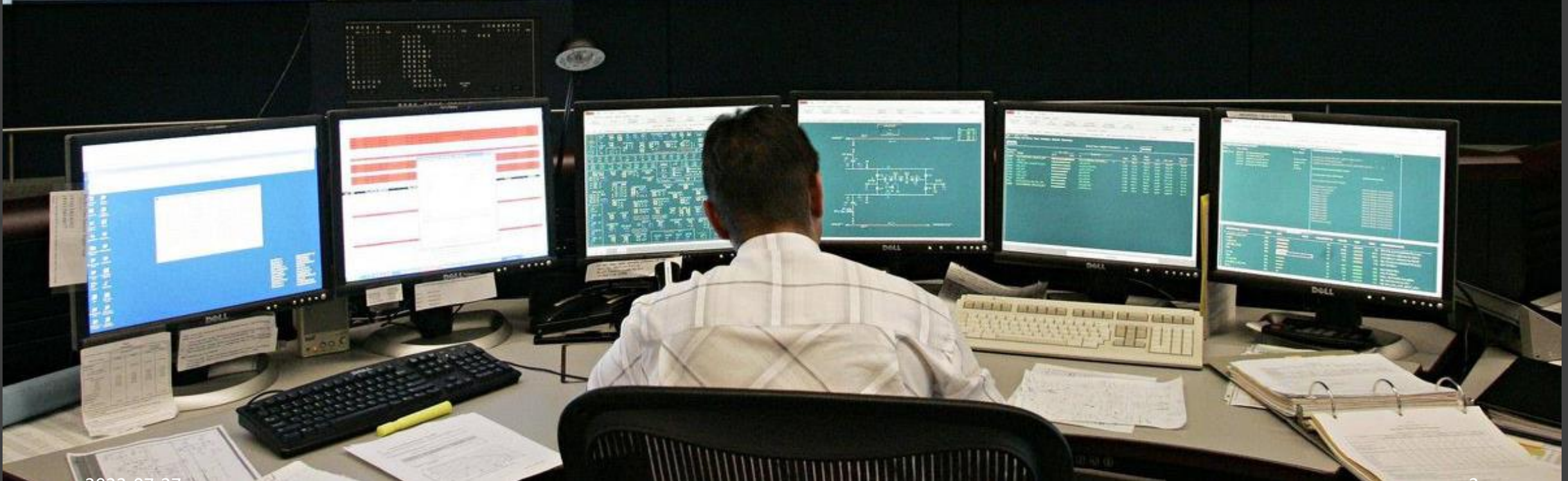
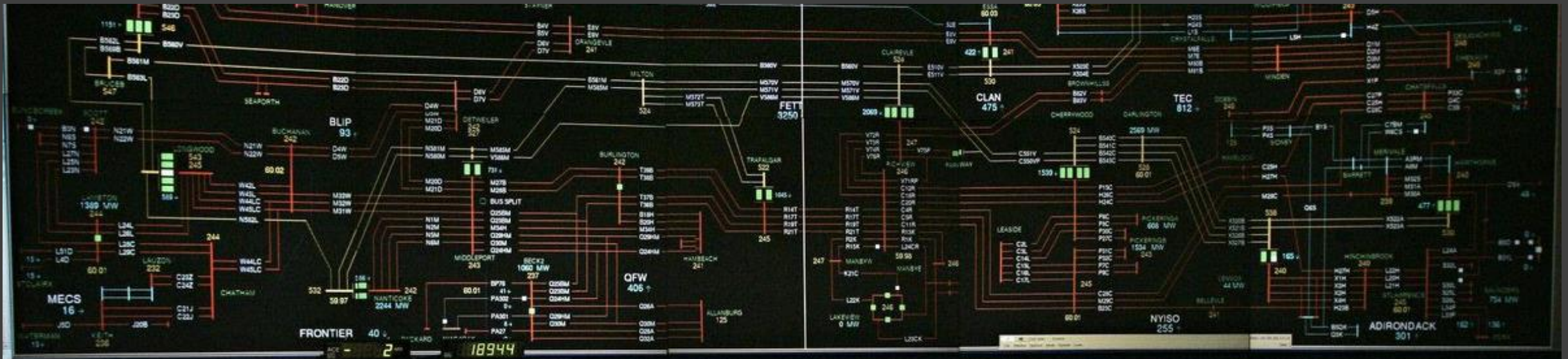
Our speaker today is Dr. Art Hunter is a retired mechanical & aeronautical engineer. For 15 years he did spacecraft design & was the Project Manager for Canadarm for Space Shuttle. He continues consulting engineering services to select clients. In the last 5 years he installed a microgrid in his home with solar & geothermal energy supply, & battery & geothermal energy storage. Grid modernization & expanded use of renewable energy resources can lead us to electrify everything to reduce use of fossil fuels, emissions, & energy costs, & build an electrical grid less subject to climate-related outages that are life-threatening disasters. This presentation explores the features of microgrids, a type of Distributed Energy Resource & Non-Wired Alternatives that can help modernize the main grid.

Dr. Hunter's presentation will be followed by a conversation, questions, and observations from the participants.

CACOR acknowledges that we all benefit from sharing the traditional territories of local Indigenous peoples (First Nations, Métis, and Inuit in Canada) and their descendants.



2022 July 27



The Energy Transition:

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

by Art Hunter Ph.D.

