


Community Energy Plan

Volume 2
Demonstration Projects Report

Township of Mulmur



June 2019

Community Energy Plan
CEP Volume 2: Demonstration Projects

Township of Mulmur
758070 2 Line East
Mulmur ON L9V 0G8

R.J. Burnside & Associates Limited
15 Townline
Orangeville ON L9W 3R4 CANADA

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R.J. Burnside & Associates Limited

Report Prepared By:

Spencer Brown, P.Eng., C.E.A.
Project Engineer
SB:kl

Lyle Parsons
Vice President Environment
LP:kl

Report Reviewed By:

Jim Walls, P.Geo., QP_{ESA}
Senior Geoscientist

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Glossary

Term	Description
°C	Degrees Celsius (unit of measurement for temperature).
BEV	Battery Electric Vehicle.
Blended Rate	A rate $/kWh for electricity including demand charges, regulatory charges, supply charges, global adjustment, and taxes.
British Thermal Unit (BTU)	A measure of energy.
CCS	Combined Charging Stations.
CEP	Community Energy Plan.
CHAdeMO	CHArge de Mode.
CO_2	Carbon Dioxide.
CO_2e	Carbon Dioxide Equivalent.
DC Quick Chargers	Direct current quick charging.
Demand Charge	Charge from Hydro distribution companies based on the capacity amount allocated to your building.
Discount Rate	Often considered the hurdle rate this is the rate which an entity can receive on other investments. A discount rate is used to discount future cash flows to measure project risk.
ECI	The Energy Cost Index (ECI) of the building (expressed in dollars per floor area per year).
ECM	Energy Conservation Measure.
EEM	Energy Efficiency Measure.
EV	Electric Vehicles.
GHG	Greenhouse Gases.
GJ	Gigajoule (unit of measurement for power).
GMC	General Motors Company.
HDD	The number of degrees of temperature difference between a base temperature (usually 18°C) and the mean daytime outside temperature on any given day.[1]
HPS Bulbs	High Pressure Sodium Bulbs.
IEAP	International Emissions Analysis Protocol.

1 (Building Codes and Standards, 2015)

Term	Description
kBTU	One thousand BTUs.
Kilowatt (kW)	1000 Watts.
Kilowatt hour (kWh)	1000Wh.
LED	Light Emitting Diode.
m^3	Meter cubed a unit of volume.
Megawatt (MW)	1000 kilowatts.
Megawatt Hour (MWh)	1000kWh.
MEP	Municipal Energy Plan.
MPAC	Municipal Property Assessment Corporation.
Net Present Value (NPV)	The value of all the future cash flows added up and multiplied with the discount rate.
NRCan	Natural Resources Canada.
Peak Demand	The largest power consumption for a system, usually over a 1-year time period.
Return on Investment (ROI)	The ROI is the net profit of an investment divided by the capital cost. Comparing ROI's of different investments provides a good way to make financial decisions.
Simple Payback	The time in years it takes to recoup an initial capital investment. Comparing paybacks of different investments provides a good way to make financial decisions.
Site EUI	The Energy Utilization Index (EUI) of the Site (expressed in $kBtu/ft^2$ [MJ/m^2] per year).
Source EUI	The Energy Utilization Index (EUI) of the Source (expressed in $kBtu/ft^2$ [MJ/m^2] per year).
Watt (W)	Unit of Power in Joules/s.
Watthour (Wh)	A measure of power over time – 1 Wh is 1W power consumption over 1 hour.

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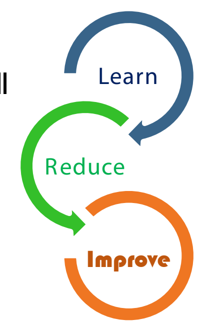
1.0 Introduction

1.1 Purpose of the Demonstration Projects

This is a companion document to the Community Energy Plan, Volume 1. The purpose of this report and the demonstration projects which we reviewed is to provide a few examples of energy saving or renewable energy projects. These demonstration projects will help illustrate that there are viable solutions for energy conservation and renewable energy. The projects are intended to demonstrate that the CEP goals can be achieved. Those goals are:

- Cost Savings: Through education and energy conservation measures Mulmur plans to demonstrate the benefits to reducing energy use;
- Economic Growth: Mulmur's economic objective is to implement strategies that will keep more energy dollars in the community and thereby spur local economic activity;
- Energy Security: Aligning the built environment, energy and land use growth planning: To help identify the best possible energy options to create a complete community and enhanced mobility; and
- Protecting the Environment: CEPs, and the associated energy conservation plans can consequently drive significant emissions reductions.

The demonstration projects documented in this report are provided for educational purposes only. They provide information and references that will help guide Mulmur residents, business and local institutions identify and implement project solutions that achieve the above goals and specifically show how to:



- Improve energy efficiency;
- Reduce energy consumption and greenhouse gas emissions;
- Save on costs; and
- Foster renewable energy production and economic development.

2.0 Demonstration Projects that Illustrate Sustainable Energy Solutions

Several demonstration projects examples were reviewed to indicate that action by Mulmur residents is not only possible but will provide cost effective solutions with a reasonable rate of return (ROI) on investments that may be under consideration. If the demonstration project example chosen as examples would not pay off in a reasonable time period, this information has been provided. In most cases the proposed project investments in either energy conservation or renewable energy provide a positive return. The demonstration projects include the following:

2.1 Energy Audit of the North Dufferin Community Centre, Honeywood Arena

The purpose of this audit is to show the benefits of a formal professional energy audit and how it can save money for property owners. In this case several energy saving measures were recommended that with investments will save the Township of Mulmur a range from $22,000 to $28,500 (rounded) per year with a reasonable pay-back period depending on government programs and actual energy prices. If that savings estimate was constant over the next 10 years it would represent $220,000 to $285,000 in savings at the arena. Other potential measures that have a longer payback period were not recommended.

2.2 A Demonstration Solar Feasibility Assessment for a Typical Mulmur Community Residence

The solar feasibility assessment demonstrated that even under the current net-metering program by the Ontario Government a solar project can have a reasonable payback on the investment. The average residential house size in Mulmur is 1854 sq. ft. (Volume 1, Section 3.2.2). To replace all existing energy sources consumption (electricity, oil, propane, wood) the average residence is estimated to require approximately 20 kW of electrical energy. The capital investment payback period or ROI for a solar system that is paid for 10%, (without a loan) is about 11.5 years. The system is expected to generate electrical power and revenue for at least 30 years following installation. This solar system would be connected to the grid under the net-metering program and will provide all of the electrical energy needed for the average Mulmur home.

