

The Energy Transition:

How Microgrids Can Help Rapid Modernization of Ontario's Power Grid
Through Electrifying the Economy and Decarbonizing the Power Supply

by Art Hunter Ph.D. art.cacor@gmail.com

[Canadian Association for the Club of Rome \(canadiancor.com\)](http://canadiancor.com)

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

Legitimacy - Home and Community Matter

A livable Climate, Shelter, Water, Soil, Safety and Energy are essential to physical wellbeing. Humans have become addicted to electricity as it has become vital in order to be safe, independent and secure with survivable resources in a shelter. Community cultural and social activities follow once safety is secured

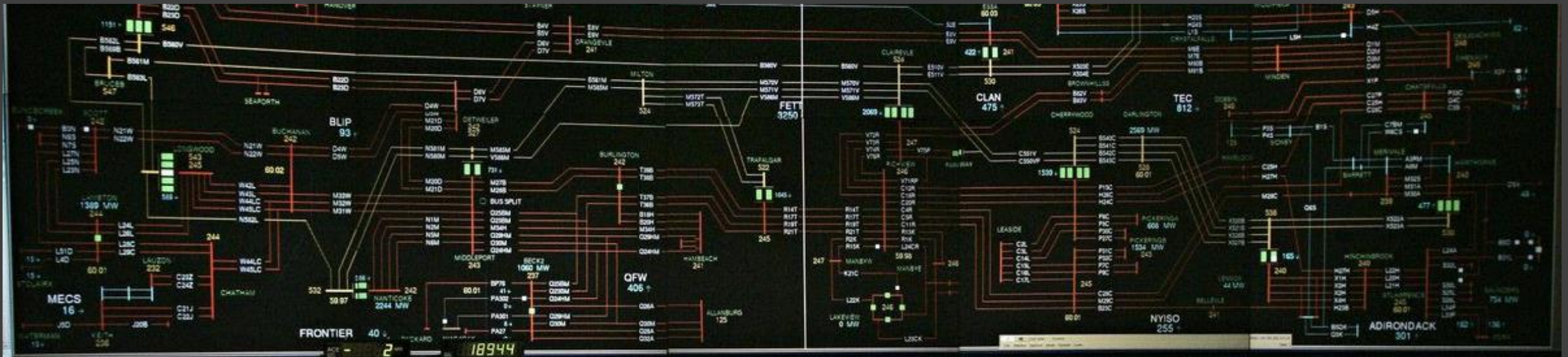
"To call these things sacred is to say that they have a value beyond their usefulness for human ends, that they themselves become the standards by which our acts, our economics, our laws, and our purpose must be judged. No one has the right to appropriate them or profit from them at the expense of others. Any government that fails to protect them forfeits its legitimacy." Ref: Starhawk; from "The Fifth Sacred Thing."

Instead, our neoliberal economic system is wrongly based on growth, profit and consumption:

"Earth's dominant cultures, value affluence, economic growth and corporate profit above all else"

"No amount of profit is enough even in private healthcare"

"What we can do for ourselves and each other is **have plans in place** so that if something does happen, the level of chaos and fear can be reduced, and we can all be there to help each other through"



IESO Command and Control Center



Expand Microgrid Use Mission Statement

- Use less energy and generate local renewable electricity integrated with storage and utility grid networks to encourage social behaviour change, reduce health risk, and advance energy security, resilience and reliability with substantial cost and consumption reductions. Attempt to expand microgrid use as a super-tipping point ecosphere affordable saviour based on evidence-based decision making, grounded in science and Indigenous knowledge

More fun, less stuff



What is a Microgrid ?

Unique design and operations with interconnected parts

One generator or more, some load or all of these parts make up 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”. Apartment owners and others can still participate by owning shares in [community-owned renewable energy projects](#)

A microgrid can exist without a connection to the grid and it 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. An energy lifeboat



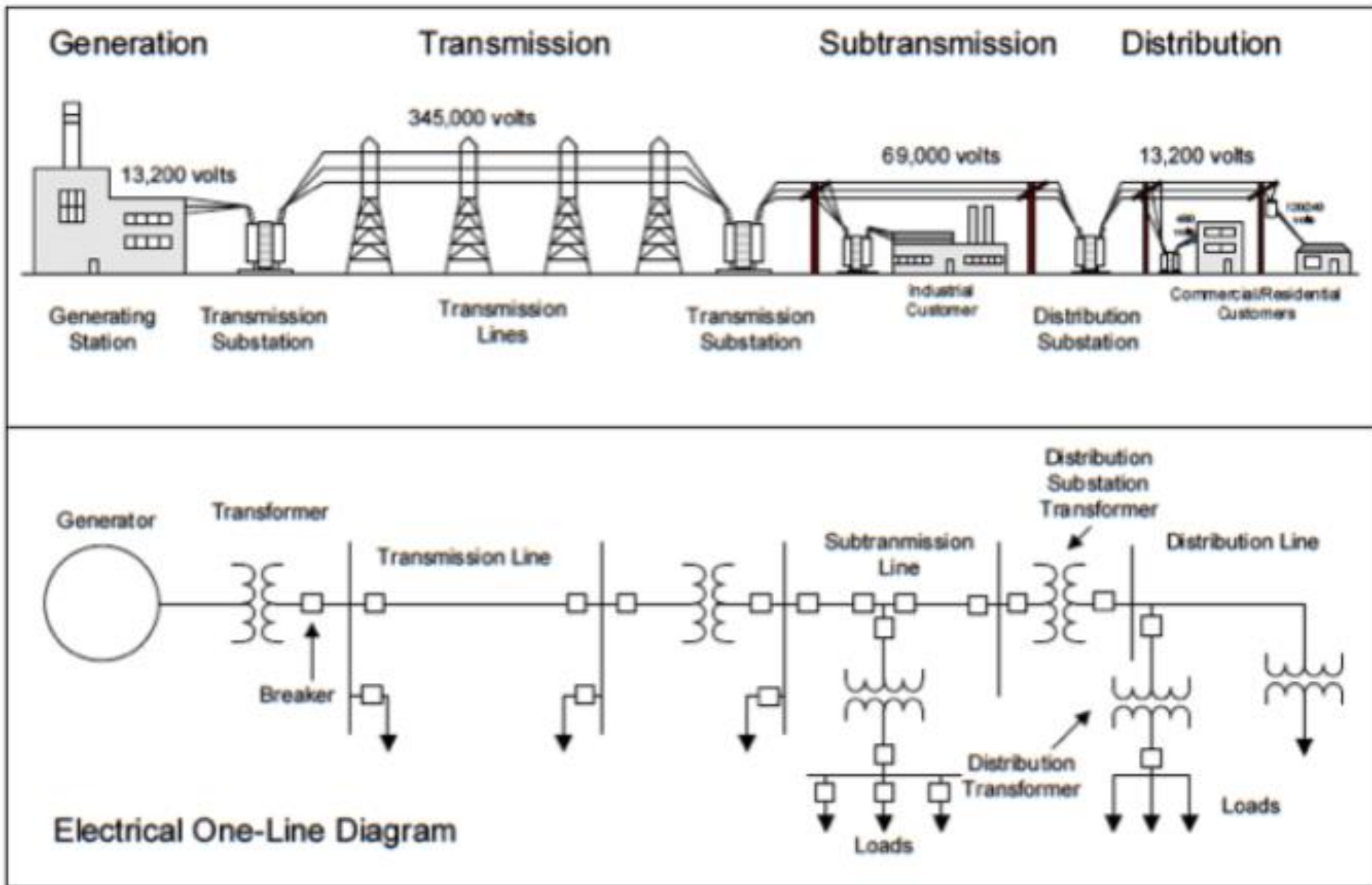
Government and Other Positions on Renewables

- There is renewable policy support with:
 - The federal government [Clean Electricity Standard](#)
 - Most provincial governments and utilities
 - City governments
 - Healthcare providers
 - Citizens
 - Many Industries
- But the very profitable fossil fuel industry lobby is successfully pushing to delay by taking advantage on individual's reluctance to act on facts
- Electricity is the lifeblood of society (agriculture, water, shelter, transportation, health, safety, happiness, communications-entertainment, industry, education), and our tolerance for outages is lower than ever: a growing disparity

The Purpose of this Presentation

System not Silos -
Liberation

- Purpose: To State the Characteristics and Advantages of Microgrids
- Microgrid hardware is already commercially available. The outstanding issues are regulations, appropriate business models, management, financing and deployment scaling
 - The homeowner should not have to finance retrofits and microgrids any more than they are not asked to directly finance the next power plant
- Adaption means: Actions that reduce functional loss and damage from actual or expected climate change threats, while taking advantage of potential new opportunities to thrive (liberation)
- Grid power outages are disasters while microgrids are a pathway to deliver reliable pre-disaster non-emitting energy and instant disaster relief to communities (Energy Liberation and Freedom)
- Traditional electricity utilities, electrical vehicles, and microgrids are strongly linked as an energy system rather than 3 separate silos



1/2; Typical electric power system single-line diagram Beneficial Microgrids

Ontario Grid Component Parts

• Substation transformers	3,238
• Transmission Lines (using metal towers)	23,000 km
• Distribution transformers	1,102,000
• Distribution Lines (often with wooden poles)	60,000 km
• Power poles	10,850,000



- What could possibly go wrong with this widely dispersed aging infrastructure?