Canadian Association for the Club of Rome (CACOR)

27 July 2022

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

Define a Distributed Energy Resource and a Microgrid

A Distributed Energy Resource (DER) 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, or controls load”

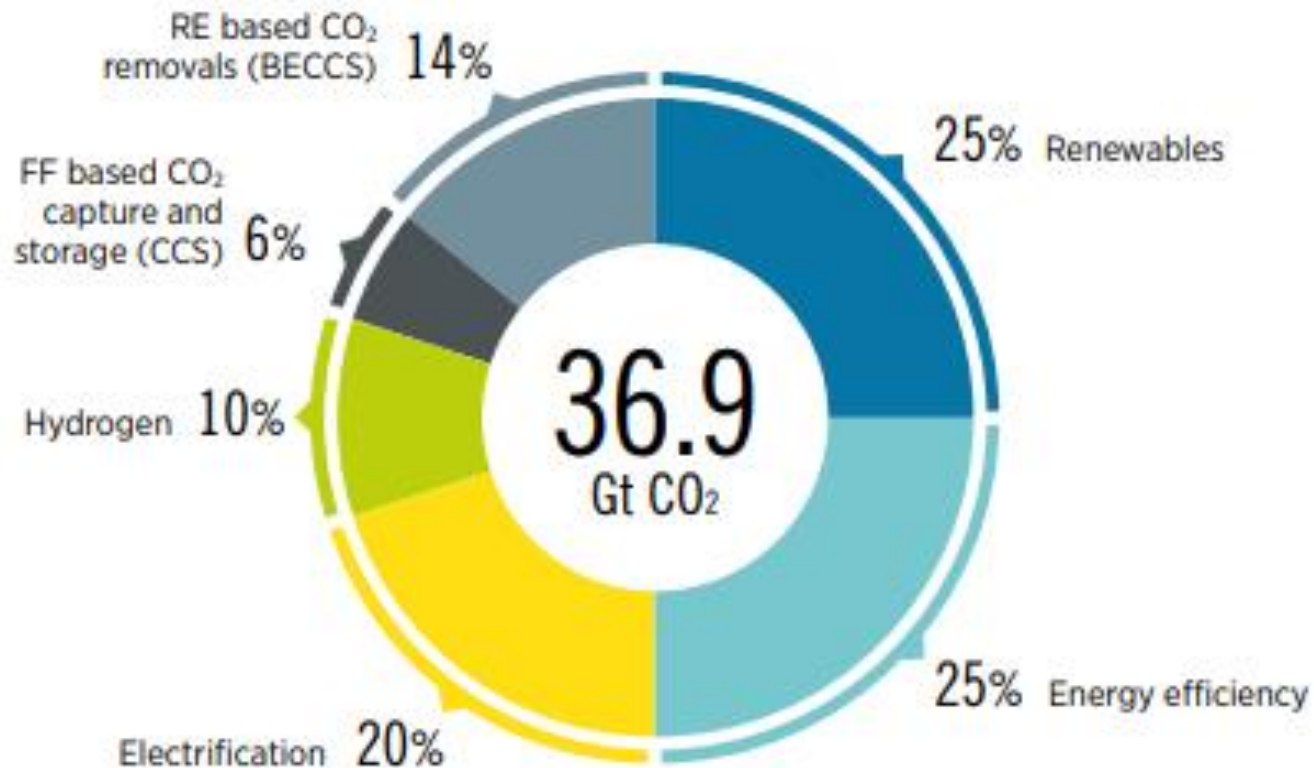
A microgrid can exist without a connection to the grid and becomes a DER when authorized and connected to the grid



Reducing emissions by 2050 through six technological avenues

70% may be provided by microgrids

The International Renewable Energy Agency



In the age of variable renewable energy, electricity should be procured considering the characteristics of decentralized generation technologies.

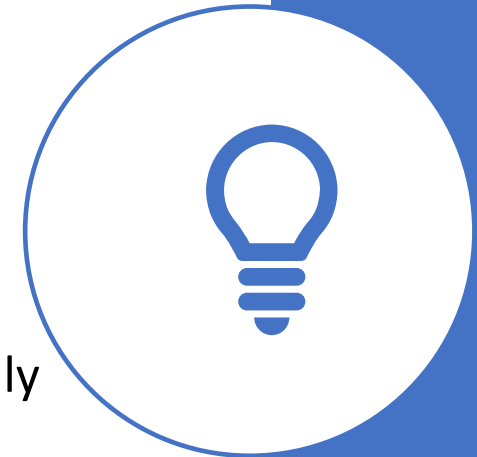
Other government levels

2030 Emissions Reduction Plan: Canada's Next Steps for Clean Air and a Strong Economy

- There is renewable policy support with:
 - The federal government [Clean Electricity Standard](#)
 - The provincial governments
 - City governments
 - Healthcare providers
 - Citizen demands
 - Industries
- But the 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

Climate Solutions are Connected

- Many technologies available
- Grid-tied and off-grid innovations
- Extensive grid modernization needed to withstand wilder weather while accommodating EVs, renewable energy and emission avoidance
- How to deliver this electrical energy to the end consumer via existing and highly modified electrical grids
- Primary requirements are: Improve reliability, reduce costs, reduce fossil fuel use, enhance survival (deadly outages) and advance integration of Distributed Energy Resources (DER) as Non-Wired Alternatives (NWA)



The Purpose of this Presentation

Objective #1

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 only 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

The Purpose of this Presentation

Objective #2

Prepare to Survive

- We are in the Anthropocene where human activity has taken us into resource consumption overshoot and our population is far in excess of being sustainable
- Predictions of a major population correction
- The only debate is when this correction will start, when will it stop, what is the end condition of humanity and Earth's natural systems.
- Some say we should acknowledge this inevitable adjustment. Prepare to survive
- This presentation advances one of many tools, microgrids, that has the potential to make individual or community power available prior to, during and after this population correction

Energy Transition:

A serious effort to electrify everything

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

Energy Transition:

