Renewable Energy Action Plan

Oxford County

Growing stronger together

2022-2032

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PREFACE

On June 24, 2015, Oxford County Council unanimously passed the goal of 100% renewable energy (RE) by 2050, detailed in the *100% RE Plan* for the County community (all energy users within the County's geographical boundary). Since that date, County Council has thoroughly committed itself to sustainability with the addition of the Zero Waste and Zero Poverty initiatives. This *Renewable Energy Action Plan* (hereafter the *REAP*) aims to outline a road map for how the County, as an organization, will contribute to the 100% RE community goal within its own facilities portfolio. The goals of this plan are to reduce energy dependence and greenhouse gas (GHG) emission sources, as well as increase renewable energy generation on property owned and operated by the Oxford County organization. While the *100% RE Plan* is for the broad community, the County organization is an important part of that plan, not only as a contributor, but as a leader in demonstrating how it can achieve its own sustainability goals and share this knowledge with other organizations both within and outside of the County boundary.

1 OVERVIEW

1.1 About Oxford County

Oxford County is an upper-tier municipality located in southwestern Ontario and home to approximately 125,000 residents. The services provided by the County include, but are not limited to, engineering services, facilities, fleet, housing, libraries, planning, roads, waste management, water & wastewater collection & treatment, paramedicine and long-term care.

1.2 Purpose of the Plan

While County Council initially adopted the *100% RE Plan* in 2015, the County organization began investing in and installing renewable energy systems in 2011. These projects began with small-scale solar photovoltaic (PV) installations that were under the provincial Feed-In Tariff (FIT and Micro-FIT) program, which began in 2009 as a means of promoting greater use of renewable energy systems. Since then, there has been a gradual increase in the County's renewable energy portfolio, which then grew significantly in 2015 after County Council adopted the *100% RE Plan*.

The *100% RE Plan* is a community-wide initiative in which the County organization does not lead but has a major role to play. This role is not only as a contributor to addressing the energy consumption and generation potential of the County's own facility portfolio but also to be a leader within the community and demonstrate active support for the community goal. As shown in Figure 1 below, the *100% RE Plan* has a number of contributor groups, including individual residents, organization groups, businesses residing in the community and governments, which include the lower-tier municipalities, as well as the County organization. To date, the County organization has drafted and released an *Energy Management Plan (EMP)* and *Green Fleet Plan (GFP)*, which both lay out initiatives and objectives that contribute toward the County organization's goals and feed into the efforts to advance the *100% RE Plan*. While the County has continued to advance its renewable energy portfolio, it has not developed a longer-term roadmap outlining what that advancement looks like into the future. The purpose of this *REAP* is to outline opportunities to advance the County's renewable energy profile through increases in renewable energy utilization, by way of generation and harvesting, as well as energy conversions which in turn will reduce overall GHG emissions in the County's facility portfolio. The *REAP*, along with the *EMP* – which primarily focuses on energy conservation – and the *GFP* – which focuses on fleet energy consumption and emissions – holistically lay the groundwork for the County organization's contribution to the community *100% RE Plan*.