Grid Damage with Climate Change

- High winds, wildfires, freezing rain, mud slides, floods, tornadoes, hurricanes, droughts and other weather extremes are well known to cause widespread damage and power outages
- Increased temperature shortens large power transformer lifetime
- High temperatures reduce transmission line power capacity
- High temperature and moisture encourage rate of decay at the base of wooden poles
- Vegetation growth with lengthening growing season require changes to vegetation resilience management

U.S. utilities spending less to produce power, more to deliver it

Annual costs of major U.S. utilities by category

Cents per kWh in real 2020 dollars

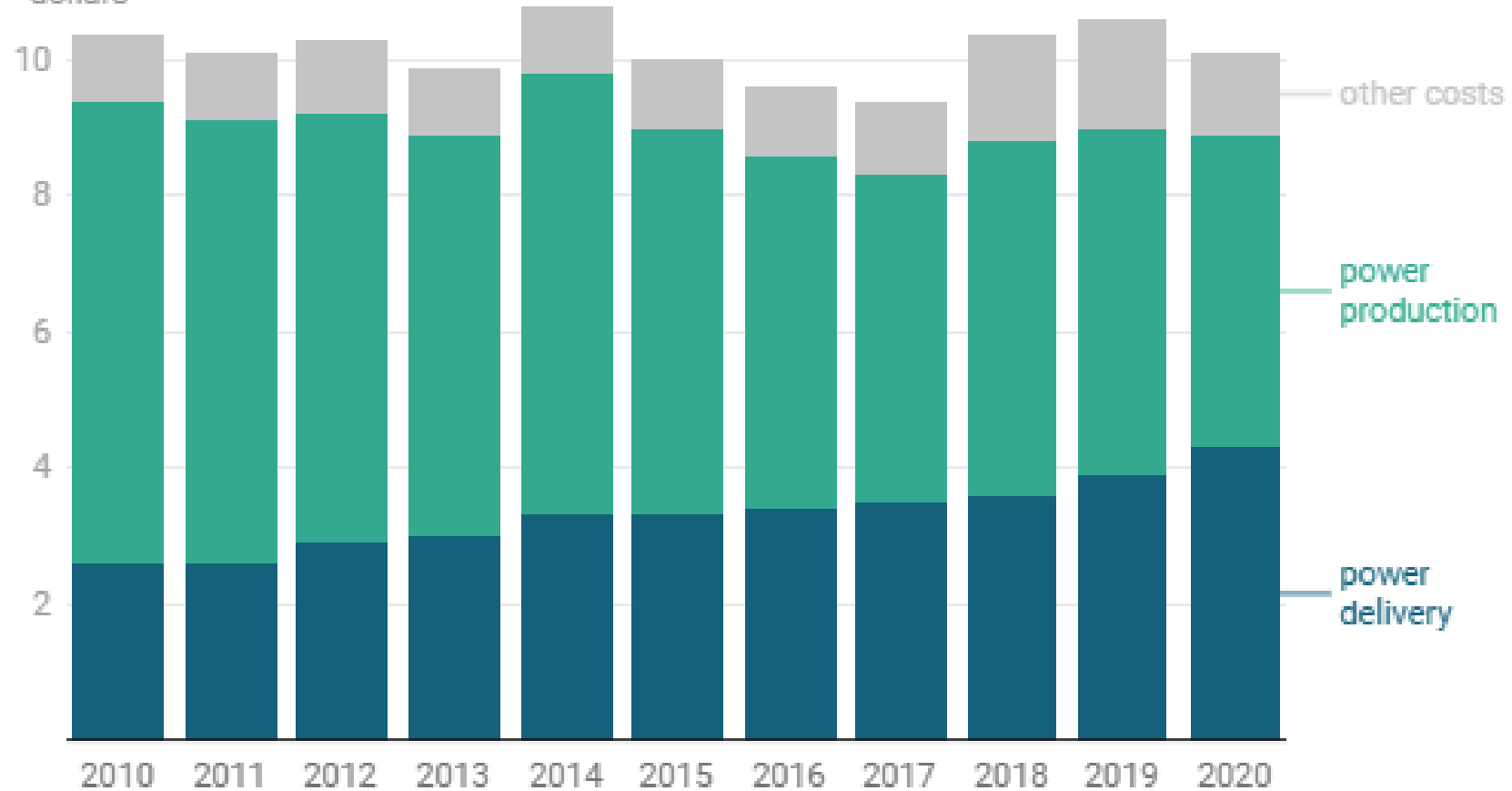


Chart: Canary Media • Source: [FERC via EIA](#) • [Embed](#) • [Download image](#)

Beneficial Microgrids

Energy Transition to Include Microgrids



- The centralized, fragile and antiquated electricity grid is the traditional supplier of electrical energy
- Four main Energy sectors:
 - Traditional Electrical Grids with central power generation
 - Buildings (loads)
 - Heating and cooling
 - Lighting
 - Appliances and specialty demands (communications)
 - Industry – broad spectrum of energy loads
 - Transportation of people and goods
- Microgrids can support supply liberation to all four categories at a local building or community scale – perhaps > 500 homes
- Microgrids and Energy Communities (linked microgrids sharing resources) will minimize transmission and distribution (T&D) losses, significant delivery and substantial capital cost reductions

Energy Transition to Include a Feasibility Study

- An interconnected network for electricity delivery from utility producers to consumers over a wide area is known as an energy grid. A microgrid is a scaled down version of an energy grid; it operates on a local scale to connect businesses and homes to nearby energy resources such as solar panels, generators and battery storage
- Feasibility studies assess how to power communities or selected portions using microgrids. These studies, driven by a set of design requirements, identify design options, costs and schedules
- Microgrids have the potential to help communities become more resilient to power outages related to extreme weather or other grid service interruptions, reduce energy costs, and transition towards 100% renewable energy
- The design authority often coordinates the disposition of the recommendations with all stakeholders prior to initiating the formal system development

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 harvesting sunlight and using battery storage
- Adds about \$20,000 to the cost of each house.
 - [Link to original article](#)
- The right combination of distributed solar-plus-storage systems can reduce the costs of getting to a 100 percent carbon-free grid [by tens of billions or even hundreds of billions of dollars](#), compared to relying solely on utility-scale clean energy and batteries and high-voltage transmission grids.

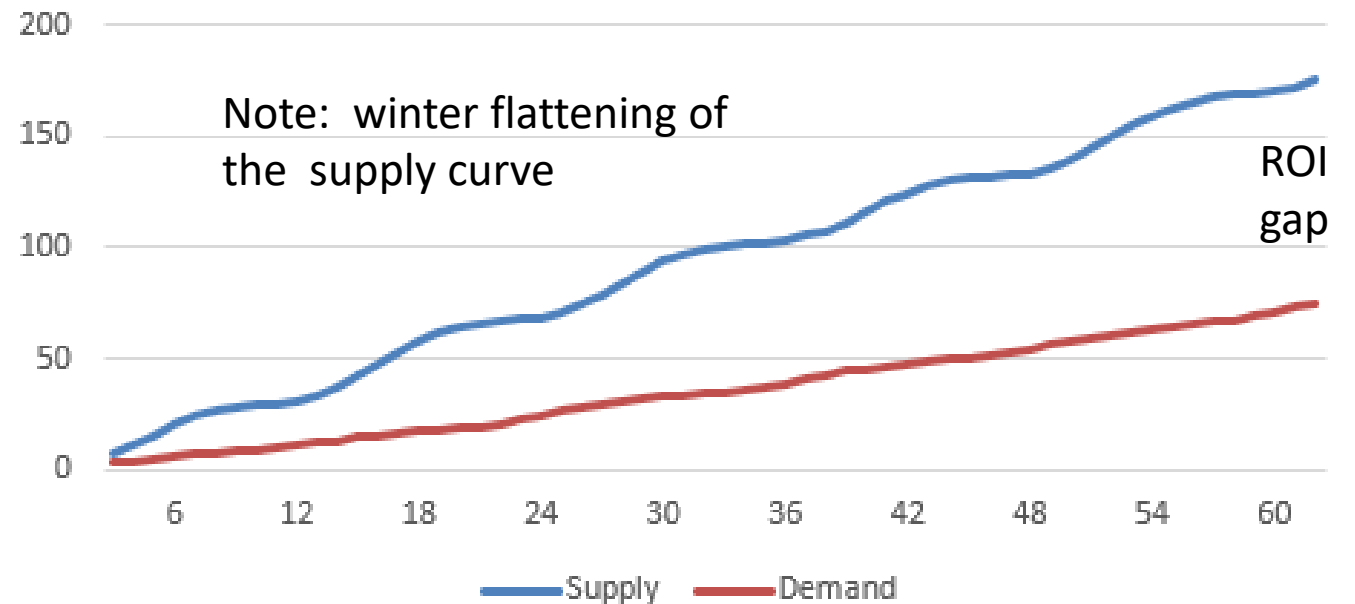
Performance of the Manotick Microgrid

(solar, batteries, heat pump, EVs)