Massive Scale > 200,000
aggregation

Example

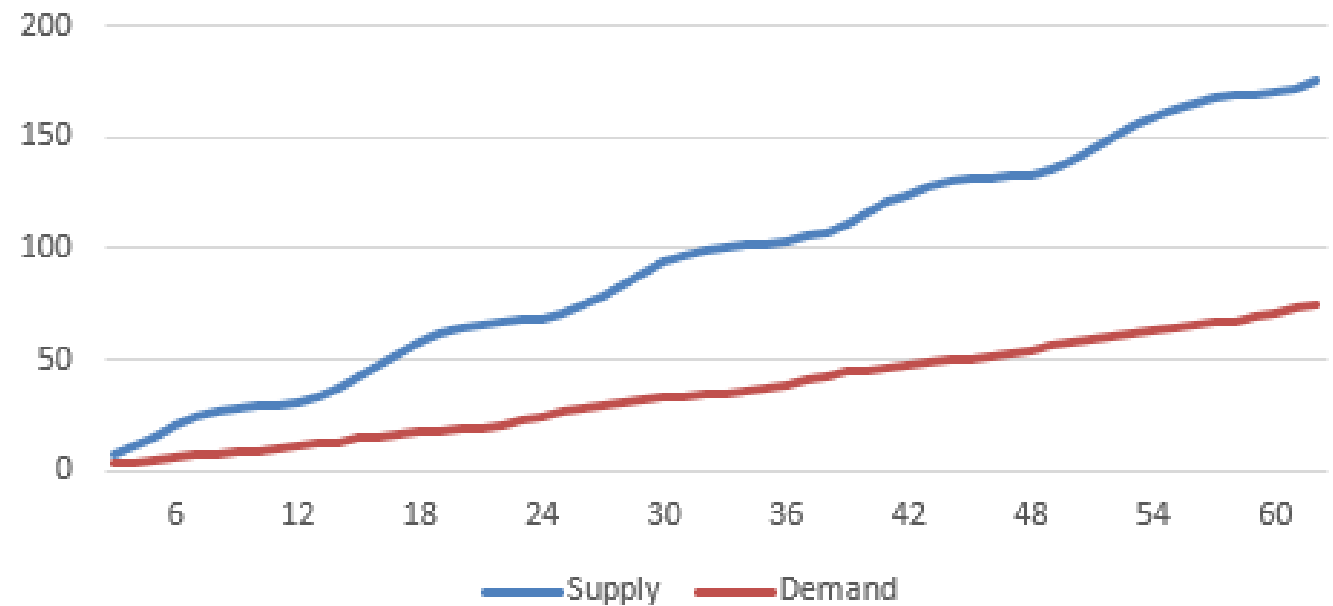
A builder plans 200,000 home microgrids using solar and zinc batteries

- Zinc batteries are cheaper than Lithium
- Homes made from recycled plastic and no lumber
- 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

\$27,510 ROI

Manotick Microgrid Cumulative MWh of Supply and Demand for 60 months



Energy Transition

and

Modernization

(how to deliver
“electrify
everything”)

- Aging infrastructure
- Demand is expanding with population
- Energy costs have strong growth pressures called fossilflation
- Reduce costs with an increase in resilience, and reliability
- Microgrid market in the USA expected to reach valuation of US\$206 Billion by 2031
- Many energy technologies are very mature

2022 U.S. Power Sector Outlook

The Renewable Energy Transition Takes Off

- With sufficient **storage**, renewable generation could meet as much as 94% of demand
- [DOE Invests \\$61 Million for Smart Buildings that Accelerate Renewable Energy Adoption and Grid Resilience | Department of Energy](#)
- EVs can be a grid resource, not just a new load
 - **vehicle-to-grid (V2G)** technology
- EVs penetration became more versatile, total expenses decreased significantly
 - Cutting energy consumption costs by **50–85%**