2.3 A Demonstration Heating Source Assessment for an Average Mulmur Community Residence

A simplified lifecycle cost analysis comparing different heating sources; propane, oil, geoexchange (geothermal) heat pump (GSHP), and air source heat pumps (AHSP) were analyzed. For all cases analyzed ASHP and GSHP outperform the fossil fuel furnace options. The high efficiency furnace for both oil and propane were a lower Net Present Cost than the mid efficiency furnace. GSHP and AHSP have a high initial capital cost but a low yearly operating cost. Based on these assumptions geoexchange systems and air source heat pumps could offer financial benefits to Mulmur Residents however more detailed lifecycle cost analysis for site specific considerations should be undertaken before any development decisions are made. For the base case scenario, the ASHP had a net present cost of $35,000 compared to $42,700 for a high efficiency propane furnace.

2.4 Electric Vehicle (EV) Infrastructure Assessment

The EV infrastructure assessment determined that there is currently limited publicly available electric charging stations in Mulmur. Two locations were identified at the time of this report's production. One is located at the Mansfield Ski Resort, Airport Road. and the other electric charging station (just outside of Mulmur) at Trillium Ford (located at Highway 10 between Primrose and Shelburne).

The assessment reviewed the critical issues to consider when selecting EV charging locations and charger needs depending on use expectations. For example, home use overnight charging versus commuter use.

The assessment also provided a review of EV's currently available on the market. It was determined that EV's that are both cost competitive with conventional internal combustion vehicles and can achieve significant travel distances before needing to be recharged are now available. EV's available include cars, SUV's and light trucks. Also, operational costs associated with EV electrical use and repairs is substantially lower than internal combustion vehicles. Mulmur residents are strongly encouraged to consider purchase or lease of an EV.

2.5 Agricultural Anaerobic Digestion (AD) Assessment

Our review looked at a potential project opportunity for Mulmur agricultural operations to benefit from renewable energy and energy conservation.

An anaerobic digester (AD) is considered a renewable energy technology. The anaerobic digestion process occurs in an enclosed vessel where agricultural manure and/or plant waste materials are broken down by micro-organisms in the absence of oxygen. Methane gas is generated and is directed to an internal combustion engine powering an electrical generator (for electrical production). The heat produced from the facility can also be used.

According to a report by Robert C. Anderson, Don Hilborn, and Alfons Weersinka,[2]

> *"…Previous studies have generally found ADs to be a poor investment for private firms without public assistance. The mixed results on the financial feasibility of ADs could be due to the site of the analysis since results vary with size, geographic location or the type of AD system, which are not standardized but rather customized to the individual situation."*

2 An economic and functional tool for assessing the financial feasibility of farm-based anaerobic digesters by Robert C. Anderson, Don Hilborn, Alfons Weersinka
https://www.sciencedirect.com/science/article/abs/pii/S0960148112005782

Our research found that projects could be viable under certain circumstances and with public sector grants.

2.6 Demonstration Project Example Limitations

The energy audit undertaken by R.J Burnside & Associates Limited (Burnside) for the North Dufferin Community Centre, (Arena) at Honeywood is based on data supplied by the Managers of the arena and Township Staff. This energy audit can be relied on by the Township of Mulmur (Mulmur) and Arena Management to make decisions on specific actions that can be taken to substantially reduce energy consumption and costs at the arena. If the recommended improvements are taken the associated GHG emissions will be reduced as well.

Some of the example demonstration projects do not provide detailed financial assessments either because the cost data is highly variable and sensitive to current market conditions. This applies to the electric vehicle infrastructure assessment. During our preliminary review of the feasibility of anaerobic digestion (AD) of agricultural waste materials the technology was found to be not feasible unless public grant programs were provided. It was also determined that each AD project would need to be assessed on a case specific basis. A more detailed assessment was not undertaken.

Please note that the other project demonstration examples and cost estimates (where provided) are based on the information shown with general limitations or conditions stated. For those considering implementing one or more of these demonstration projects the information provided should serve as a guideline to assist in decision making. Should residents choose to proceed with a similar project on their property it's feasibility should be assessed independently by a qualified professional.

3.0 Demonstration Projects

The above listed demonstration project examples are reviewed in the sections which follow.

3.1 North Dufferin Community Centre, Honeywood Arena – Energy Evaluation

Energy evaluations and audits are conducted by qualified professionals who will review your home or business and assess building energy efficiency and cost implications. The North Dufferin Community Centre (Arena) energy evaluation and audit demonstrates the value of a professional energy manager's assessment of facilities.

3.2 Energy Audit Strategies and Methods

This report review includes all the energy and cost saving measures as follows with regards to both functionality and code upgrades:

- Building Automation Systems (BAS);
- Boilers, furnaces, heaters;
- Toilet and fixture replacement;
- LED lighting;
- Roof insulation;
- Rooftop solar; and
- Heat Recovery.

The energy audit method can be broken down into four phases which are described as follows:

3.2.1 Baseline Development

This involved gathering all pertinent data: billing information histories, drawings, specifications, engineering report(s), conducting a site visit including an interview with the building operator. An equipment list and potential energy saving measures were reviewed.

3.2.2 Analysis and Energy Efficiency Measures (EEMs)

Historic data for utility and energy consumption simulation was collected. Building assessment report(s), drawings and other related information were provided by Mulmur staff. Burnside analysed potential Energy Efficiency Measures (EEMs) for conventional and renewable energy technologies. The assessment took into consideration the building behavior, operational schedule changes and deficiencies.

3.2.3 Energy Efficiency Results and Recommendations without Incentives

Fourteen separate Energy Efficiency Measures (EEMs) were identified with implementation costs and annual energy savings estimates. Eight Energy Efficiency Measures (EEMs) recommendations were identified with implementation costs and annual energy savings estimates. The annualized savings of all recommendations totals $21,996 (at projected energy prices). If fully implemented, the average weighted payback period from annual energy savings for these EEMs is estimated to be 8.0 years.

3.2.4 Energy Efficiency Results and Recommendations with Climate Action Incentive Fund (CAIF)

There is a program expected to be announced from the Federal government to provide incentives to Municipalities for energy efficiency and renewable energy projects. A similar program for private businesses was operational in 2019 providing 25% incentive on capital costs. The tables below outline the revised paybacks for projects (at 25%), should this program be launched.

Details are outlined in the table below from the CEP, Volume 3, North Dufferin Community Energy Audit Report.