\$27,510 ROI

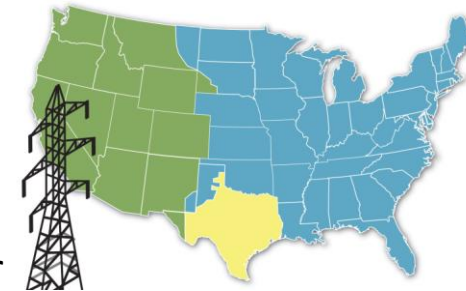


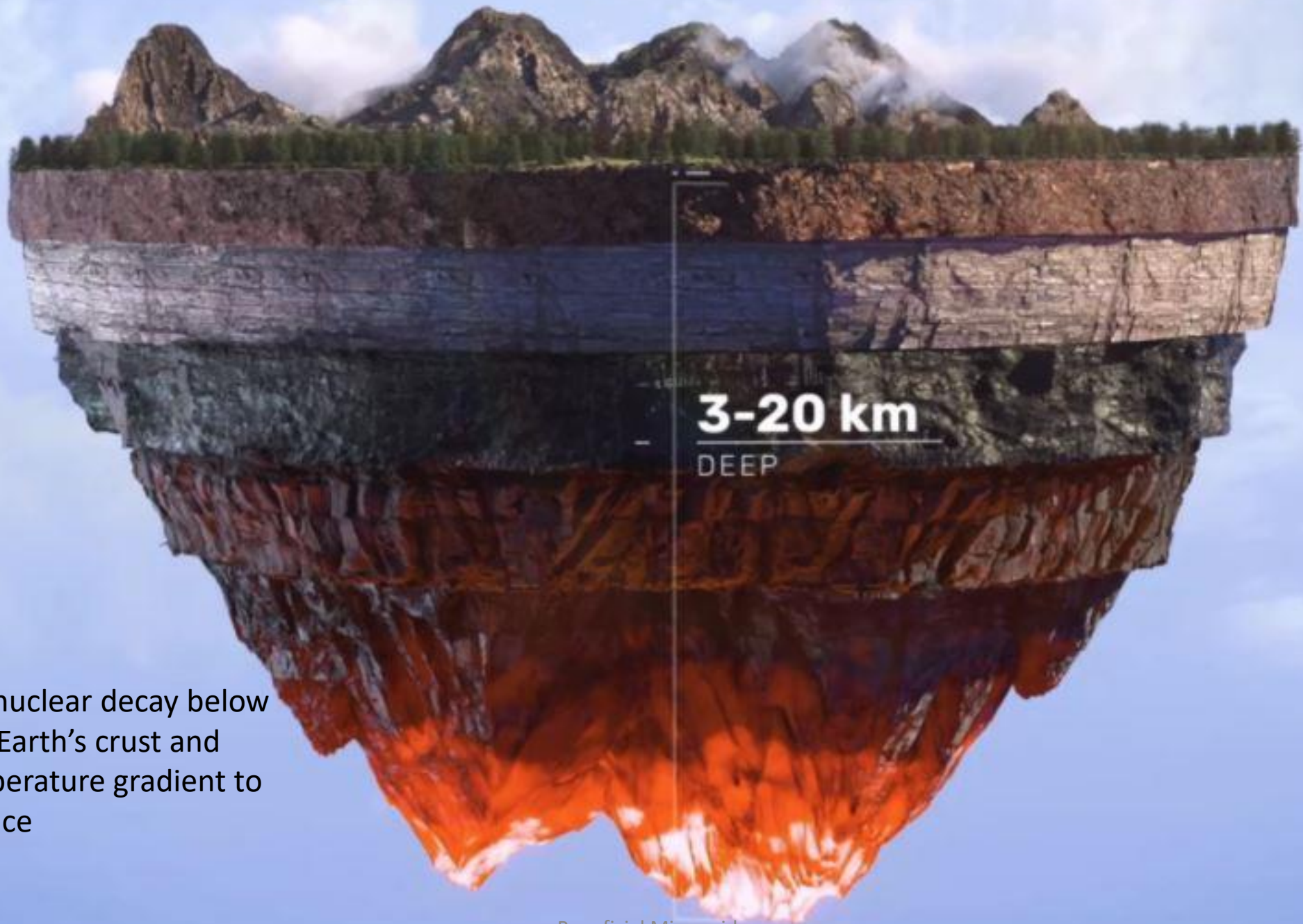
Manotick Microgrid Cumulative MWh of Supply and Demand for 60 months



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
 - New designs and repairs should be based on weather projections for 30+ years
- 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](#)) and Micro Modular Reactors (MMR) are other non-emitting power generating technologies





Hot nuclear decay below
thin Earth's crust and
temperature gradient to
surface

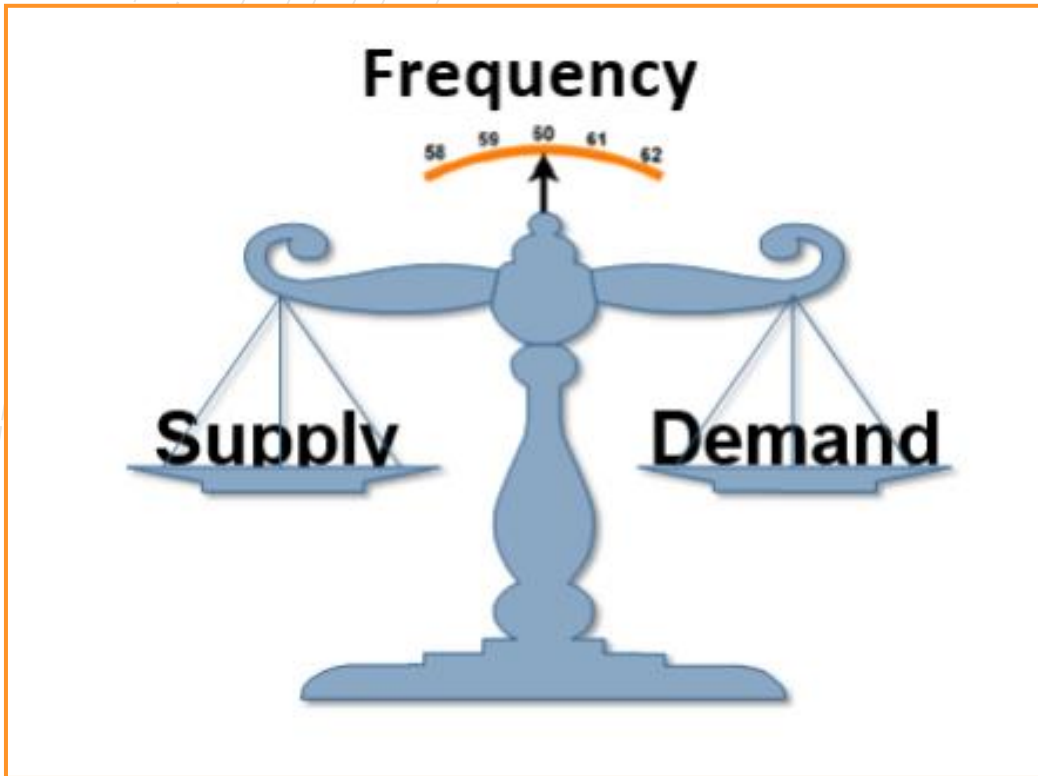
Thermal Battery – Svec Coil, May 2018.
Leda clay is an aquitard
– note vertical trench walls



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 transmission tower lines to Local Distribution Companies
- Local Distribution Companies (LDC) – 78 in Ontario. Each has its own local management and distribution network to its retail customers

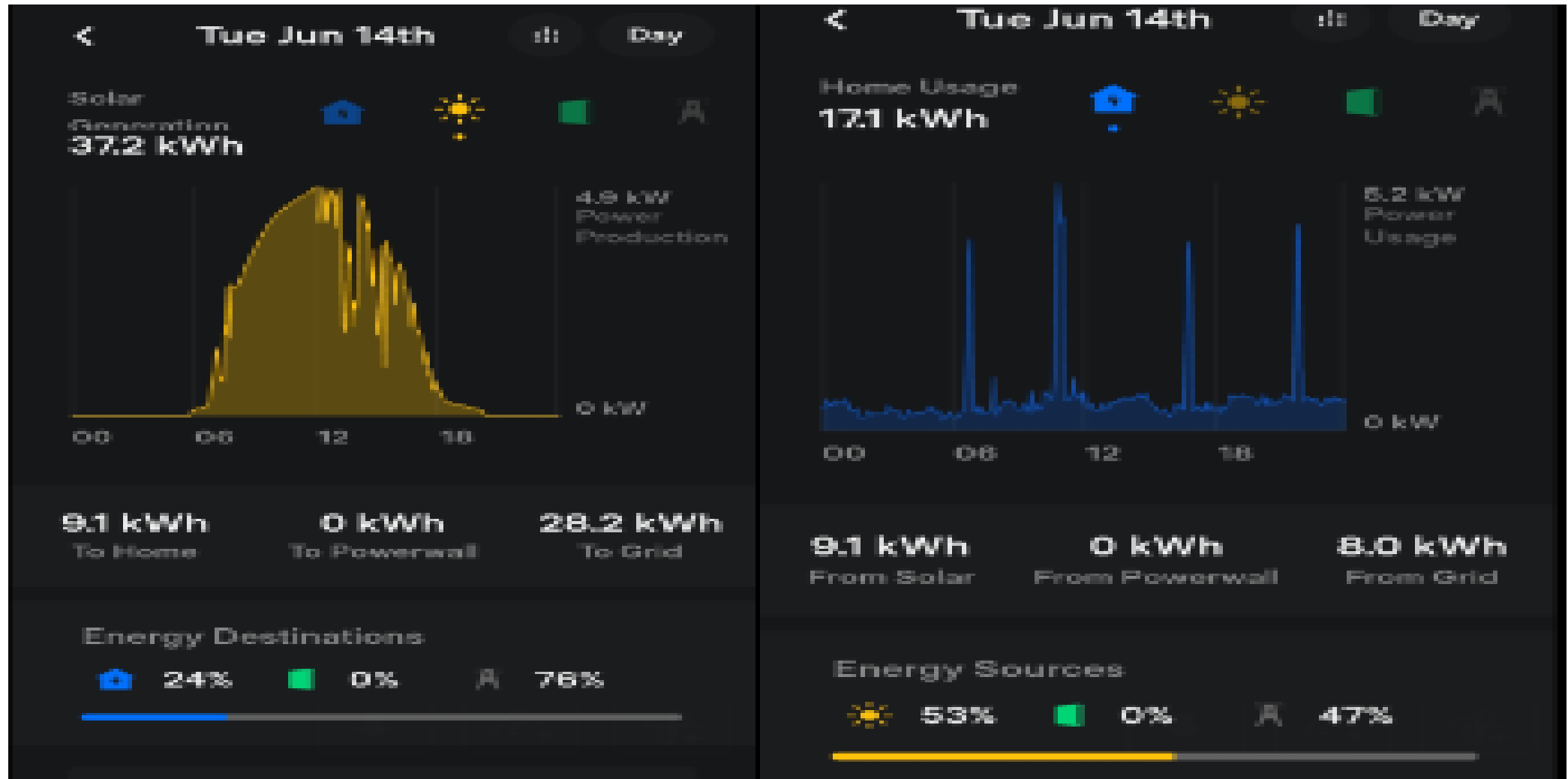
Grid Managers Balancing Flexibility and Response