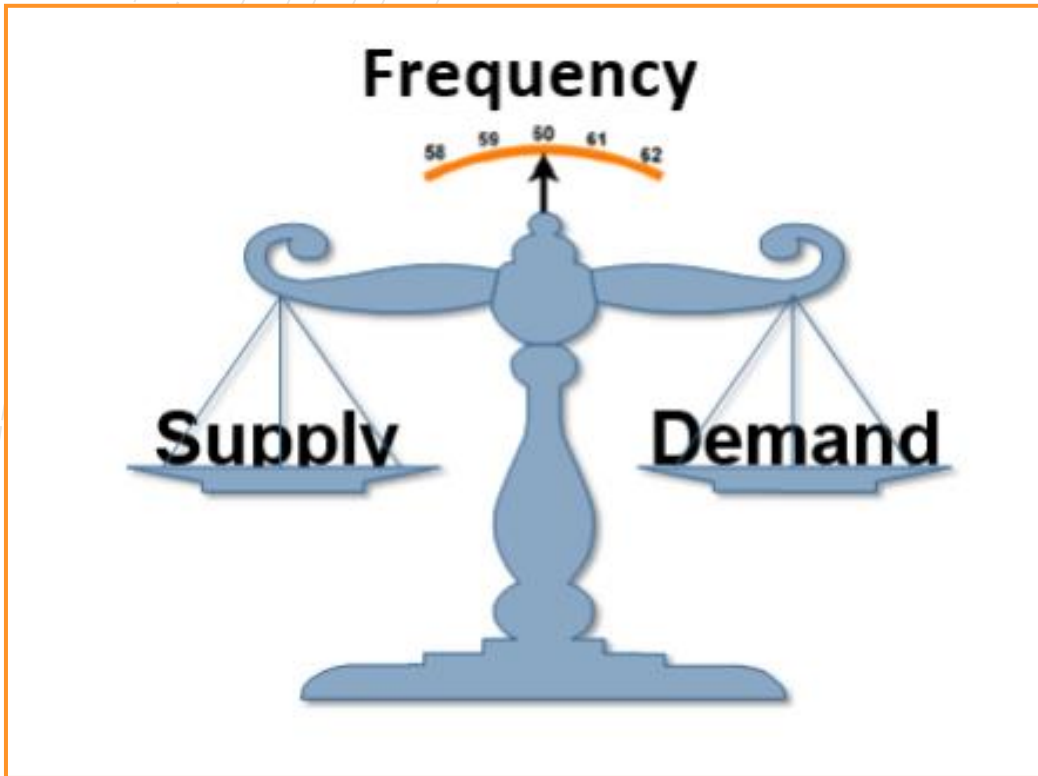
North American Grids: energy sources

- Three North American independent grids in Canada, USA and Mexico
 - East
 - West
 - Texas
- Over the past 130 years proved fragile but stable
 - Design 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
- Tidal, wave, bio, both fission and fast breeder Small Modular Reactors (SMR) are other competing power generating technologies

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 Mandate



- Deliver to every corner of the grid
- Demand varies constantly
- 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)



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

Role of Energy Management

- Energy Management can be convenient
- Lifestyle procedures quickly adjust, and waste is mainly eliminated
 - Hot water is an excellent example. The Manotick Microgrid routinely heats water 4 times a day
- It means prioritizing different loads
- Awareness leads to self-imposed energy waste avoidance

IESO DER Roadmap

(A microgrid can be a DER)

- **DER Definition:** **Distributed energy Resources (DERs)** are resources that generate energy, store energy, or control load and that are connected directly to a local distribution system
- **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 for DER integration

IESO Demonstration 2021 and 2022

- **DEMONSTRATION OBJECTIVES:** Demonstration in York Region to 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 not used as NWA, the DERs are expected to be available to support wholesale-level 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

The objectives of the Demonstration include: (part 1)

- Exploring the use of auctions
- Exploring models of coordination and interoperability between the IESO and a microgrid aggregator
- Demonstrating the interest of parties in participating in and the potential for the creation of a Local Energy Price
- Assessing the interest and ability of different DERs to compete to provide capacity and energy and reserve services through 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 the Demonstration include: (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 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