Table 1: North Dufferin Community Centre Energy Efficiency Recommendations with CAIF Funding

EEM No.	Energy Efficiency Measure	Measure Type	Approximate Annual Savings	CAIF Incentive	Net Estimated Costs	Simple Payback Years
1	LED Lighting – Interior Lights	Upgrade Building Systems	$216.00	$374.00	$731.00	3.4
2	LED Lighting – Exterior Parking Lot Lights	Upgrade Building Systems	$160.00	$223.00	$568.00	3.5
3	Install Programmable Thermostats	Upgrade Building Systems	$750.00	$100.00	$300.00	0.4
4	Building Envelope Analysis – Roof Insulation	Upgrade Building Envelope	$1,780.00	$2,125.00	$6,375.00	3.6
7	Water Conservation -Low Flow Fixtures	Upgrade Building Systems	$490.00	$450.00	$1,350.00	2.8
10	New Zamboni Hot Water System	Upgrade Building Systems	$1,165.00	$2,000.00	$6,000.00	5.2
11	Desuperheater	Upgrade Building Systems	$3,710.00	$10,625.00	$31,875.00	8.6
12	DDC Controller	Upgrade Building Systems	$5,000.00	$11,250	$29,904	6.0
14	Rooftop Solar	Renewable Technology	$12,435.00	$28,594.00	$85,781.00	6.9
		Totals	**$25,706.00**	**$55,740.00**	**$162,884.00**	**4.5**

Note: 4.5 years is simple payback is an average of all projects.

3.3 The Benefits of Renewable Energy Generation at Home or Business

There are currently over 60 Mulmur residents and businesses who have installed a renewable energy project on their property. Mulmur was an early adapter of this technology and has benefited with reduced total energy costs at their municipal buildings. The renewable energy systems installed in the community to our knowledge were all solar photovoltaic (PV) roof top or ground mount systems.

There are still opportunities to develop either small wind or solar renewable energy project on Mulmur properties through the "Net-Metering" program. The Independent Electricity System Operator's (IESO) Feed-In-Tariff (FIT) program previously offered a guaranteed rate for electricity exported to the grid from renewable energy installations. Renewable energy projects with a capacity between 10 kW to 500 kW were eligible for the FIT program. This particular program is now cancelled, but renewable energy net-metering projects are now allowed. For details see Ontario Regulations (O. Reg.) 541/05: Net-Metering.

Net-Metering presents an opportunity to gain value from connecting a renewable energy source to the grid. The program is managed by the local distribution company which in Mulmur is Hydro One. Based on our understanding of the Ontario regulations there is now no size limitation for Net-Metering, but project size is limited to the total average daily use calculated on the basis of the total annual energy use anticipated at your property over a typical year. Net-metering allows you to send excess electricity you generate from renewable resources to the distribution system for a credit toward your annual total energy consumption and the associated costs. It is a “trade” of electricity you supply against electricity you consume. Once connected to the distribution system, Hydro One will read the meter as they do now but subtract the value of electricity supplied to the grid from your bill. There is no benefit for installing larger systems that would generate more electrical energy than what you would use since under the Ontario Regulations there is no payment for electrical power delivered to the grid in excess of what would be used in one year. Depending on the type and size of system other local or provincial approvals may be required.

Mulmur passed a By-Law No. 39-2019 with respect to Green Energy including local permitting requirements for wind, solar and bioenergy. This By-Law can be found in Appendix A. The current By-Law allows for a solar system up to 20 kW that according to estimates would power a typical residential house in Mulmur. However, there are restrictions with respect to placement of the systems and on wind projects. If requested, Burnside can provide some recommendations concerning modifications to the By-Law that would help encourage adaption of renewable energy at Mulmur’s residential, business and institutional locations.

The following table provides some information to help inform the readers about the total energy use, and total area potentially needed to allow for a solar installation that would supply the energy needed for the examples indicated.

Table 2: Estimate of Area Needed for Solar Collectors on Various Mulmur Buildings

Examples	Total Energy Use (kWh)	Total Amount of Solar Needed (kW)	Total Area Needed (Sq. Ft.)	Total Available Rooftop* (Sq. Ft)	Difference of Area Needed for Ground Mount (Sq. Ft.)
Primrose Public School	1048611	904	40679	16000	24679
Honeywood Arena	457000	394	17728	8700	9028
Average House in Mulmur	22917	20	889	0-500	389-889
Highest Residential Energy Use in Mulmur	133611	115	5183	N/A	N/A

Notes: Energy Use based on Data collected from Mulmur and Utilities. It includes electrical, oil, and propane consumption. Amount of Solar needed is based on 1160 kWh/kW. Total Area based on 45 sq. ft. per kW of solar.
*Estimated from Google Earth

Wind power projects do not require the kind of space as required for installation as solar, however they can only viable in locations where there are good wind resources available and the turbines are sufficiently high to take advantage of the winds. Unlike solar, wind resources require some period of study at the proposed project location to determine if they are sufficient to support a project prior to installation.

3.3.1 Project Example of a Solar PV System for the Average Mulmur Home

Based on our estimates shown above of total energy consumption at an average Mulmur home approximately 20 kW systems could supply all of the energy needed and displace any use of Hydro One supplied electrical energy and oil or gas from others as shown below.

An analysis was completed to determine the solar array size for a typical house in Mulmur, and an estimated cost and return on investment for that system. The goal is to show that solar is an investment Mulmur residents should consider in response to rising energy prices. Paying an initial capital price for a system insulates property owners from rising electricity prices, and fuel prices if electricity is used for heating.

Table 3: Estimated Annual Energy Consumption for a Typical Household in Mulmur (2018)

Energy Use	Energy (GJ)
Appliances, Lighting, Cooling	12.8
Heating (Space)	52.8
Heating (Water)	17.0
Total	**82.5**

Converting total energy consumption to kWh:

82.5GJ*277.78 kWh/GJ= **22,916 kWh/ year**.

Assuming a rooftop/ground mount solar panel array placed at 15° south facing, a good approximation of power production per kW is 1160 kWh/kW per year[3]. A kW of high efficiency solar panels typically uses about 45 sq. ft. of roof space[4].

Therefore, approximately 19.8 (20) kW of solar would be necessary to provide enough energy to power an average house in Mulmur.

Therefore, 20 KW of Solar using high efficiency panels would use approximately 900 sq. ft. of space. This means a typical house could have some solar on the roof and some on a ground mount system or all as a ground mount system.

A typical house with electric water heating and oil furnace would use (17.0 + 9.37 + 2.55 + 0.924 GJ) = 29.844 GJ * 277.778 kWh/GJ = 8,290 kWh of electricity.

8,290kWh/ 1160 kWh/KW per year = 7.15 kW of solar.

Costs, Return on Investment Payback Period

Assumptions:

- Capital cost is $2530.00/kW for residential system[5]; and
- Revenue rate is $13.5 c/kWh for low density hydro one customer increasing at 4 percent per year over 25-year timeline = 13.5*1.04^25/2 = 36 c/kWh.