- Deliver energy to every corner of the grid with a supply that exactly meets the demand (both supply and demand intervention flexibility)
- Demand varies constantly by time, community end users and building functionality. While a handful of power plant owners are paid to keep the grid operating, millions of homeowners were paid nothing for energy conservation when asked
- Microgrids can work as a helpful tool to the IESO and LDCs as ancillary balancing services using Distributed Energy Management Systems (DERMS)
 - Use as peak load sources and storage
 - Short term solution is to vary the local frequency (millihertz)
 - Or to vary the delivered voltage (millivolts)

Solar Supply

Home Demand



Actual solar supply (37.2 kWh) compared to actual load demand (17.1 kWh). Excess (28.2 kWh) stored on grid

Delivery Speed Flexibility



- Supply must keep up to demand but supply switching 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 are common
- [home-load-vs-microgrid-solar-supply standard](#)
- Special arrangements with big industry on phased demand 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
- **Savings:** Once deployed, the savings outweigh the deployment of DER assets
- **Contract Terms:** DERs currently participate in the IESO's wholesale market with more than 20 billion dollars in transactions settled annually. 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). These are serious big dollar transactions.



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
- **May** be R&D platforms
- **Often Includes** the ability to “island” - DER becomes a microgrid

Describe Microgrid Details– part 2

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

- No such thing as only one microgrid design and configuration. Many microgrids may be interconnected to make a micro-utility
- Many global jurisdictions are well advanced in integrating microgrids with their grids to stop making demands on Nature's resources
- Used electric vehicle batteries (degraded instant high current production) become a microgrid-storage resource (requires lower instant current production)
- Space solar farming as a DER concept is [being tested](#).
- Geopolitics of the EU – Russia energy adjustment is providing the political will to speed [innovation and deployment](#).
- [MICROGRIDS NOW on Vimeo](#)

Wind and Solar Hybrid DER



Microgrid Benefits (1)

Supply Reliability

power is there when we need it

greater energy independence

fossil fuel liberation

1. A Reliable Microgrid and an Unreliable Grid

- Canada's aging electrical infrastructure investment is \$235 Billion, and climate induced outages cost \$12 Billion in repairs per year. There is also the cost of outages to the customer. Grid outages are common and can have very widespread geographic reach
- Extremely reliable microgrids keep the internal lifeline power flowing immediately by automatically disconnecting – or islanding – from the central grid when riding through and recovering from power outages
- Often explained as “energy independence” or “self-sufficiency” or “energy security” or “fossil fuel liberation” delivering safety and accessibility
- Solar panels for harvesting sunlight have just a 0.05% failure rate when it comes to reliability and lifespan
- Lithium-ion batteries and solar panels can have a lifetime of about 40 years with limited aging degraded performance
- Microgrids serve as a **sustainable**, affordable alternative to the unreliable and highly vulnerable vast power lines of central grid systems currently in place

Microgrid Benefits (continued) (1)

Battery Reuse

1. A Reliable Microgrid and an Unreliable Grid (battery reuse)

- Lithium-ion batteries have a lifetime of about 40 years with limited aging degraded performance (maximum charge retention and maximum rate of discharge)
- Battery reuse:
 - EV demands are for high electrical current (battery discharge) to give instant torque to the wheels. When this drops off, then the battery cells are totally reusable for:
 - Microgrid energy storage
 - EV Charging station storage
 - Last option is to recycle to recover the valuable minerals

Microgrid Benefits (2)

Resiliency

Means **anticipate**, absorb, accommodate, and recover stronger from the effects of a power outage

2. A Microgrid Enhances Resilience and Liberation

- Resilience describes the ability to avoid power outages, adapt and recover stronger to support safety, a secure shelter, electrical energy production, food storage and food preparations, water supply, health status, transportation, and communications. It is the ability of a physical, social, or ecological system and its component parts to **anticipate**, absorb, accommodate, and recover stronger from the effects of a power outage in a timely and efficient manner
 - Transforms a passive user into an active participant that thinks differently about energy and welcomes opportunities to strengthen designs and procedures based on measurable sustainability ideals and initiatives
 - Expand new opportunities to deliver energy to emergency services (hospitals, fire station, police suggestions) using EVs and their mobile batteries
 - Optimized interaction of EVs with the electric grid by tracking the connect time, power level usage and location
- [\(5\) WEBINAR: Solar Generators in Ukraine: A Case Study on Resilience - YouTube](#)

Microgrid Benefits (3)

Lower Energy Cost
improving electricity affordability

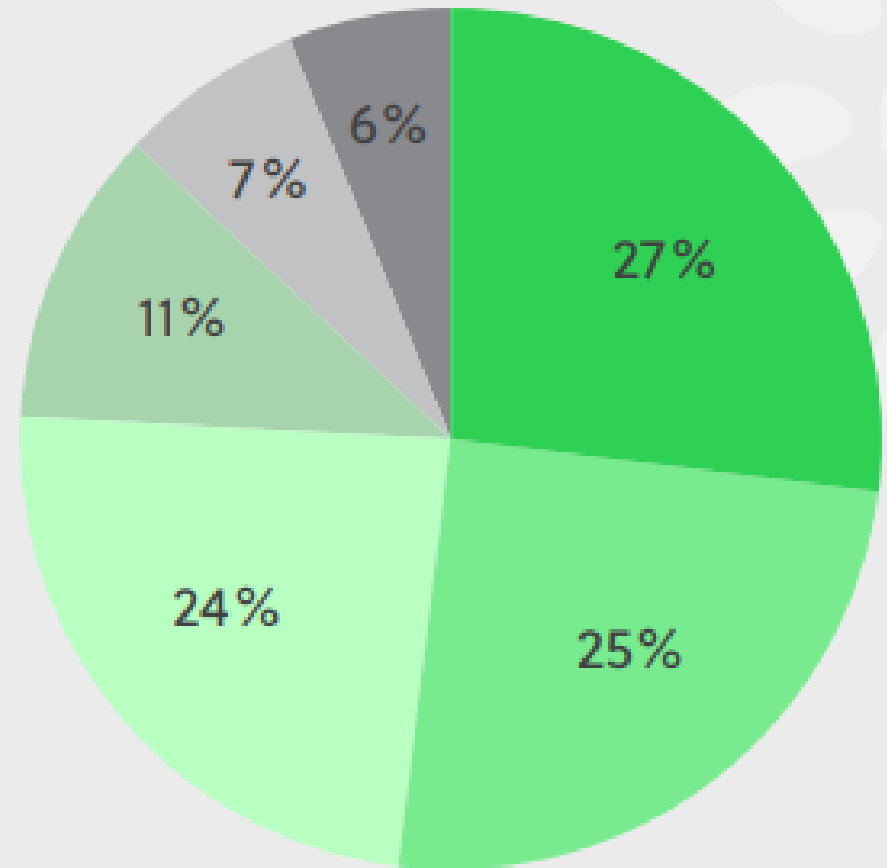
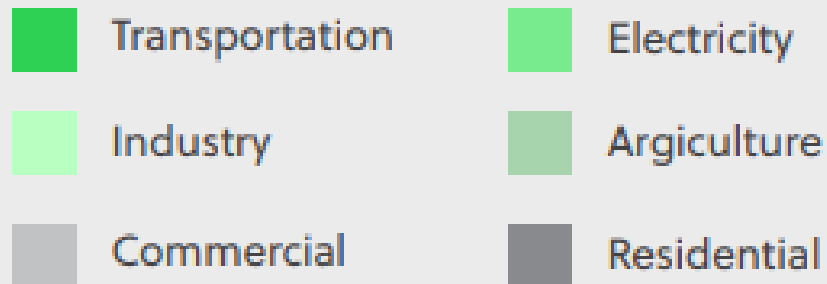


3. A microgrid can lower energy costs for consumers and the grid managers

- The City of London calculated energy costs at over \$2 billion. That figure represents a significant economic development opportunity to reduce/generate energy locally. Microgrids deliver efficient management of supplied energy. Clean energy is now the safe, smart bet for conservative investors
- Rapid transition to 100% clean energy is the [cheapest of all possible energy futures](#), yielding US\$12 trillion in savings by 2070.
- Becomes a unifying stakeholder organization for:
 - Utilities, Municipal planners, Emergency Responders, Community Groups, Special interest organizations
- An owner/operator of a microgrid can be a utility, homeowner, community, campus, building owner or other organization who can use it to isolate from price volatility while reducing emissions and saving customer's money.
- Community ownership permits the community to decide on the next phase of system management, expansion or improvements
- By 2029, solar and wind energy could be the cheapest in the world at less than \$2 per megawatt-hour (2 cents per kWh)