Grid Aggregation in Ontario

- On 1 April 2022, two 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

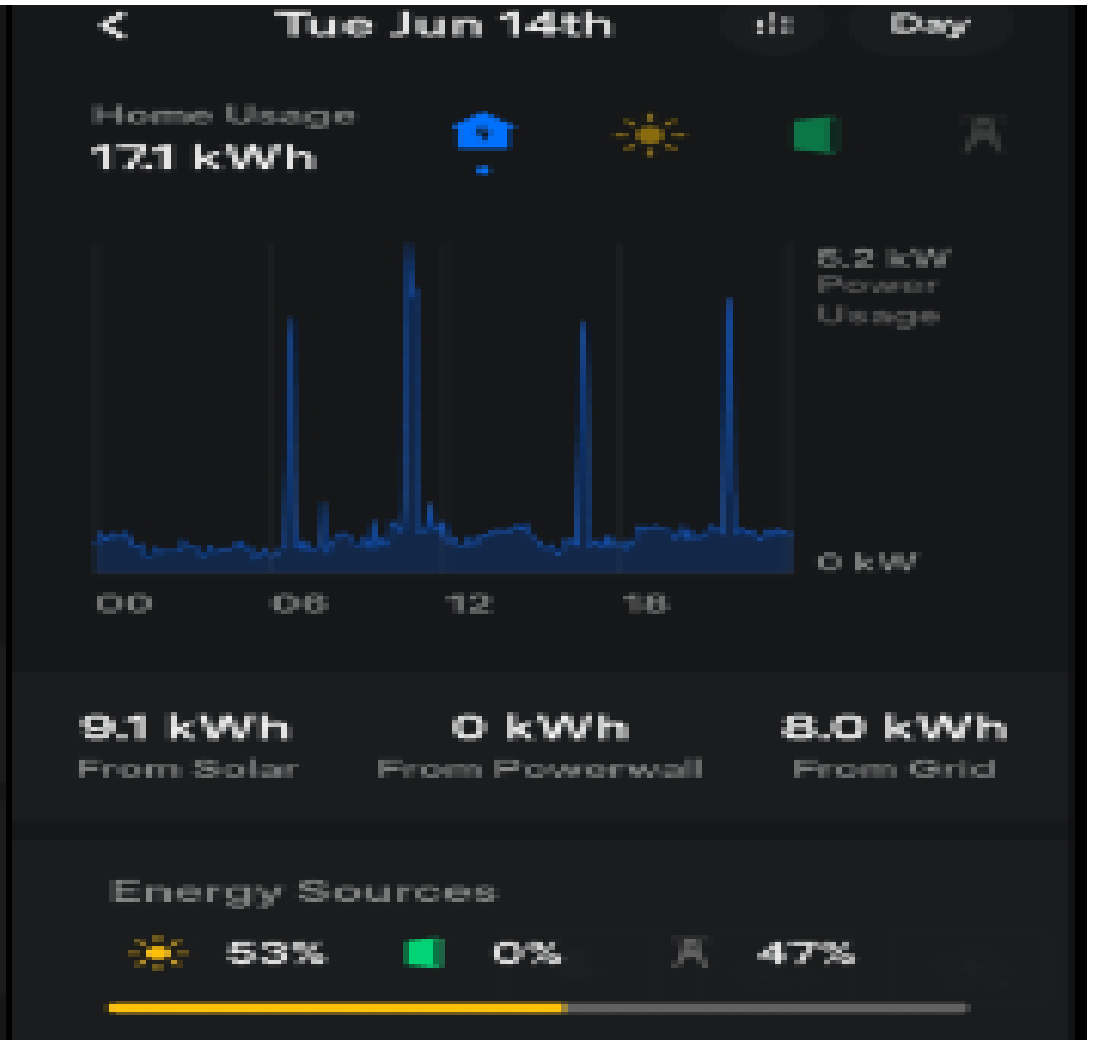
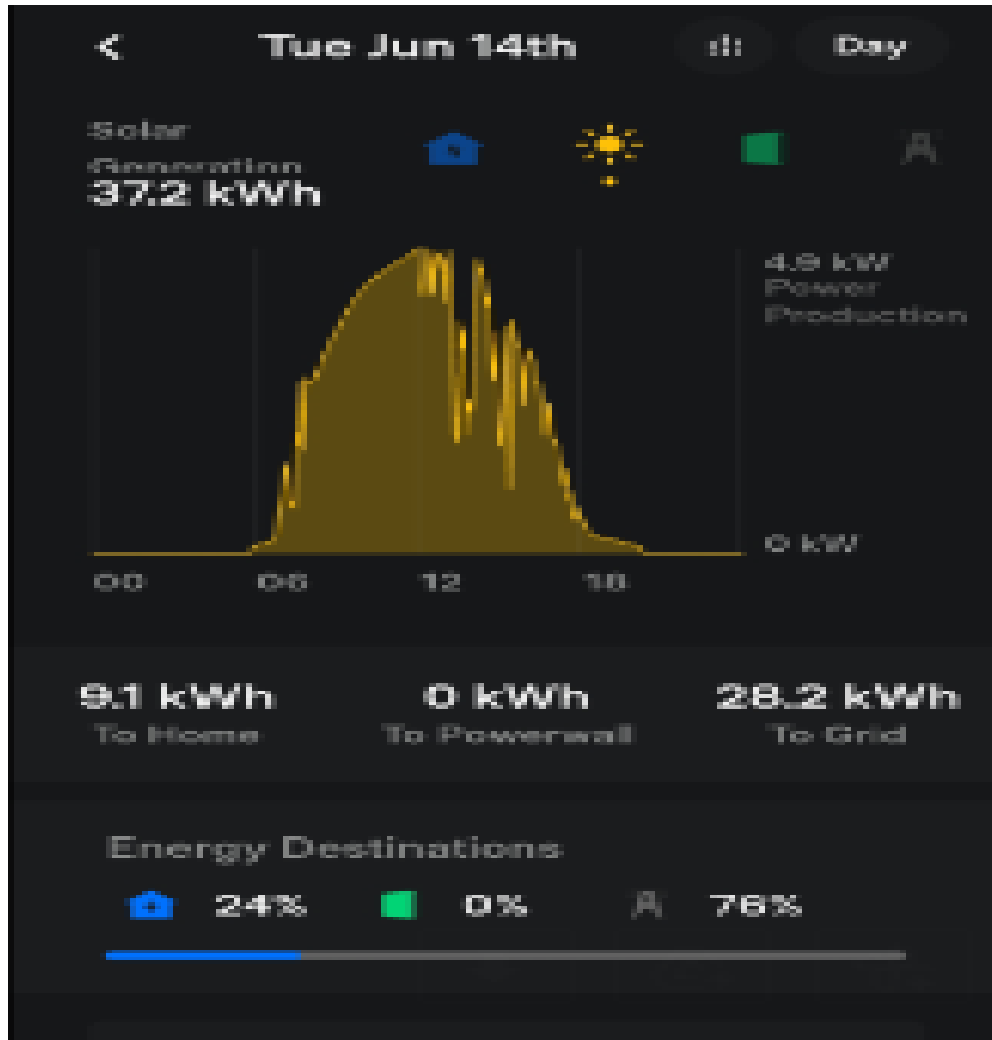
[New Project Exhibits Use of Aggregated Clean Energy for Utilities - Canadian Association for the Club of Rome \(canadiancor.com\)](https://canadiancor.com)

- The other project is run by Toronto area Enel X

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

Solar Supply

Home Demand



Grid with 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
 - Electrify Everything

Why the demand for Microgrids?

- A microgrid is a controllable self-sufficient energy system that serves a discrete geographic footprint in real-time
- They are electrical and thermal systems that permit individuals, communities, companies, and organizations to take control
 - **Economic and social benefits**
 - **Environmental benefits**
- The future of deeply decarbonized grids
 - combine technologies designed to generate round-the-clock, zero-emissions power with others that store energy for months.
 - Microgrids with V2G connectivity can assist the power grid with demand response and storage

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 connectivity.
- **May** have a contract with a Local Distribution Company to sell or store excess power