Average kWh over 25 years = (13.5 + 36)/2= **24.7 c/kWh average over 25 years.**

Return on Investment and Payback of 20 kW System

Assumptions:

- Switch all energy use to electricity;
- 20 kW* $2530.00 / kW = $50,600;
- 11.5% Capacity factor (90% of 1st year production – Average over the course of the system);
- Electricity payment rate = 24.7 c/kWh or $247.00 / MWh;
- Inflation 2% / year;
- Discount rate 2%;

3.https://energyhub.org/ontario/#targetText=The%20rough%20calculation%20is%20simple,cost%20approximately%20%2421%2C707%20to%20install.
4 https://news.energysage.com/how-many-solar-panels-do-i-need/
5.https://energyhub.org/ontario/#targetText=The%20rough%20calculation%20is%20simple,cost%20approximately%20%2421%2C707%20to%20install.

- Project life 25 year;
- No Loan – Pay cash for system; and
- Operation and maintenance costs average ~1% of capital cost / year increasing at 2% / year inflation = $660.00 / year.

Results:

- 6.9% ROI;
- 11.7-year simple payback; and
- Net Present Value of $31,560.00.

Bank Loan Scenario

Considering the same assumptions above, except a 25-year loan at 4 percent interest rate with 25% down payment the results are:

- 14.1% ROI;
- 11.7-year simple payback; and
- Net Present Value of $22,082.00.

3.4 Demonstration Heating Source Feasibility Assessment

A simplified lifecycle cost analysis comparing different energy sources and different types of heating sources was completed. Propane, oil, geoexchange (geothermal) heat pump, and air source heat pumps were analyzed. Generally, residential geoexchange systems and air source heat pumps have a higher initial capital cost, but a lower operating cost, and environmental benefits compared to fossil fuel options.

Burnside understands that natural gas is currently unavailable to most of Mulmur and may never be available. There is a small area serviced along Highway 10 between Primrose and Shelburne. Currently, heating is provided for most of Mulmur by propane, oil, or electric furnaces, as well as electric baseboard heating and unknown quantities of wood. The following is a simple lifecycle cost comparison between a high efficiency propane and oil furnaces, mid efficiency propane and oil furnace, geoexchange heat pump, and an air source heat pump for a typical Mulmur household heating demand.

Model Assumptions:

- 2% discount rate;
- 3% base case inflation rate fuel and electricity costs;
- 52.8 GJ heat energy needed per year for average house in Mulmur;
- 39L of propane per GJ[6];
- Base case delivered propane cost 0.70/L (from Bryan's Fuel, Nov.15, 2019);
- Base case delivered oil cost 1.30/L (from Bryan's Fuel, Nov. 15, 2019);

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6 http://www.energy.gov.ab.ca/about_us/1132.asp

- Base case average residential electricity cost 0.134$/kWh (Hydro One);
- Geothermal capital cost $27,500.00;
- Air Source Heat Pump cost $16,000.00;
- Mid efficiency propane furnace capital cost $5,000.00;
- High efficiency propane furnace capital cost $7,000.00;
- Mid efficiency oil furnace capital cost $5,000.00;
- High efficiency oil furnace capital cost $7,000.00;
- All systems have a lifespan of 20 years;
- Capital Cost Assumptions highly dependent on-site conditions and requirements;
- Does not include water heating;
- Does not include air conditioning; and
- Assumes house already has ducts.

A base case and 3 different sensitivities based on changing energy costs were explored in Table 4 below. The darker colour identifies the lowest cost option with the light colours representing the highest cost options.

Table 4: Heating Systems Lifecycle Cost Comparison

					Mid Efficiency Propane Furnace	High Efficiency Propane Furnace	Mid Efficiency Oil Furnace	High Efficiency Oil Furnace	Ground Source Heat Pump	Air Source Heat Pump
					Capital Cost					
					$5,000.00	$7,000.00	$5,000.00	$7,000.00	$27,500.00	$16,000.00
		Fuel Cost		**Fuel Cost Inflation %**	**Total Net Present Cost per System**					
Current Energy Rates Increased at 3% per year.	Base Case	Propane $/L	0.70	3%	$45,500.81	$42,723.83	$53,234.93	$49,643.83	$38,378.64	$34,919.37
		Electricity $/kWh	$ 0.14	3%						
		Oil $/L	$ 1.30	3%						
Current Fuel Rates Increased at 5% per year.	Case 1	Propane $/L	$ 0.70	5%	$53,635.52	$50,002.25	$63,035.32	$58,412.59	$35,878.64	$34,919.37
		Electricity $/kWh	$ 0.14	3%						
		Oil $/L	$ 1.30	5%						
Current Electricity Rates Increased at 5% per year.	Case 2	Propane $/L	$ 0.70	3%	$46,088.67	$43,139.16	$53,822.78	$50,059.16	$38,221.55	$38,993.99
		Electricity $/kWh	$ 0.14	5%						
		Oil $/L	$ 1.30	3%						
Current Electricity and Fuel Rates Increased at 5% per year.	Case 3	Propane $/L	$ 0.70	5%	$54,223.38	$50,417.58	$63,623.17	$58,827.93	$40,721.55	$38,993.99
		Electricity $/kWh	$ 0.14	5%						
		Oil $/L	$ 1.30	5%						

For all cases ASHP and GSHP outperform the fossil fuel furnace options. Even when the electricity rates rise faster than fossil fuel rates, the ASHP and GSHP options have a lower Net Present Cost. The high efficiency furnace for both oil and propane were a lower Net Present Cost than the mid efficiency furnace. GSHP and AHSP have a high capital cost but a low yearly operating cost. Based off these assumptions geoexchange systems and air source heat pumps could offer financial benefits, however more detailed lifecycle cost analysis for site specific considerations should be undertaken before any development decisions are made.

The model above uses an average Mulmur house heating energy requirement. A smaller household with a reduced energy demand may benefit more from a propane furnace as there are less associated fuel costs. Similarly, a house or building with a larger energy demand could benefit more from a GHSP or AHSP system as the fuel costs are less per energy unit. In addition, having a GHSP or AHSP system allows a household to avoid being subjected to the price volatility of the fossil fuel market, as well as substantial GHG emissions will be reduced over the lifespan of the system. With Canada's Carbon Tax heating with an efficient electricity-based system would benefit the environment and may turn into a substantial economic benefit for home and business owners as well.

3.5 Electric Vehicle Infrastructure Assessment

Burnside reviewed the available data on typical driving habits in Ontario. Average driving distances of households is based on NRCan information and was presented in the 2 Degree Institute Report, dated September 2018.[7] It shows the estimated annual distance travelled is 16,000 Km. Based on 261 workdays in that year, a typical daily work commute in Ontario would be approximately 61 km. Even if the daily commute is substantially greater, battery electric vehicles (BEV's) or electric vehicles (EV's) can now easily achieve these distances on a single charge.