Microgrids Can Deliver Benefits in all Sectors

2020 U.S. GHG Emissions by Sector



Source: EPA

Microgrid Benefits (4)

Clean, Green & Sustainable

4. A microgrid improves the environment and promotes clean sustainable energy

- Sustainable green power production and storage technologies are used
- Some Utilities have implemented a robust day ahead and real-time energy market using DERs with centralized dispatch has demonstrated reduced energy costs by hundreds of millions of dollars each year. Extending this to microgrids < 1MW is included in grid modernization plans
- Large (>1 MW) Microgrids are used to meet on-site electricity demand, fulfill local grid electricity needs (i.e., non-wires solutions) and provide wholesale market services (i.e., capacity, energy and ancillary services)
- Microgrids provide the intersection of professional judgment, energy management, behaviour and ecology in preparing for the future through sustainable community building

Microgrid Benefits (5)

Wireless Solution



5. A Microgrid Strengthens the Central Grid

- They act as an additional easily expandable local supply resource that grid operators can call upon as required
 - microgrid controller should be able to
 - accept control commands
 - engage in site wide area optimization
 - report its own health
 - provide historic performance
- They avert the need to build and repair more distant power plants and vulnerable transmission lines (estimated at \$3 Billion/year in Ontario)
- Most electrical energy is used almost immediately after it is generated into nearby loads (roof panel to kitchen toaster). Decentralized energy without use of transmission and distribution lines
- [\(13\) Transactive Energy and Community Microgrids via Blockchain Technology - YouTube](#)

Microgrid Benefits (5)

Wireless Solution



5. A Microgrid Strengthens the Central Grid (2)

\$165 billion

The [cost of damages](#) from a massive hurricane, a historic drought, and 16 other major disasters across the US in 2022. (includes grid repairs)

Threats, Adaptation and Demand Growth

- Projected Electricity demand increase is up to 30 per cent by mid-century. Microgrids can grow in number and capacity
- The damages to electrical transmission and distribution infrastructure will decrease the reliability of the electricity system as more of those components will fail more often, leading to more frequent outages. It is certain that costs will increase dramatically as electricity is essential (lifeline) for shelter, safety, appliances, food, water, health, heating, cooling, communications, education and transportation
- In practice, appropriate adaptation measures would also increase the reliability of the grid, which will reduce interruptions in critical services like water supply, medical care, and telecommunications caused by power outages. There are also the associated costs of cascading economic and social disruptions
- Microgrids are considered a viable pathway to address this critical issue

Microgrid Benefits (6)

Cybersecurity

6. Microgrid cybersecurity, Energy Security, and Emergency Response

- Experts are concerned about grid vulnerability to intentional attacks
- Security, affordability and sustainability are very strongly linked in a microgrid
- Security may require crate-sized mobile microgrids that deliver power to command centers, neighborhoods or campuses isolated from the Internet
- Effective cyber attacks on microgrids would be rendered increasingly difficult as target numbers increase (say 200,000 microgrids) with different firewall designs

Microgrid Benefits (7)

Social Value

7. A Microgrid Brings Social Value

- A community microgrid is not using power from a plant hundreds of kilometers away. It is the stakeholder closest to customers
 - 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. They will empower microgrid managers to react to local demand conditions
- Microgrids moderate an intense sense of how absurd our political and social realities are. We’d like to see a kinder world, but we’ve created a system that profits a very narrow minority when so many more people could be living more meaningful and useful lives
- The microgrid operations center could become a simple local hub for emergency transportation, electricity, water, food, information and communications (internet, radio, TV and telephone) to strengthen relationships

Microgrid Benefits (8)

Well-being

8. A Microgrid Improves Community Well-being

- The neighborhood microgrid becomes a place of refuge that is reactive to misfortune
- These social centers foster community identity, camaraderie, collaboration and a culture rooted in a distinct sense of place
- When all else fails, everybody in that local community can feel comfortable knowing that there is at least one safe place that they can go where the power is always on, and they can communicate to their families and neighbours that they're OK. Building community pride supports unity
- They provide energy future proofing as microgrids constantly evolve and the platform readily accepts configuration changes, operational mode adjustments, new innovations in hardware and software, interface variations and growth

Microgrid Benefits (9)

Versatility

9. A Microgrid has Operational Versatility

- There are MANY ways to optimize internal energy use. Versatility is vital to anticipatory adaptation and this in turn to graceful survival. During prolonged outages, a microgrid becomes the mission control center for emergency services
- Microgrids are scalable and modular. Intentional oversizing the generators and storage capacity provides internal and external operational versatility
- Live testing on the Manotick Microgrid using low energy demand scenarios have resulted in “normal” procedural changes to eliminate waste and determine the best times to consume energy
- Geographic coverage is flexible and modifiable in real-time as strategic and tactical conditions change i.e. more neighbours can participate in emergency support

Microgrid Benefits (10)



10. A microgrid brings long term investment value to owners

- 20% of Canadians live in energy poverty. A simple single solar panel microgrid reduces this poverty. A properly designed microgrid will stop energy poverty and reduce operational cost
- If investments in renewable energy and grid modernization are to successfully advance Canada's near zero emission goals, they must include actions to improve the resilience of the grid itself
- Overdesigned microgrids mean they produce more than they consume
 - Sell excess to the main grid to participate in grid ancillary voltage, frequency services and peak demand (4 p.m. thru 9 p.m.) support
 - Produce Hydrogen which is also sold

Microgrid Benefits (11)

Energy Awareness

11. A Microgrid Greatly Increases Energy Awareness

- Using Level 1 Electric Vehicle charging at home (120 Volt standard home outlet) has less stress on battery life and often requires no additional electrical technician or hardware costs. Charging at high-speed Level 3 facilities cost about 5 times the home charging amount
- Microgrid owners tend to pay closer attention to the factors affecting energy waste and conservation. A smartphone app provides detailed real time and historic energy data which can drive strategy, encourage a focus on community needs and provide the owners with optimization command and control authority
- Solar panel unpredictable output attributes encourage some Microgrid owners to manage energy quantities down to one kilowatt-hour (a very small amount of energy)
 - Lifestyle adjustments, procedural change or home renovations often follow. Long term record keeping is vital
- You can't manage what you care about if you can't measure its variable energy demand and variable supply

Microgrid Benefits (12)

Inflation Proof & Energy Freedom



12. A microgrid provides isolation from energy price inflation

- The direct impacts of microgrids on energy price inflation are sharply reduced or zero
- The real world consists of ever-increasing energy costs. Unfortunate non-microgrid consumers can be controlled by suppliers for life
- Disconnecting from the inflating energy supply infrastructure to achieve Energy Freedom is often an owner's primary objective
- Installation costs become an investment that can yield about 10% ROI

Microgrid Benefits (12)

continued

Inflation Proof & Energy Freedom



A typical energy inflation notice



Account number: xxx-xxx



Your bill is projected to be 31% higher
than normal.

For the billing period starting January 17, 2023.

Microgrid Benefits (13)

Causing Harm or Competition

13. Is operation of a Microgrid compatible with nature's energy flows and will it cause harm?

- 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
- These energy resources do not compete with anybody else's resources. Others are free to follow your example
- The Manotick Microgrid energy systems are 100% compliant with natural energy flows leaving no damage and causing no harm without competition

Microgrid Benefits (14)

Survival

Requires habitual climate, shelter integrity, health, food, water, energy

14. How will a Microgrid Aid in Survival

- **Ottawa Derecho:** Ontario and Quebec grid failures of 25 May 2022, resulted in 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 habitual climate, safety, shelter integrity, health, food, water, energy (for heat, cool, appliances)
- [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 delivering services to the community
- Ease of future growth to add new generating or storage capacity
- Constant technology advancement and product upgrades are readily integrated
- It is an affordable learning platform using local employment
- 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

- Grid threats are mainly local (flood, fire, weather, drought, mud slides) that require adaptation investments. Impacts of outages are very widespread. Microgrids are proven isolation solutions that can function wherever solar, rivers and wind can access
- Benefit-to-Cost ratios of 9 to 1 through 38 to 1 have been published for grid adaption investments – repair cost avoidance is vital
- Ontario grid repair projections are still based on average weather conditions for the past 20 years rather than projected conditions for the next 30+ years. They remain fragile
- Overlapping past event grid “repairs” and new weather event damage shall soon be unaffordable and outages will be very much longer than a few days
- Microgrids have proven to gracefully survive other than direct hits
- [How is Climate Change Affecting Canadians](#)

Microgrid Benefits (17)

Microgrid vs Generators

17. Microgrid vs Generators

- Generator investment ROI is zero, but it ties up capital. Microgrid ROI starts upon installation (capital is immediately working for you)
- Generators burn fossil fuels (\$) and need frequent attention during an outage. They require monthly maintenance for generators which is zero for microgrids
- Generators produce deadly carbon monoxide and Greenhouse Gas CO2. However, locally stored non-deteriorating propane is often the best backup fuel to microgrids
- Generators produce noise and fumes 24/7, possibly from multiple directions around your community during an outage.
- Generators depend on functioning gasoline, natural gas or propane delivery infrastructure. Power outages often mean delivery delays. A microgrid is stand alone
- Fuel for generators are subject to cost inflation. Microgrid energy is free

Microgrid Benefits (18)