Describe Microgrid Details– part 2

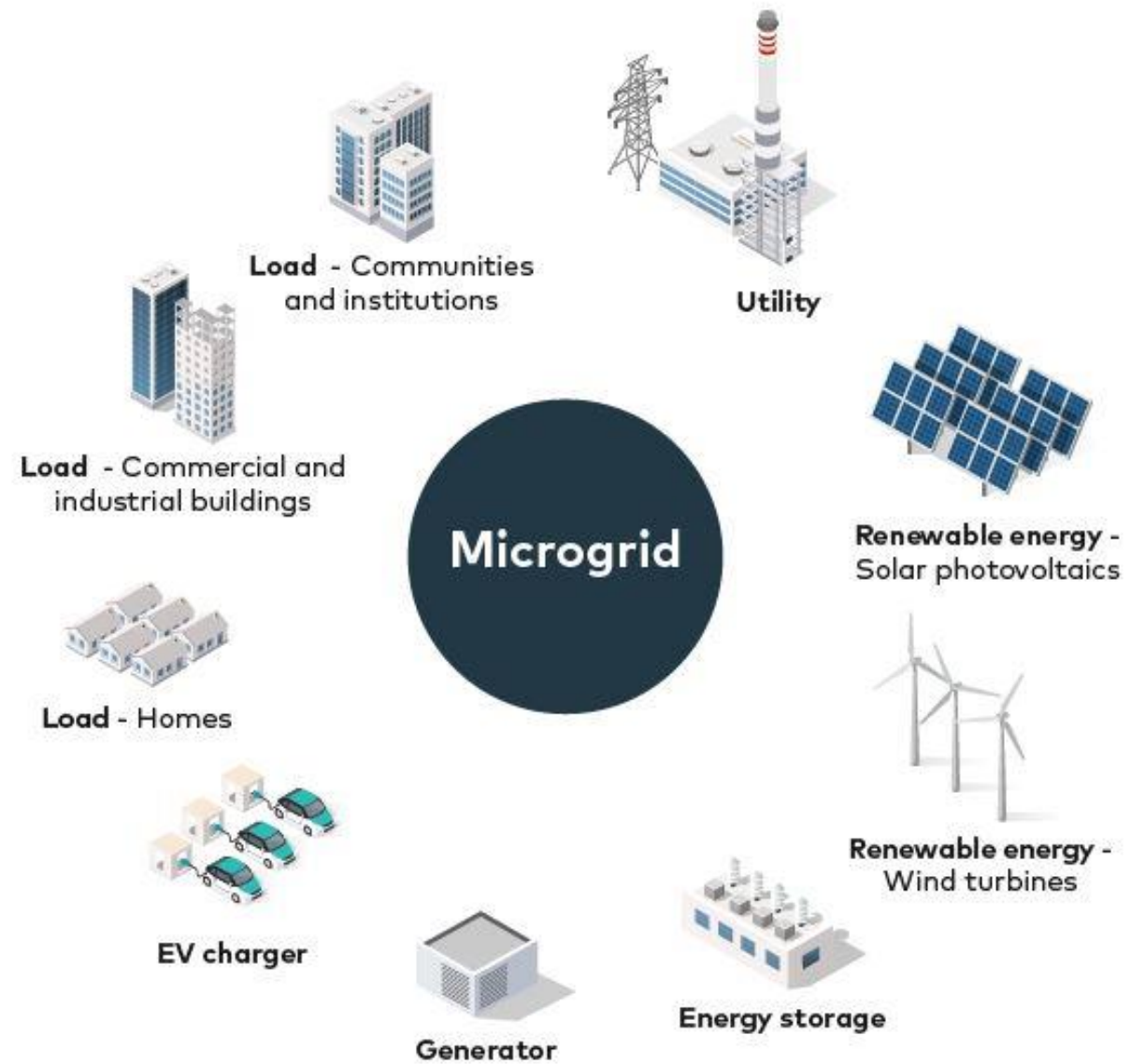
They are a Distributed Energy Resource – a Non-Wired Alternative

- May be R&D platforms
- Often Includes the ability to “island” - DER becomes a microgrid
- No such thing as only one microgrid configuration
- Many 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

Electricity Moderation Rates using Microgrids

- The age and condition of each utility's equipment
- The size of the utility service area
- Customer density, and location of customers relative to one another
- The number of residential customers compared to the number of businesses and industrial customers
- The geographic location of customers and the complexity of maintaining distribution equipment within the region. For example, it can be more costly to maintain equipment in more rural or cottage areas due to the terrain

What is a Microgrid ?



Microgrid Benefits (1 of 16)

Supply Reliability

1. A reliable microgrid vs unreliable grid supply

- Microgrids keep the power flowing immediately by disconnecting – or islanding – from the central grid when it begins to fail
- Goals and commitments are not the same as action and progress
- Often explained as “energy independence” or “self-sufficiency” or “energy security”

Microgrid Benefits (2)

Resilience

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

- 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 power production and storage technologies are used
- Microgrids intelligently integrate these renewables into the energy mix
- 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

Microgrid Benefits (5)

part 2

Wireless Solution

5. A microgrid strengthens the central grid

- Some studies consider the number of microgrids required 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

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

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) rates 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 energy use through management to reduce risk. Versatility is vital to graceful survival
- Intentional oversizing the generators and storage capacity provides 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 charge and a properly designed microgrid will stop energy poverty
- Overdesigned microgrids mean they produce more than they consume
 - Sell to the main grid
 - 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 demand
- 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 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 the Manotick 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 Earth
- 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 Earth
- 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 ‘micogrid’ 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
- 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

- Advantage of Proactive adaptation to climate change impacts
 - Current business as usual GHG growth 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 “replacements” and weather events shall soon be unaffordable and outages will be very much longer than a few days

Community microgrids

- Networks of off-grid home microgrids connected by a DC cable bus that loops through the neighborhood. This allows the homes to share their energy resources. These now exist or are under development in
 - Florida, Texas, California, Maryland, Illinois, and Utah with interests in other states
- The lead company wants to work with 10,000 customers by 2024, with the eventual goal of 40,000 customers. The company sees itself eventually becoming something like a national utility — a contemporary version — serving a network of off-grid systems
- [Original article](#)

The Energy Transition: How can Microgrids Help to Electrify Everything in Ontario's Power Grid