Those who make the switch to an electric vehicle or a hybrid vehicle will typically install a Level I or Level II charger in their home. EV's are typically supplied by the manufacturer with a Level I charger but can be charged substantially faster with a Level II charger. Level I chargers can be plugged into a common 115/120 V circuit. Level II chargers require a 220/240 V connection and can operate at different amperage levels. The higher the amperage the faster the charge time. For example, a 240 V, 48 amp Level II charger will provide approximately 51 km (32 miles) of range per hour of charging. Level II chargers are readily available on the market today.

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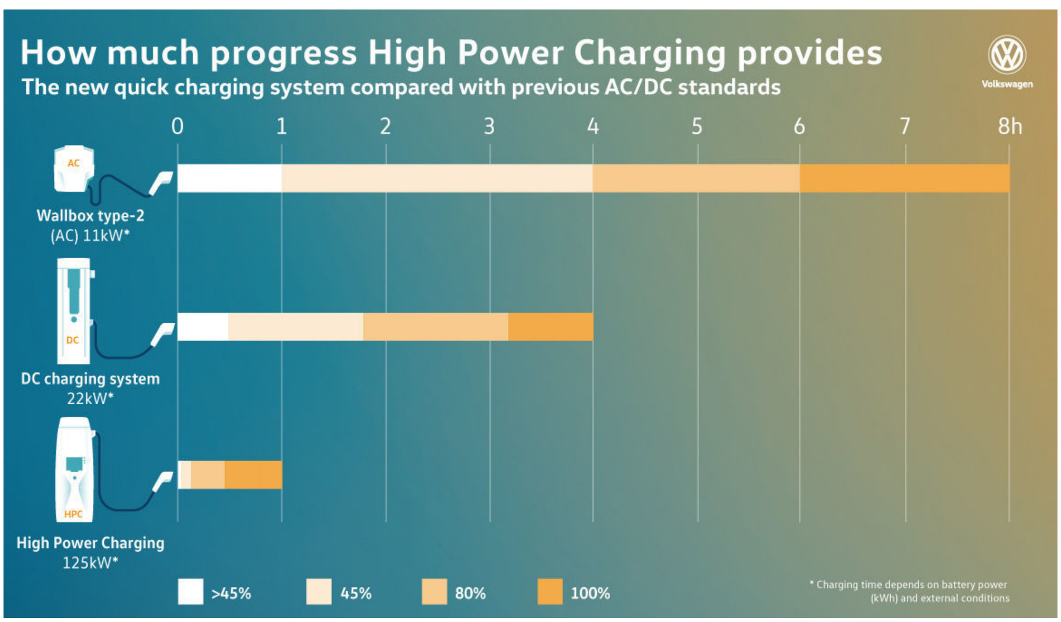
7 2 Degree Institute, Comparing Fuel and Maintenance Costs for Electric and Gas-Powered Vehicles in Canada, by Ryan Logtenberg, James Pawley, and Barry Saxifrage, September 2018.

There are also Level III chargers (also readily available on the market) which require high voltage connections and will charge the EV vehicles with the capability to accept a fast charge rate much more quickly. The following sections discuss some of the issues to consider prior to installation of Level III fast chargers. For commuting EV owners, it is expected that fast chargers will be the charging stations of choice. Unless it is at a workplace where the vehicle can be left for a period of time drivers will be unlikely to want to wait 3 to 4 hours for an EV Level II charge. If users have a choice, they will quickly gravitate to Level III fast chargers. Some are choosing Level II chargers because they are less expensive, but it may be that this infrastructure will not be actively used as more and more Level III stations are installed. For this reason, Level II chargers are recommended at workplace locations or where drivers will be parking their vehicles for several hours and Level III chargers are recommended for locations serving commuters who are passing through and traveling greater distances. If fast chargers are not possible high amperage, Level II chargers are recommended.

Charge time varies with different Electric Vehicles, EV's charger type (power station), acceptance rate and battery size. See the referenced web sites for examples of typical charge times.[8] Coming in the near future will be even higher power charging but the EV vehicle batteries must be designed to accommodate these higher charge rates. Something to keep in mind when purchasing an EV.

Figure 1: Hours Charger Systems Take to Charge Electric Vehicles



Increased charging capacity (max. 125 kW) cuts charging times down to the length of a coffee break.[9]

8 https://suncountryhighway.ca/ev-charge-times/ and https://www.clippercreek.com/charging-times-chart/
9 Volkswagen News Room, dated, 09/18/18 E-mobility, All about the modular electric drive matrix (MEB) https://www.volkswagen-newsroom.com/en/stories/all-about-the-meb-4206

3.5.1 Determine Locations for Installation

EV fast charging stations are recommended at locations where owners can leave their vehicles for an hour or less and do something else. Many businesses and municipalities are viewing the establishment of these stations as an opportunity to encourage vehicle users to shop, make use of recreational facilities and other activities while the vehicle is being charged. The only EV charging station (there are 4 outlets) that we are aware of in Mulmur at this time is located at the Mansfield Ski Club. Although just outside of Mulmur there are also Level III chargers at Trillium Ford located just west of Primrose. Several additional locations in Mulmur may be considered for installation of EV Level II or Level III charger infrastructure as follows:

- Mulmur Township;
- Terra Nova;
- North Dufferin Community Centre – Honeywood;
- Mansfield;
- Dufferin County Museum;
- Primrose; and
- Violet Hill; and
- Rosemont.

Burnside was advised that Dufferin County was planning to apply for NRCan for funding to install at least 20 charging stations throughout Dufferin County. The status of that program is unknown at the time of this report's publication.

3.5.2 Electrical Grid Connection Point and Capacity

Hydro One (the local distributer in Mulmur) will need to be contacted to determine the appropriate connection point and electrical circuit capabilities in the vicinity of the location(s) selected. The project charger Level II or III may be limited by the available connection grid source.

3.5.3 Transformer Installation or Upgrading

DC Fast Charge projects almost always require a stepdown transformer from the main 600V feed to the 480V input required for the charger. Transformer size is a critical consideration for cost-containment when accommodating future expansions. The requirements will be determined by the available grid capacity and connection point established. Level II chargers operate at 240 V and may allow for simpler installation.

3.5.4 New Electrical Panel

Each port requires a dedicated dual-pole minimum 40 A breaker at 240 V by code. If there is no accessible panel with spare breakers or extra capacity, a new one will have to be installed. Electrical panel size is a critical consideration for cost-containment when accommodating future expansions.

3.5.5 Cord Management System

A mechanism can be installed to manage cord retraction and avoid cables being strewn across the ground. This important to avoid liability issues from tripping hazards or cord damage from snow removal equipment.

3.5.6 Bollards, Signage, Site Painting, and Station Branding

Bollards are almost always selected by station hosts to protect equipment from vehicle damage. While not currently specified in the Ontario Building Code (OBC), it may be added in the future.