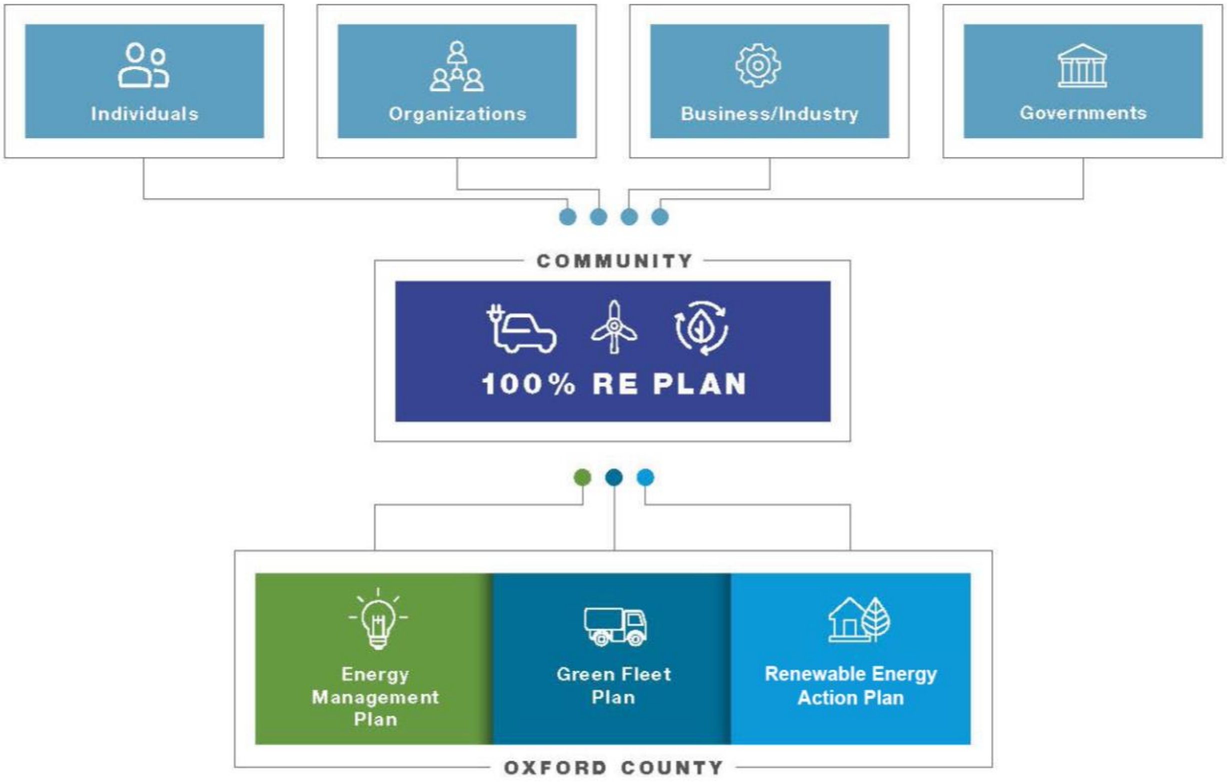

Figure 1 – 100% RE Plan Contributors

Further to supporting Oxford County's community goals, these three plans collectively support the federal government's mandate to achieve net-zero emissions by 2050. The *Canadian Net-Zero Emissions Accountability Act*, which became law on June 29, 2021, enshrines in legislation Canada's commitment to achieving net-zero emissions by 2050. As such, this *REAP* is a step towards supporting the overall emissions goals for the country as a whole.

To date, the County's deployed renewable energy systems have mainly been solar PV-type, which makes up 98% of the County's portfolio, with the remainder being solar thermal. Table 1 below outlines how the County's solar PV portfolio has grown since 2011. In total, the County has deployed systems at 18 different sites with a total capacity rating of 1,502 kW. Further to that, the total PV system generation baseline in 2021 was estimated at 1,781 MWh, and the actual generation was 1,836 MWh. Figure 2 shows that the cumulative generation from 2011 to the end of 2021 has been 4,680 MWh.

Table 1 – Municipal Solar PV Generation (2011 to 2021)

	Added Capacity (kW)	**Added Generation Baseline (MWh)**
2011	19	23
2012	10	12
2014	30	36
2016	53	63
2017	280	332
2019	120	142
2020	757	898
2021	233	276
Cumulative	1,502	1,781