- Microgrids are an essential part of modernization of Ontario's power grid
- Verified business models shall be of great interest
- Cities and LDCs will have new command and control responsibilities
- Aggregations of buildings, fleets of electric vehicles, and communities into virtual power plants are expected to fully transform the electrical grid infrastructure

Reliable Microgrid Summary

- **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

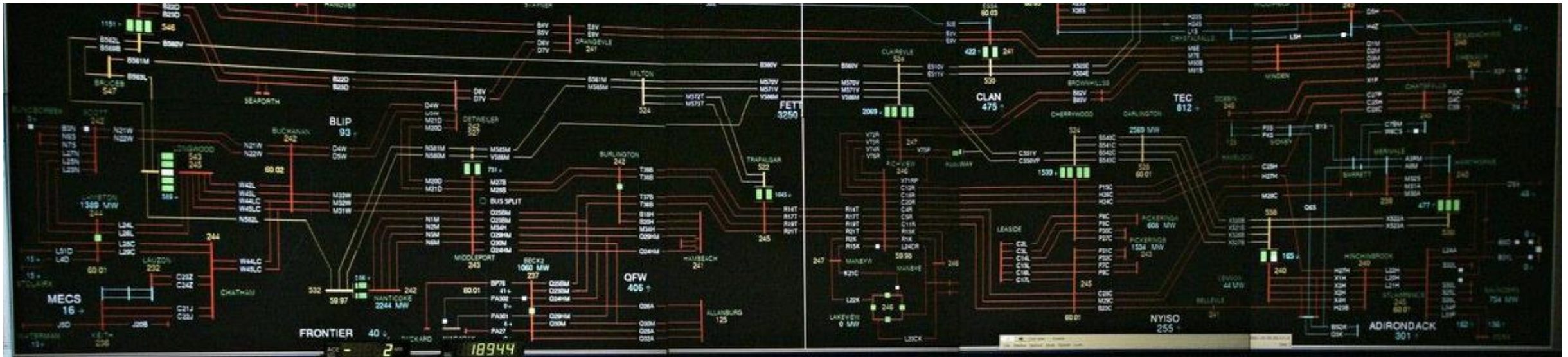
The Electrify Everything Transition

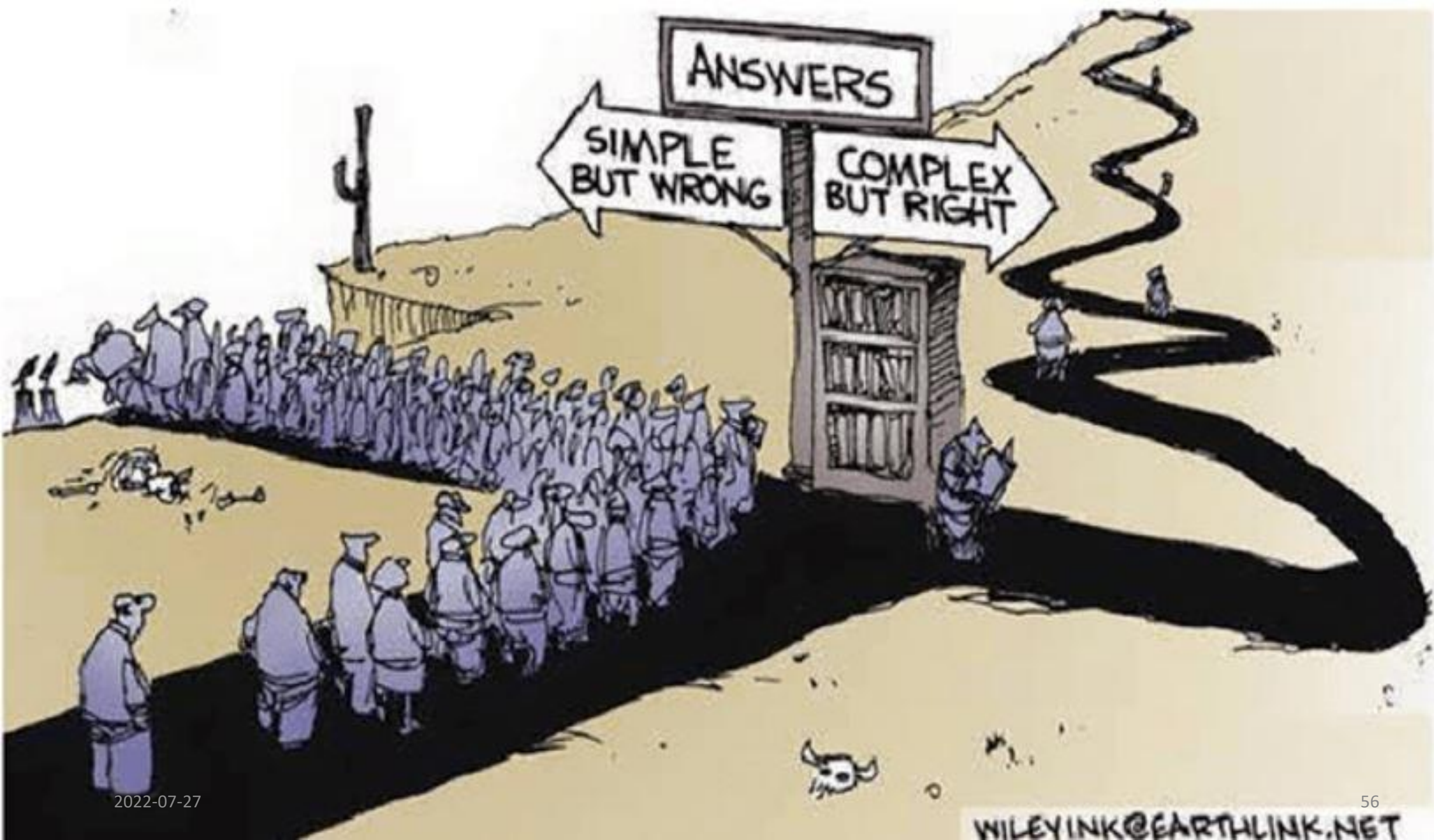
- Many market studies and some pundits are predicting
 - Massive investments from fossil fuels to renewables in the next decade
 - One pundit even suggested \$150 trillion in a “Great Market Distortion” starting soon
- Community adaptations using microgrids are encouraged.