Signage will assist drivers in finding the station and prevent non-EVs from occupying the parking spaces required to access the chargers. It was noted by a majority of respondents in Partners in Project Green's Station Owners Survey that increased signage would be a key consideration for their next install.[10]

Station wrapping, and decals can be added to remind users who is responsible for supporting the transition to electrified transportation. Some stations offer LED screens where videos of your choosing can be played on loop. Many EV charging stations can be identified through the internet. Petro-Canada is introducing EV fast chargers across Canada on the TransCanada Highway.

3.5.7 Networked Station

Knowledge and capabilities are gained by both the municipality and users from a networked station. Networked stations are essential to avoid equipment obsolescence over time. As demand for EV stations rise, management features offered by software platforms will become a need-to-have rather than a nice-to-have. Drivers will need to know if the station is available before they arrive. Although many municipal jurisdictions may not be considering charges for use of the charge stations, measures will be needed to ensure the service is not abused by drivers who overstay reasonable charging times. One option might be to consider hardware/software stations that can accommodate payment for service in the future.

If charges for use are to be considered payments will have to be managed smoothly and clear and easy internal reporting on station use will be more important as the number of units grow. Consideration could also be given to charging an appropriate rate per hour for use of the charger's level of service (i.e., Level II or III). A networked station will provide considerable data for system monitoring by Mulmur as well as convenience for the users.

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10 Charge Up Ontario, A Guide for Businesses To Invest In Electric Vehicle Charging Stations, Partners in Project Green, December 23, 2016. https://www.partnersinprojectgreen.com/wp-content/uploads/2017/01/PPG_Charge-Up-Ontario_EVSE-Report-UPDATED-MARCH_1_2017.pdf

3.5.8 The Status of EV Development

Both electric cars and light trucks are being rapidly developed and have evolved into viable alternatives for drivers over the use of internal combustion vehicles. The driver stress associated with limited battery life and distance has largely been eliminated with cost comparable vehicles that are achieving in a number of cases over 400 km (250 miles) in range on a single charge.

With an EV, drivers don't have to worry about oil changes and many other maintenance issues associated with internal combustion vehicles. Time for servicing is avoided. The current cost to charge them is less expensive compared to equivalent kilometres in a vehicle driven by an internal combustion engine. According to a report by the 2 Degree Institute[11], in Ontario a battery electric vehicle (BEV) costs 66% less than a gas-powered vehicle per year in fuel and maintenance over the same type of vehicle. The national average savings of driving a BEV was $26,947.00 over 10 years. BEV's do not require oil changes, transmissions or exhaust systems and electric motors have only one moving part so fewer breakdowns.

For drivers who need a truck or SUV these are expected to be on the market in 2020/21. EV's can generally be charged at night when electrical costs are at their lowest rate (currently about 6.5 cents per kWh in Ontario - exclusive of delivery & regulatory charges). According to Plug'n Drive[12] Battery life in most EV's is now generally being warranted by the manufacturer for at least eight years.

Those considering this technology one might also note that a renewable energy project installed at your home could be used to charge your vehicle. This is an advantage not easily achieved with an internal combustion engine.

Green Car Reports[13] is one source that provides very good current data on EV's. They also review hybrid and other fuel-efficient vehicles. A few examples of EV's that are affordable and comparable in price to similar internal combustion vehicles are as follows.[14] Please note that many of these models offer larger battery capacity (and increased range) options.

- 415 km (258 mile) 2019 Hyundai Kona Electric crossover starts at $44,999.00 Manufactured Suggested Retail Price (MSRP);
- 362 km (226 mile) 2019 Nissan Leaf Plus starts at $42,298.00 MSRP;
- 416 km (260 mile) 2019 Tesla Model 3 starts at $44,999.00 MSRP; and
- 381 km (238 mile) 2019 Chevy Bolt starts at $44,800.00 MSRP.

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11 2 Degree Institute, Comparing Fuel and Maintenance Costs for Electric and Gas Powered Vehicles in Canada, by Ryan Logtenberg, James Pawley, and Barry Saxifrage, September 2018.
12 Plug'n Drive located at 1126 Finch Ave. W. North York, www.plugndrive.ca/electric-vehicle-faq/
13 https://www.greencarreports.com/news/buying-guides
14 Prices from Plug'n Drive web site, www.plugndrive.ca/electric-cars-available-in-canada/

In Canada as of August 2019 there were 26 battery electric vehicles and 23 plug-in hybrid electric models for sale. There is currently a Federal EV credit of $5,000.00 for vehicles priced under $45,000.00.

For those considering an EV drop in to Plug'n Drive located at 1126 Finch Avenue West, North York. Plug's Drive is a non-profit organization committed to accelerating adaption of EV's. They provide an unbiased source of information on EV's, charging stations and the electricity sector. There are many other EV's entering the market in 2020 to 2021.

The following is a condensed version from an article published in Green Car Reports.[15]

> *The Rivian R1T is due toward the end of 2020. Rivian will build a truck useful and stylish, luxurious and emissions-free. The company claims that the Rivian R1T truck will have a range of up to 640 km (400 miles) with up to 820 pound-feet of torque. That rivals some heavy-duty diesel-powered pickups.*
> *An electric Volvo XC40 will debut on October 16, 2019.*
> *New automaker Polestar will sell an all-electric sedan called Polestar 2. It scheduled to appear in 2020 and is expected to cost about $45,000, have a 440 K (275-mile) range, 408 horsepower, and offer a performance upgrade.*
> *The Porsche Taycan will arrive later this year with more coming next year, including less-expensive variants. The Taycan Turbo is a fast performance sedan.*
> *The Tesla Model Y compact crossover is slated to finally arrive in 2020. The Model Y shares about 75 percent of its parts with the Model 3 and should deliver a range of 448 to 480 km (280 to 300 miles). Some early versions are expected to cost $60,000, and lower-priced models may arrive sometime in 2021.*
> *VW's first vehicle on sale in the U.S. will be the Tiguan-sized ID 4 (or ID 4X) modular electric drive matrix (MEB) that may arrive in 2020 with other types scheduled for 2022. The automaker hasn't yet unveiled production-ready versions of the ID 4 but has hinted that when it arrives to U.S. customers it could undercut other EV crossovers such as the Tesla Model Y by thousands of dollars. Cost and size aside, VW's plans for MEB are massive; the automaker will build millions of vehicles using the architecture.*
> *Mercedes is planning an EQC crossover with a 80-kwh battery. The manufacturer-provided estimates have varied between 320 to 446 km (200 to 279 miles). The EQC is loosely based on the GLC-Class but uses two asynchronous motors to make 402 horsepower.*

15 https://www.greencarreports.com/news/1125399_the-most-important-electric-cars-for-2020

> *Although slated to be available for 2020, the Kia Soul EV may take longer to arrive. That could be due to higher-than-anticipated demand in Europe and difficulties sourcing the 64-kwh liquid-cooled battery pack that may deliver up to 389 km (243 miles) of range.*

Tesla has also just announced its CyberTruck for delivery in 2021 and (at the time of this report) already claims to have over 150,000 orders. The truck's starting price will be $39,900.00 (USD). The truck will be available in 3 models the lowest with a very competitive cost to comparable gas models will have 400 km (250 miles+) of EPA estimated range and 7,500 lbs. of towing capacity. The top model will have over 800 km (500 miles+) of range and will have towing capacity of 14,000 lbs.