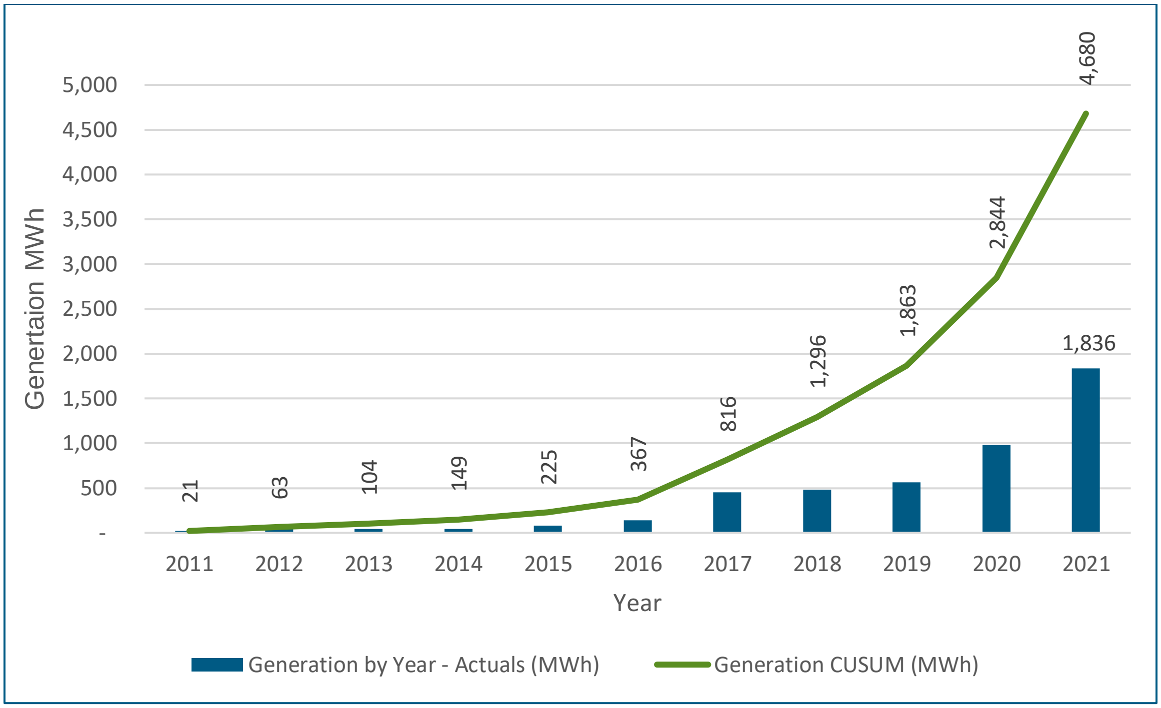

Figure 1 – Municipal Solar PV Generation

While the County organization has become very familiar with the technology and effort to install and operate this type of technology, it is understood that solar PV alone can only progress the 100% RE goals so far. A core objective of this *REAP* is to expand to other types of renewable energy technologies to explore additional implementation options. At the same time, the *REAP* provides a roadmap to grow the solar PV portfolio that the County organization has established to date.

1.3 Relationship to Oxford County's Strategic Plan

The *REAP* meets the County's initiative as set out in the following sections of the *Strategic Plan 2020-2022*:

3. iii. ***A County that Thinks Ahead and Wisely Shapes the Future*** - Demonstrated commitment to sustainability by:

- *Ensuring that all significant decisions are informed by assessing all options with regard to the community, economic and environmental implications including:*
  - *Life cycle costs and benefit/costs, including debt, tax and reserve levels and implications*
  - *Responsible environmental leadership and stewardship*

4. ii. ***A County that Informs and Engages*** - Inform the public about County programs, services and activities through planned communication that includes:

- *A County Report Card that engages and informs our community and celebrates our successes and our history*

5. ii. ***A County that Performs and Delivers Results*** - Deliver exceptional services by:

- *Conducting regular service reviews to ensure delivery effectiveness and efficiency*
- *Developing and tracking key performance indicators against goals and report results*
- *Identify best practices and appropriate benchmarking*

1.4 Goals and Objectives

The *100% RE Plan* outlines various targets related to energy conservation, GHG reduction and renewable energy generation. This *REAP* focuses on the latter-two items, as the *EMP* already has goals and objectives for energy conservation. For the purposes of this plan, the goals set out in the *100% RE Plan* will be used for the *REAP*, with the targets based on the County's original 2015 baseline. The target goals are outlined below in Table 2. "Renewable energy mix" refers to the percentage of renewable energy utilized from generation and harvesting from County-owned systems, versus total energy consumption. In order to reach the net 100% Renewable energy goal, the remainder would require purchasing from the Grid. The performance of this *REAP* will be measured against these targets, specifically striving for the 2030 targets.

Table 2 – 100% RE Plan Targets (for REAP)

Year	Total Reduction of GHG Emissions	Renewable Energy Mix Target	Renewable Energy Purchased Mix Target
2015	-	-	5.5%
2020	3.2%	5.3%	6.1%
2025	14.1%	11.7%	7.3%
2030	25.0%	19.5%	15.6%
2035	36.0%	29.1%	10.4%
2040	46.9%	41.4%	12.7%
2045	57.8%	57.8%	15.6%
2050	68.7%	80.3%	19.7%

1.5 Planning and Execution Strategy

The initial version of the *REAP* takes a 10-year outlook for project implementation. The *REAP* outlines financial requirements for each project, as well as anticipated outcomes resulting from implementation. Anticipated outcomes are estimates at this time and will need to be validated during the design phase of each project. The multi-year *REAP* will assist the County's Public Works department with allocating budget requests on an annual basis by giving a clear outline of what projects are to be implemented. The 10-year timeline was selected as it aligns with the Capital Plan requirements, and it is very likely that technology will evolve to the point where anything planned further out may be obsolete or no longer the best option.