- The 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 \(canadiancor.com\)](#)





GOCOMICS.COM/NONBEQUITUR

Grid Enhancing Technologies

- Permit more energy flow over existing infrastructure. Requires improvements in the technologies of
 - Dynamic line rating
 - depends on load and flow direction and existing designs
 - Advance control over power flows
 - Measurement, AI, supervision, fault awareness
 - Optimization of the system topology
 - Many options are available. Good news for disaster operations.
- Presently only considering options with a Benefit to cost ratio $> 4:1$
- New LDC infrastructure has set a local priority using NWA hardware

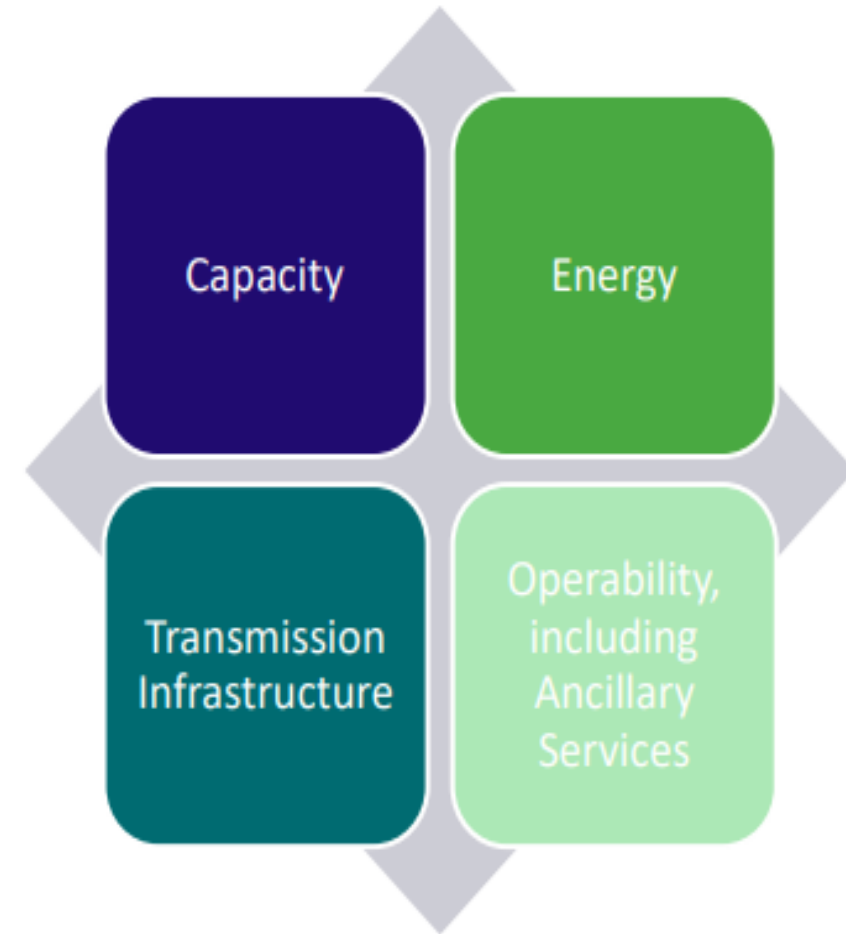
8 Survival Skills That Kept Native Americans Alive

1. Nature Has Everything You Need
2. Fathers: Teach Your Children how to survive
3. Live in Harmony with Nature
4. Waste Not
5. Make it Yourself
6. Enhance Situational Awareness
7. Blend In
8. Learn the Medicinal Value of Plants

Elements of a Reliable Electricity System

A reliable system must possess adequate:

- **Capacity**, to meet peak electricity demand at any moment in time
- **Energy**, to supply electricity demand over a period of time
- **Transmission Infrastructure**, to deliver electricity from generators along high-voltage power lines to load centres
- **Operability**, to be able to manage a variety of real-time conditions
- **Ancillary Services**, critical to reliable grid operation, including frequency regulation and voltage control



“Doomer” Argument

- Doomer’s Arguments:
 - Building microgrids (or whatever is proposed) will use massive amounts of fossil fuel produced energy, rare Earth metals and resources. There is not enough in the Earth’s crust.
 - Everyone of our 8 billion people can’t do this. There is not enough time or money.
 - The process of trying to save the planet with microgrids will accelerate the decline.
- My Doomer-Survivalist Comment:
 - Agreed, there is energy content in everything humans do and 85% presently comes from fossil fuels. Adaptation and mitigation are powerful microgrid outcomes. Prepare to survive by whatever means you are able.
 - Stopping consumption of Earth’s resources means stopping human activity. Population reduction seems to be the sole solution or we trigger total annihilation. It is NOT futile to prepare to survive especially if the disaster is already happening.
 - Investing in demonstration survival technologies will be carried forward by those who survive the inevitable decade long big population corrections (famine, national unrest, pandemics, increasing frequency and intensity of disasters, sea level rise, wars). We need to help subsequent generations adapt to nature’s cycles during and after these population corrections. Prepare to survive immediately.