3.6 Agriculture Opportunities for Anaerobic Digestion for Electrical Generation

Our review looked at 1 demonstration opportunity for agricultural operations to benefit from renewable energy and energy conservation. Burnside reviewed the opportunity for anaerobic digestion of plant and animal wastes.

An anaerobic digester (AD) is considered a renewable energy technology. The anaerobic digestion process occurs in an enclosed vessel and where manure and/or plant waste materials are broken down by micro-organisms in the absence of oxygen. Methane gas is generated and (for electrical production) is directed to an internal combustion engine powering an electrical generator. The heat produced from the facility can also be used. A good source of information on most aspects of this technology can be found on the Ontario Ministry of Agriculture, Food and Rural Affairs OMAFRA website.[16]

AD of farm wastes is beneficial to the environment even though there is still carbon dioxide gas released from the process. This is because it lowers greenhouse gas emissions, reduces odours and pathogens in the nutrient by-product materials (called digestate). Methane is a greenhouse gas and it traps 84 times more heat per mass unit than carbon dioxide. Since the methane is subject to combustion in the AD process the remaining gas is reduced to carbon dioxide. Also, if the digestate meets regulatory requirements it may be used as fertilizer. The digestate has the same nutrient content as the original feed stock. As mentioned, additional benefits of AD accrue from the reduction of odour and fewer pathogens. In Ontario a percentage (25) of off-farm wastes can be added to an on-farm AD process. In certain circumstances the off-farm waste can be increased to 50%. Provincial and local approvals are required, and some restrictions apply. Selection of certain off-farm materials can make the digestion process more efficient, increase the amount of methane generated and electricity.

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16 http://www.omafra.gov.on.ca/english/engineer/facts/15-031.htm

Hundreds of these facilities have been constructed and are operating in Europe. There are approximately 38 AD facilities currently operating in Ontario mostly at dairy farms.[17]

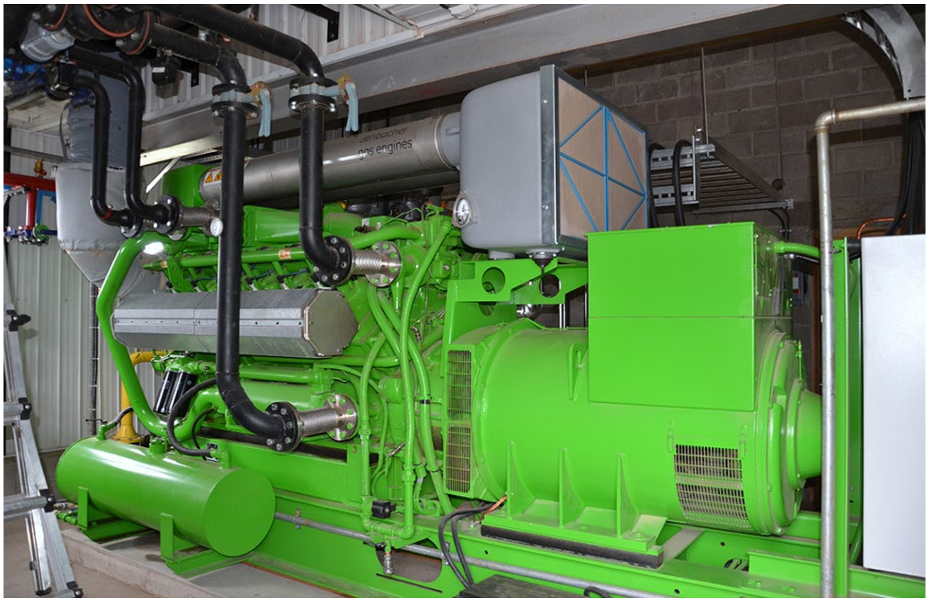
Unless the agricultural operation is large with a continuous supply of waste material and a substantial demand for electrical use on the farm in question, project feasibility would be questionable. Some large projects in Ontario are under consideration to produce renewable natural gas (RNG). There are also some very small AD systems that produce gas for electrical generation in the 10-kW range, however if is unlikely that with the current Net-Metering program in Ontario these would be financially viable without grants or subsidies.

Figure 2: A Manure-Based Anaerobic Digestion System on a Dairy Farm.[18]

17 Personal Communications with Chris Duke, Environmental Management Branch, OMAFRA, dated October 23, 2019.

18 Picture from: Anaerobic Digestion Basics, Factsheet - ISSN 1198-712X, Copyright Queen's Printer for Ontario, Agdex#:720/400, Publication Date: August 2015, http://www.omafra.gov.on.ca/english/engineer/facts/15-031.htm

Figure 3: Biogas System Producing Electricity by Burning Biogas in a Co-Generation System[19]



According to a report by Robert C. Anderson, Don Hilborn, and Alfons Weersinka,[20]

> *"…Previous studies have generally found ADs to be a poor investment for private firms without public assistance. The mixed results on the financial feasibility of ADs could be due to the site of the analysis since results vary with size, geographic location or the type of AD system, which are not standardized but rather customized to the individual situation."*

The report presents a free workbook that can be used to determine the financial feasibility of a farm-based AD. The authors conclude that for the livestock sector,

> *"Investment in an AD is financially feasible only for the largest dairy farms in Ontario under current electricity prices, which are approximately six times greater than the wholesale price. Shifting to a duel fuel continuous system would improve returns, as would the availability of additional substrate material in the form of solid grease and vegetative waste. Reductions in capital cost and improvements in the efficiency of the technology are probable given the relatively infant status of the biogas sector but these future enhancements would likely only alter the investment decisions for large commercial dairy farms."*

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19 Picture from: Anaerobic Digestion Basics, Factsheet - ISSN 1198-712X, Copyright Queen's Printer for Ontario, Agdex#:720/400, Publication Date: August 2015, http://www.omafra.gov.on.ca/english/engineer/facts/15-031.htm

20 An economic and functional tool for assessing the financial feasibility of farm-based anaerobic digesters, Robert C. Anderson, Don Hilborn, Alfons Weersinka https://www.sciencedirect.com/science/article/abs/pii/S0960148112005782

This analysis was undertaken at the time Ontario offered a FIT program with electrical prices much higher than today's Net-Metering prices. The need under today's Net-Metering program to essentially require matching electrical production with its use on the same property would present added challenges to project financial feasibility. As stated in OMAFRA Fact Sheet,[21]

> *"Net-Metering is an agreement where the energy generator (the AD operator) pays the electricity distributor only for the net amount of electricity consumed. This allows the AD facility to generate electricity at any time, send it to the grid and then use electricity at any other time. The net billing or reconciliation is within a specified period of time (1 year). The electricity distributor bills the facility for the net amount used. Generally, offsetting the farm's energy use will provide insufficient savings to cover the capital and operating costs of an AD system…"*

This is unfortunate since there may be some mid sized and larger farm operations in Mulmur that might potentially benefit from if some of the current provincial net-metering requirements were to consider virtual net-metering or some other system that would promote AD use from farm wastes. The virtual net-metering concept would allow property owners to amalgamate and total all of their electrical consumption from various owned properties and/or, facilities but locate the electrical generation facility on one property. In the future to mitigate the GHG effects of agricultural waste material funding programs may be needed to promote AD on farms.