Fossil Fuels Health Risk

18. Fossil Fuels Health Risk

- Gasoline, natural gas, propane are highly volatile and subject to leaks, fire hazard, toxic fumes and explosion
- Maintaining burner safety requires yearly inspections and replacements by certified professionals. Supply chain delays are common
- The ground may become contaminated by fossil fuel leaks which has a negative health impact on ground water for wells, smell and atmospheric toxic gas releases
- Methane (natural gas) wells are notorious for leaking and this gas is 80 times more powerful in atmospheric warming relative to CO2
- Alberta and Saskatchewan have many hundreds of abandoned and leaking wells that require public funding to properly seal
- Microgrids have none of these safety disadvantages

Microgrid Benefits (19)

Virtual Power Plant Partnerships (VP3)

19. Virtual Power Plants (VPP) and Partnerships (VP3)

- A virtual power plant (VPP) is a collection of small-scale energy resources that, aggregated together and coordinated with grid operations, can provide the same kind of reliability and economic value to the grid as traditional power plants. (3 MW to 300MW)
- Expansion of VPPs can be gradual, local, rapid, easy and cost effective. Removes the need to build another conventional power plant
- It may require fragile transmission and distribution system modifications if located away from the demand load
- VPPs typically save burning fossil fuels in power generation
- A VPP could use recycled EV batteries for grid energy storage or charging stations
- Need standardization and flexibility in laws, regulations, hardware, software, procedures, and business models for interoperability and planning
- Tesla is working with the Texas and California grid regulators and managers to build out several VPPs – as separate utilities (micro-utilities). Ford, General Motors, Google Nest, OhmConnect, Olivine, SPAN, SunPower, Sunrun, SwitchDin, Virtual Peaker, Enel, and Volkswagen occupy this sector as well

Project Symphony

Our energy future

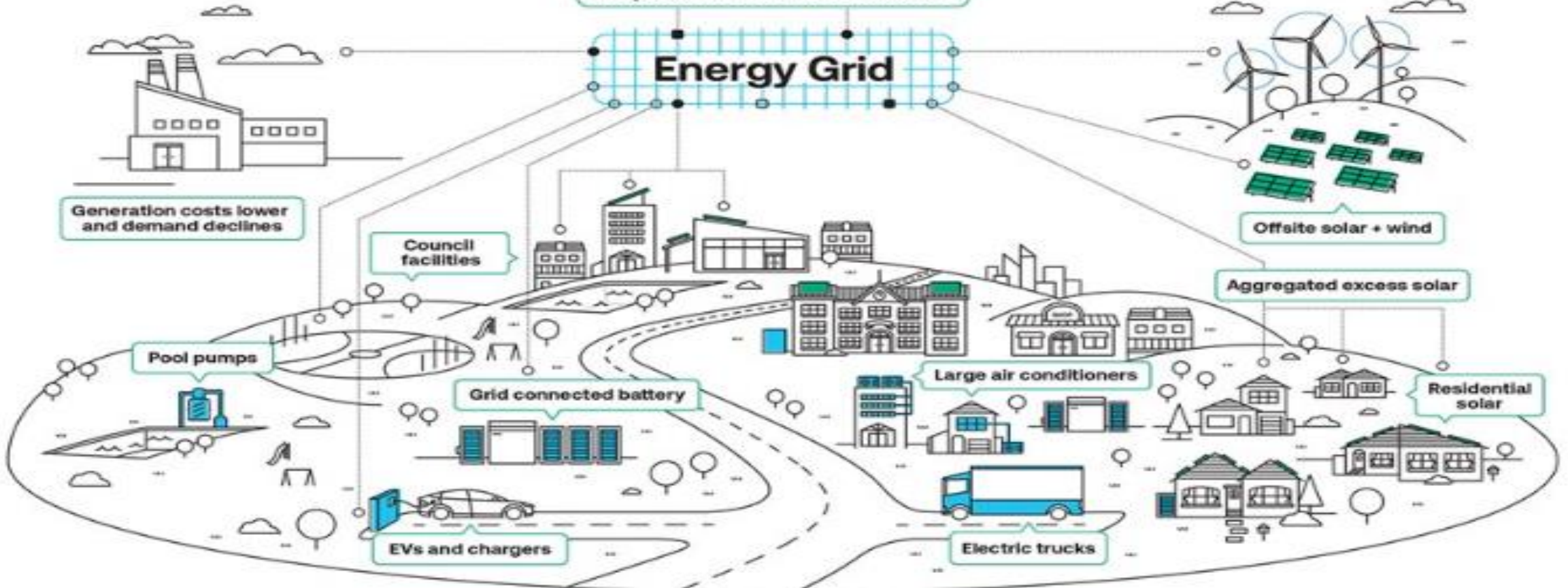


Virtual Power Plant



Excess community energy dispatched in future markets

Energy Grid



Australian Pilot Project

<https://youtu.be/Ok1iSoPN0u4>

Beneficial Microgrids

Microgrid Benefits (20)

Microgrids provide Utility Update Deferral



20. Microgrids Provide Utility Update Deferral

- After microgrid or VPP service payments, the utility can defer or prevent some expansion of generation and transmission/delivery infrastructure while charging growth customers (and electrify everything increased consumption clients) the existing rates for massive profits
- Utility savings are with deferral of updates to transformers, transmission towers and wires, distant generating station, storage (battery or other load shifter), utility solar or wind farms, peak loading management, maintenance and disaster repair, inspection, training, and administration
- Utilities are the biggest beneficiary, but they do not fund the capital cost of microgrids
- Microgrid owners should either be paid a capital cost single payment, the utility required to pay to install and own the microgrid and lease the rooftop space or pay the microgrid owner substantive energy usage rates (say \$2.00 per kWh) for maintenance and growth. A monthly capital cost allowance must be paid for being on standby to support grid demands
- The homeowner should not have to finance retrofits any more than they are asked to directly finance the next power plant.
 - [Financing Retrofits - Canadian Association for the Club of Rome \(canadiancor.com\)](https://canadiancor.com)

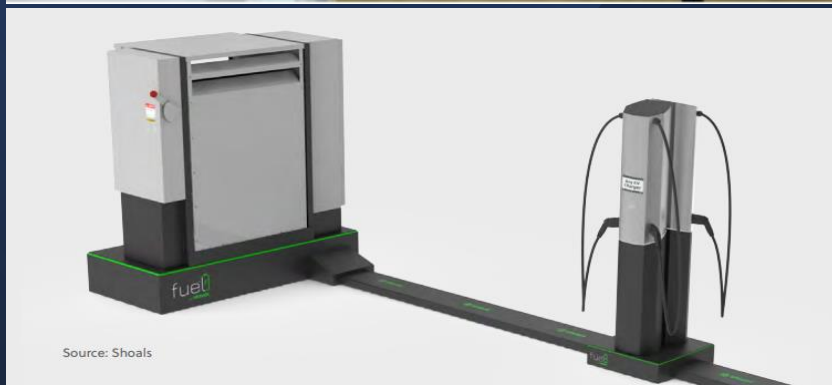
Microgrid Benefits (21)

Fleets of Electric Vehicles

21. Fleets of Electric Vehicles as a Microgrid

- Fleets consist of busses (school and municipal), delivery (trucks, vans and cars), idle emergency vehicles (ambulance, fire, police), rental car business locations, airport and school parking, smart charging stations at destinations (motels, restaurants, shopping malls), EV friendly hockey rinks and recreation centers, workplace and vehicle maintenance facilities. These all include dynamic quantity of EVs that are idle some of the time
- Fleet charging and grid support (fleet discharge) energy management is utility software controlled
- Utilities with technical skills, existing decision-support systems, grid and microgrid management expertise who have the most to gain could buy fleets of school busses and lease them to school boards
- Fleet solar generation canopy parking for solar charging Including excess energy export or Hydrogen manufacturing
- Energy arbitrage – variable rates are seasonal, day of week, hourly and location dependent. Buy low and sell high smooths demand
- Enhance energy security and avoid blackmail (Russia and Ukraine) or escalating consumption rates

High Power Level 3 Charging Stations as Microgrids



- The USA has a 2030 goal of 500,000 high power chargers
- Every EV charging site is unique in design and maintenance needs
- Delivery challenge of adequate power capacity at the chosen site
- The connection between utility service and the charging system includes elements such as transformers, disconnect switches and power protection panels, which must accommodate sufficient power, cabling and protection for each charger
- While fast Level 3 chargers may be necessary for highway customers who want an 80 percent charge in 20 minutes, many hotels, homes and fleet vehicles can charge overnight with Level 1 or Level 2 chargers
- Using software to manage charging times can maximize utilization and reduce peak load requirements. Adding microgrid energy storage and solar panels can reduce grid power needs. Integrating building energy systems into charging operations is a valuable option
- Businesses, have found success by offering employees free charging at work, and coffee shops and restaurants can offer customized coupons. Retailers can also use longer charging times as an opportunity to offer additional shopping options, entertainment or even amenities such as showers and laundry for travelers
- Monitoring, command and control of each charger for maintenance and customer service charges are essential

Microgrid Benefits (22)

Electric Vehicle Integration with Microgrids

Vehicle-to-Grid

Energy systems
in the age of electric



22. Electric Vehicle Integration with Microgrids

- When you add electric vehicles and different charging rates at different times of day, with a seamless digital experience, it shall enable personalized battery optimizing charging at minimum cost
- Having a connection to a compliant two way charging point (even away from home) opens the possibility of providing the grid with energy between 5 p.m. and 9 p.m. (peak demand) while earning about \$2.00 per delivered kWh. Some businesses have ultra low late-night charging rates
- During grid outages a compliant EV (battery on wheels) can provide emergency power anywhere within driving range
- EV and fleet participation in Virtual Power Plants can become a significantly business opportunity
- Developing applications will become increasingly important to all stakeholders

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

- Exploring models of coordination and interoperability between the IESO, regions, communities, microgrid aggregators and microgrids with other generators (traditional & DER), transmitters and distributors
- 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 and Aggregators 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 \(solarindustrymag.com\)](#)

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

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

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 NWAs, the DERs are expected to be available to support grid needs
- DERs can offer services to defer, reduce, or avoid capital, maintenance and operating costs associated with the transmission and distribution networks
 - 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 limited capacity imports from neighbouring grids (Quebec, Manitoba, New York, Michigan, Minnesota)
- The reduction in demand is valued at twice the supply addition

Software Development

We know that one-in-100-year storms are now happening every five to 10 years. We can't out-engineer weather, but we can engineer *for* it

- 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.
 - Profiles that include elements of bidirectional power flow may have to be disaggregated to separate demand and supply profiles.