For those who may wish to review the names of companies and individuals involved in the AD business OMAFRA has provided a Contact List (see footnote[22]).

4.0 Conclusions

Clearly with limited exceptions there are many energy conservation and renewable energy projects and transportation opportunities that could financially benefit individual residents and business owners in Mulmur including the municipal government. Prospective buyers are encouraged to carefully assess the benefits and costs before going forward. Private and municipal sectors are encouraged to embrace these new technologies, accrue the financial benefits and reduce GHG emissions.

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21 Anaerobic Digestion Basics, Factsheet - ISSN 1198-712X, Copyright Queen's Printer for Ontario, Agdex#:720/400, Publication Date: August 2015, http://www.omafra.gov.on.ca/english/engineer/facts/15-031.htm

22 http://www.omafra.gov.on.ca/english/engineer/facts/ad_contact.htm

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix A

Green Energy By-Law

THE CORPORATION OF THE TOWNSHIP OF MULMUR

BY-LAW NO. 39– 2019

Being a By-law to amend By-law No. 28-18, as amended, the Zoning By-law for the Corporation of the Township of Mulmur with respect to Green Energy (Wind, Solar and Bio-Energy)

WHEREAS the Council of the Corporation of the Township of Mulmur is empowered to pass By-laws to regulate the use of land pursuant to Section 34 of the *Planning Act*, R.S.O.1990 c.P. 13, as amended;

AND WHEREAS Bill 34 was given Royal Assent on December 6th, 2018 to repeal the Green Energy Act which prohibited zoning by-laws from regulating certain green energy projects (wind and solar) but re-enacted certain parts through amendments to the Electricity Act, 1998, as amended;

AND WHEREAS Bill 34 returns authority back to local government by requiring confirmation that a project meets local zoning requirements;

AND WHEREAS O. Reg 274/18 provides basic 'Siting restrictions for renewable energy generation facilities';

AND WHEREAS O.Reg 121/19 provides for transitional matters under the Planning Act, specifically in relation to section 62.0.2 (municipal by-laws)

AND WHEREAS Council passed Resolution 243-13 regarding commercial wind turbines;

AND WHEREAS Council is satisfied that the proposed amendments to the zoning by-law are appropriate and in accordance with the Official Plan in effect at the time, as well as applicable Provincial policies and plans;

NOW THEREFORE the Council of the Corporation of the Township of Mulmur enacts as follows:

1. Section 3.2.2 Permitted Accessory Buildings and Structures is amended by adding the following rows:

	A	RR	HR	ER	GC	BP	HC	M	RE	I	OS
Non-Commercial Wind Turbine, Wind Mill	√	√	√	√	√	√	√	√	√	√	√
Non-commercial Ground Mounted Solar Project	√	√	√	√	√	√	√	√	√	√	√
Roof Top Solar Project	√	√	√	√	√	√	√	√	√	√	√

2. Section 3.2.3, Regulations for Accessory Buildings and Structures, is further amended by adding "not including non-commercial wind turbines and non-commercial solar panels" in row 4 to now read "Maximum total number of all accessory buildings or structures having a floor area of 10m2 or less, not including non-commercial wind turbines and non-commercial solar panels"

3. Section 3.4, Encroachments and Height Exceptions of Comprehensive Zoning By-law No. 28-18, as amended, is hereby further amended by adding "non-commercial" before "wind turbine" where it appears.

4. Section 3.4 Encroachments is further amended by adding the following row:

Non-commercial Wind Turbine	Maximum height shall be 50% of the distance achieved between the base of the turbine and the closest lot line, and in no instance shall the hub height be greater than 36m
Non-commercial Solar Panel	Permitted in all yards except the front and exterior side yards but must maintain a minimum side yard and rear yard setback of 1.5m

5. Section 3, Definitions is hereby amended by adding the following definitions in alphabetical order:

WIND TURBINE, COMMERCIAL

Any wind turbine or collection of wind turbines that have a rated capacity of 10kW or greater. A Commercial Wind Turbine shall be considered a principle use.

GROUND MOUNTED SOLAR PROJECT, COMMERCIAL

Any ground mounted solar panel or collection of ground mounted solar panels that have a rated capacity of 20kW or greater. A Commercial Solar Project shall be considered a principle use.

BIO-ENERGY PROJECT, COMMERCIAL

Any bio-energy project, including but not limited to anaerobic digestion, biofuel, biogas and thermal treatment facilities but shall not include projects that are accessory to a farm operation utilizing only the waste produced on the same property.

WIND TURBINE, NON-COMMERCIAL
Any wind turbine or collection of wind turbines that have a rated capacity of less than 10kW, that is utilized to power a permitted use on the same property.

GROUND MOUNTED SOLAR PROJECT, NON-COMMERCIAL
Any ground mounted solar panel or collection of ground mounted solar panels that have a rated capacity of less than 20kW.

ROOF TOP SOLAR PROJECT

Roof top solar panels of all capacities that are located on a building(s) or structure(s) that is a permitted use and not a building designed only for the purpose of solar collection.

6. Section 3.12, Prohibited Uses and Use-Specific Provisions section is hereby amended by adding the following subsection:

3.12.7 WIND TURBINES AND LARGE-SCALE SOLAR

Except where explicitly permitted by this by-law, any *Commercial Wind Turbine, Commercial Bio-Energy Project* and *Commercial Solar Project* shall be prohibited and may only be considered by a site-specific amendment to this by-law.

This By-law shall come into force upon the date of passage hereof and take effect on the day after the last day for filing appeals. Where objections to the By-law are received in accordance with the provisions of the *Planning Act*, R.S.O.1990, c.P 13, as amended, the By-law shall come into effect upon the approval of the Local Planning Appeal Tribunal.

READ A FIRST, SECOND and THIRD TIME, and finally passed this 4th day of September 2019.

Janet M Horner

MAYOR

CLERK

R.J. Burnside & Associates Limited