Business Model Challenge Part 1



- 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. Not responsible for fragile grid repairs in an emergency estimated at \$8 Billion/yr. \$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% savings)

Business Model Challenge Part 2



What Grid Management costs are avoided?

- energy generation fuel costs (embedded carbon costs)
- surplus baseload generation (over designed for contingencies)
- generation capacity capital costs
- maintaining operating reserves for emergencies
- regulation capacity
- avoided / deferred transmission capacity costs
- avoided / deferred distribution capacity costs
- transmission and distribution line losses
- resilience and added reliability. The value of such benefits is typically difficult to quantify
- Infrastructure maintenance and storm/fire emergency repair

Reliable Microgrid Summary

- **Investment Main features**

- Efficient, Safe, Sustainable, Resilient, Profitable, Distributed, Scalable, community oriented, nature friendly (no harm)

- **Provides fossil fuel free energy supply (Energy Liberation & Freedom):**

- 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

Microgrid Market Characteristics

- Microgrid Characteristics are identified as:
- By Type: AC Microgrids, DC Microgrids, Hybrid, DER
- By Connectivity: Grid Connected, Off-grid Connected, Ability to Island, Aggregation, Connection to other Microgrids, more complex
- By Component: Hardware, Software (utility and microgrid collaboration), Electric Vehicles
- By Application: Remote Systems, Institutional and large Residential Buildings, Office towers & shopping Malls, Commercial Utility, low density Residential, Mixed Community
- By End Manager/Owners: Residential, Commercial, Industrial, Institutes, Campuses, Utility, Military

The Energy Transition

- Many electricity demand market studies exist, and some are predicting
 - Massive investments migration from fossil fuels to renewables in the next decade
 - One pundit even suggested \$150 trillion in a “Great Market Distortion” starting soon
- Other USA analysis claims the microgrid market size reached a value of nearly \$12 billion in 2022. The microgrid market is expected to be \$30 billion in 2027 (annual growth rate of 20%) reaching \$65 billion in 2032
- Community adaptations using microgrids are not encouraged in Ontario by Premier Doug Ford and his climate change denier government
- The microgrid solution is an important shining star in the energy transition’s bright future. This solution using blockchain and AI is already well advanced in other parts of Canada, China, Germany and EU, South Korea, Japan, USA, Australia, India and Brazil

The Energy Transition (2)

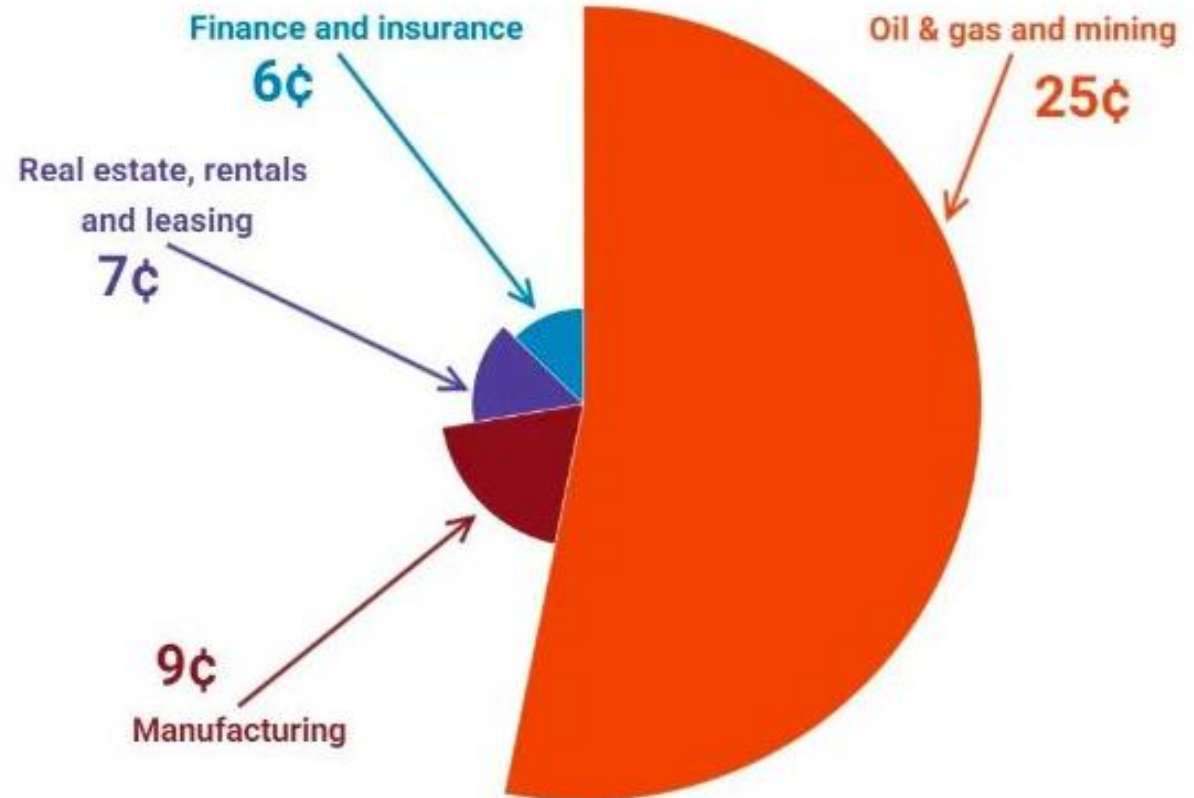
- Another study concluded [“average bills will fall 63%”](#)
- However, there are major barriers to a rapid rollout of a 100% renewable energy system: “The No 1 barrier is that most people are not aware that it’s possible. My job is trying to educate the public about it. If people are actually comfortable that it’s possible to do, then they might actually do it.”
- Electrical energy, information and labour are getting cheaper while burning fossil fuels keeps driving up the rate of inflation.
- New research indicates that [electric vehicle batteries alone](#) could provide the short-term storage needed by global grids as early as 2030.
- A rollout would hugely reduce extraction from the earth by ending fossil fuel exploitation: “The total amount of mining that’s going to be needed for wind, water, solar, compared to [the] fossil fuel system, is much less than 1% in terms of the mass of materials.”

The Energy Transition (3)

- [New nuclear plants](#) are too slow to build and too expensive compared with wind and solar, in Jacobson's view: "You end up waiting 15 to 20 years longer, for a seven to eight times higher electricity price – it just makes no sense. Even if they improve [build times], say to 12 years, that's still way too long. We have cheaper, faster, safer technologies. Why waste time?"
- numerous crises can be killed with one technological stone, without us having to wait for miracles.
- bulk stores of hydrogen in order to provide interseasonal storage.

Take from the
poor and give
to the rich

Of every extra dollar spent due to inflation, 47 cents
ended up as corporate profits for industry:
here's where they go



Data from Canadian Centre for Policy Alternatives' 2023 report: *Where are your inflation dollars going?*

Infographic by Natasha Bulowski / Canada's National Observer

The objective of this presentation has been to introduce a safe, fair and effective means to assist in climate change mitigation and adaptation while reversing 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 home, electrical power and transportation sectors.

- Primary references
 - The Dunsky report to the IESO [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 \(canadiancor.com\)](#)
 - [23 intriguing microgrid projects to watch in 2023 - Canadian Association for the Club of Rome \(canadiancor.com\)](#)

European Grid Command and Control Center



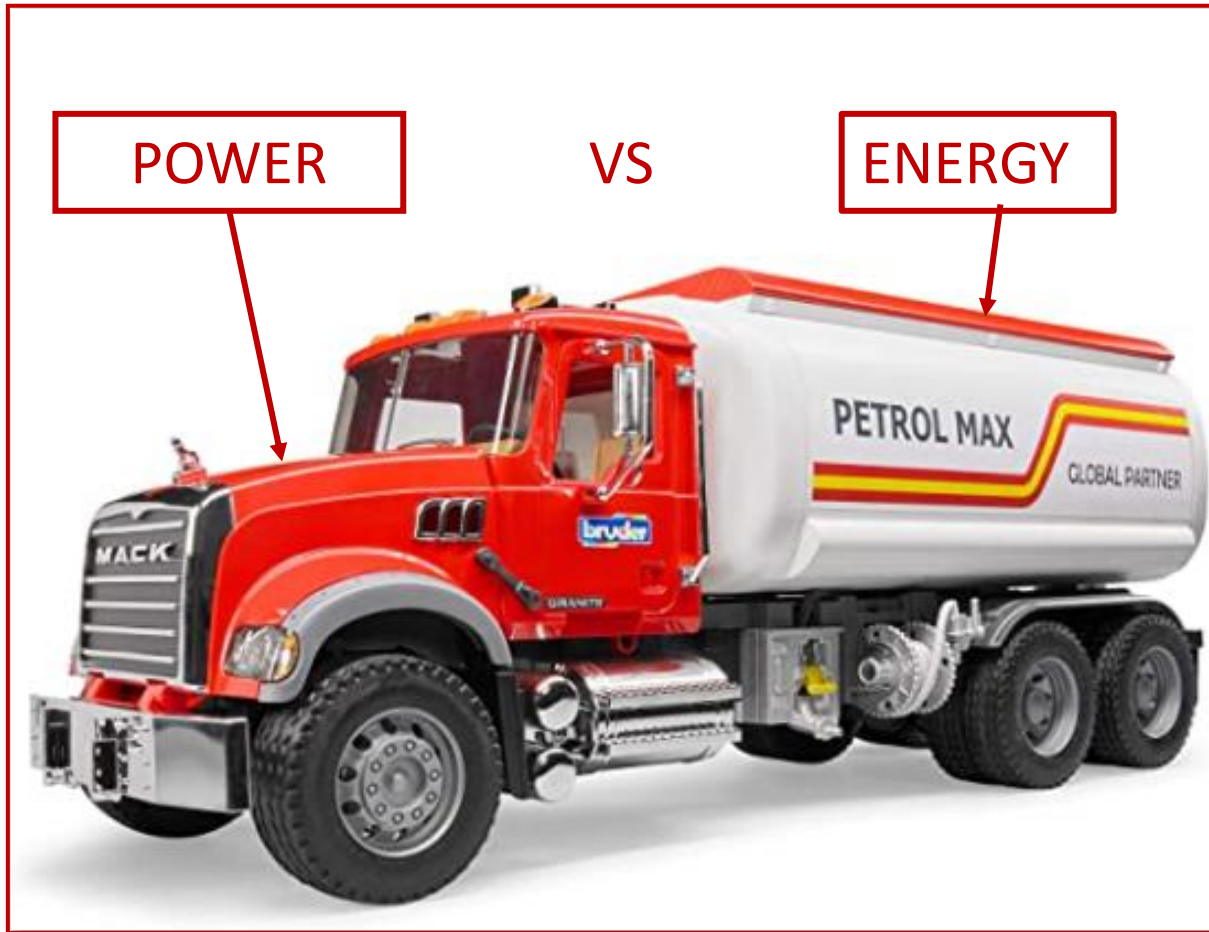
Spare slides for Q&&A

"If you have come to help me, you're wasting your time. But if your liberation is bound up with mine, then let's walk together."

Lilla Watson, indigenous Australian visual artist, activist and academic.



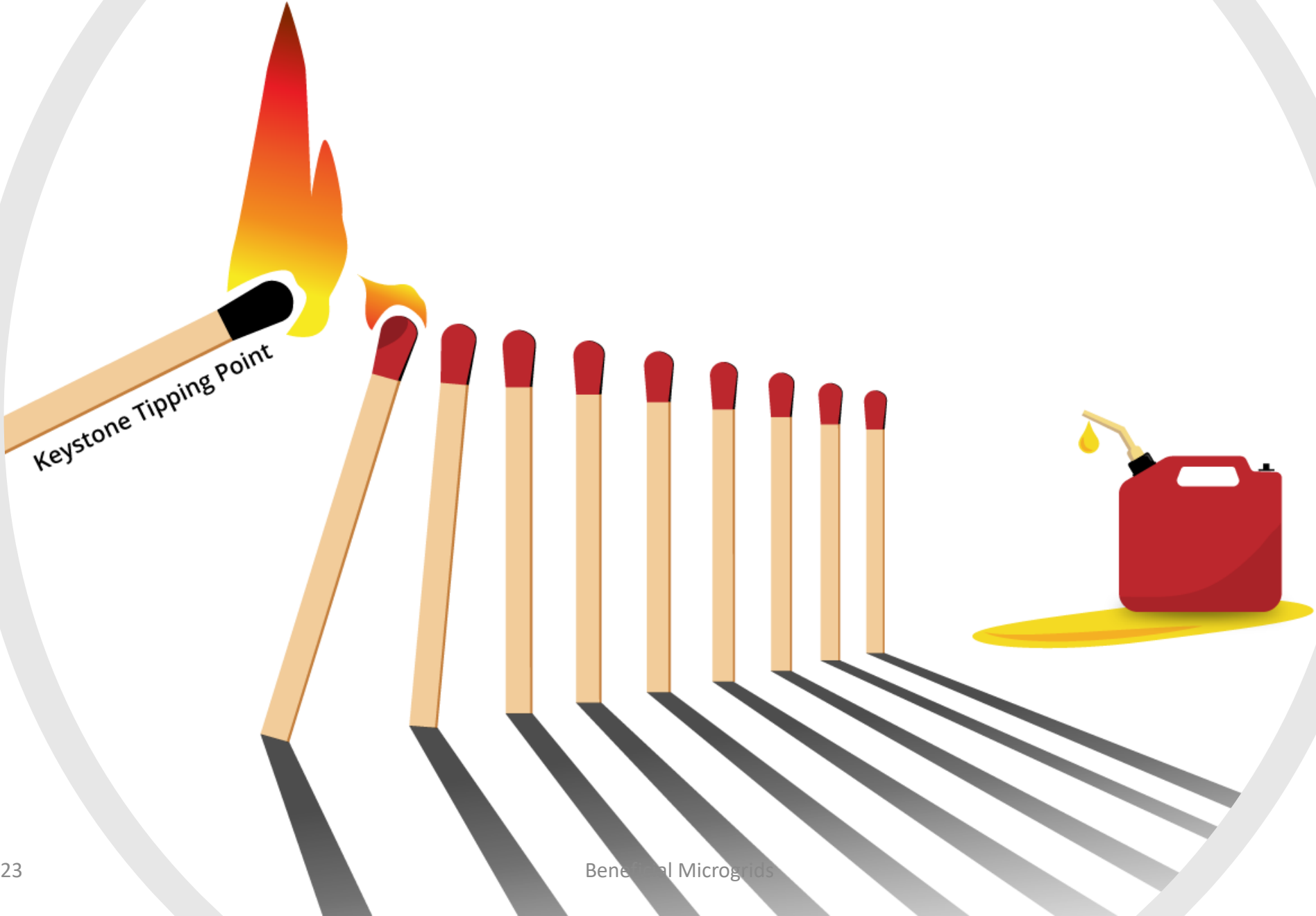
Canada vaults to No. 2 in Bloomberg's battery supply chain ranking



*Meanings
Defined*

Power units are Kilowatts
Energy units are Kilowatt-hours

Keystone Tipping Point Process





- Quebec Hydro crew after the ice storm of 1998



Beneficial Microgrids

According to ChatGPT

- A Virtual Power Plant (VPP) is a system that uses advanced control technology to aggregate and manage distributed energy resources (DERs) such as rooftop solar panels, battery storage systems, and combined heat and power (CHP) units. The goal of a VPP is to enable these DERs to act as a single, centralized power plant, allowing them to be dispatched collectively in response to changes in electricity demand or supply. This allows for better balancing of supply and demand on the grid and can help to reduce costs and increase the use of renewable energy sources.
- In general, microgrids that rely on renewable energy sources like solar and wind are considered to be compatible with nature's energy flows, as they generate power without producing harmful emissions or pollutants. These microgrids can be seen as a way to increase the use of renewable energy and reduce reliance on fossil fuels.
 - However, the compatibility and harm caused by microgrid also depend on the design, location, and operation of the specific microgrid project. The use of certain materials, construction and maintenance techniques and the impact on local ecosystems and communities should also be evaluated before construction .
 - It's important that microgrids are developed and operated in a way that minimizes harm to the environment and local communities, and the best way to accomplish that is through proper planning, and implementation of sustainable practices and guidelines.

Distributed Energy Resource (DER) According to ChatGPT

- A Distributed Energy Resource (DER) is a type of energy generation or storage system that is located close to the point of use, rather than being centralized in large power plants. DERs are connected to the electric grid, but they are typically smaller in scale and can be owned and operated by individuals, businesses, or communities, rather than by utilities. Examples of DERs include rooftop solar panels, wind turbines, small-scale hydroelectric systems, and battery storage systems.
- DERs can provide a variety of benefits to the electric grid, including:
 - Improving the efficiency of the system by reducing transmission and distribution losses.
 - Providing local power generation, which can increase grid resilience and reduce dependence on large central power plants.
 - Enhancing the integration of renewable energy sources, reducing the need for fossil fuel power generation and helping to lower greenhouse gas emissions.
 - Provide more flexibility and responsive system to electricity demand
 - Helping to reduce costs by avoiding the need to build and maintain expensive transmission and distribution infrastructure.
 - However, it also has a few challenges, such as integration with the main grid, balancing the supply and demand, and management of a large number of small-scale generators which need to be addressed in order to fully realize the benefits of DERs.

Project Symphony

- SwitchDin is an Australian company, who sits behind StormCloud – a software system already functional which embraces rooftop solar, home batteries, home EV chargers and switches loads connected at both residential, commercial and industrial sites. It is the lead integrator in Project Symphony in Western Australia, the State's largest VPP.
- [What is Project Symphony? | Western Power \(westernpower-website.azurewebsites.net\)](https://www.westernpower.com.au/what-is-project-symphony)



Solar canopy at Brookville Bus Depot in Montgomery County. The microgrid for the Depot includes a 1.6 MW solar PV array and a 3 MW Battery Energy Storage system. Image courtesy of Schneider Electric.