The project execution strategy of this *REAP* is to complete validation and design work in year one, with project tender and execution in the following year or two, depending on the project scope. This strategy aligns with the general project management strategy employed in most projects within the Public Works portfolio and gives adequate time to plan, design, budget and tender, which helps improve budget accuracy and overall project quality.

2 PLAN DEVELOPMENT

This section provides an overview of how the *REAP* was developed, and the basis for the projects that were selected as part of its 10-year outlook. Oxford County undertook a Letter of Interest and subsequent Request for Proposal process and eventually awarded a contract to JL Richards & Associates Ltd. to undertake a review of existing County properties and facilities to evaluate various technologies and their potential performance. In addition, a second screening exercise was undertaken by Zon Engineering Inc. to evaluate additional sites for solar PV feasibility only.

2.1 Site Screening

To begin, JL Richards was tasked with reviewing 41 different County-owned sites and evaluating the feasibility of 14 various renewable energy systems. County staff provided site information, including facility drawings and utility consumption data. The system types that were reviewed included the following:

1. Solar PV (rooftop)
2. Solar PV (ground mount)
3. Solar PV (parking lot canopy)
4. Solar Thermal for Domestic Hot Water
5. Solar Thermal for Ventilation Air
6. Geothermal Heat Pumps for Space Heating and Cooling
7. Air Source Heat Pumps for Space Heating and Cooling
8. Air Source Heat Pumps for Domestic Hot Water
9. Rooftop Units with Heat Pumps
10. Wind
11. Biogas
12. Wood Pellet Boiler
13. Waste Heat Recovery
14. Small Hydro

A summary of the sites that were evaluated as well as an overview of each of these technologies, is included in sections 2.0 and 4.0 of Appendix A. Each technology type was assigned a rating for each site (from 0 to 4) based on the overall feasibility of that system being implemented at that particular site. A maximum of three technologies were selected for each site, which were then presented with potential performance metrics and estimated cost to implement. Selections were limited to a maximum of three in order to keep focus on the most viable technologies for each site.

2.2 Evaluation Development

Once the site screening phase was complete, a summary was completed which outlined potential performance metrics of each proposed system related to the following criteria:

1. Annual Change in Electricity Consumption (MWh)
2. Annual Change in Natural Gas Consumption (MWh)
3. Annual Change in Electricity Consumption (%)
4. Annual Change in Natural Gas Consumption (%)
5. Renewable as Portion of Building Consumption (%)
6. GHG Reductions (tCO2e/yr)
7. Estimated Capital Costs
8. Net Change in Annual Utility Costs
9. Lifecycle Costs/GHG ($/tCO2e)
10. Green Municipal Fund Eligible (this item was removed from the evaluation as it requires a loan)

The performance of each technology for each site was scored out of 10 for each of the above 10 criteria in order to give an overall evaluation score. In addition to the base scoring, County staff took these various criteria and assigned an additional weighting based on their importance to the County's goals. Weightings were determined based on how each criteria was supported in the following documents:

- *100% Renewable Energy Plan*
- *Energy Management Plan*
- *Future Oxford Sustainability Plan*
- *Oxford County Strategic Plan*

The weighting criteria and overall evaluation philosophy were presented to and approved by County Council on April 14, 2021, through Report No. PW 2021-11.

2.3 Project Selection & Prioritization

Based on the approved evaluation criteria and weightings, County staff worked with JL Richards to complete a final ranking of all technologies. From there, the list was further vetted to get to a final set of projects. This final vetting took into account items such as selecting smaller wood pellet boiler systems first to establish a pilot site in order to test the technology. Some sites also had two high-scoring technologies; however, if one was implemented, the other was no longer viable, so this vetting removed those redundancies.

Overall, projects were selected and prioritized in a manner to balance the following items:

- Explore, test and implement new technologies that the organization is not yet familiar with. Implementation would be monitored with the goal of duplication at other sites in the future.

- Continue to grow the existing solar PV portfolio.
- Maintain an annual capital investment of approximately $1M to maintain historical investment targets. All costs identified are estimated in 2021 dollars, and actual annual budget requests will take into consideration more accurate estimates obtained through the design process.

In addition to the technologies and projects noted above as part of the assessment by JL Richards, Solar PV sites were included based on assessment by Zon Engineering, as well as one additional project; Woodstock WWTP Biogas Utilization, initially identified in the *EMP*, has been included in this list as it is undergoing feasibility assessment, with results expected later in 2022.

This plan includes a study to explore the utilization of biogas at the County's Waste Management Facility (OCWMF) in Salford. The OCWMF began operation in 1986 and has a maximum approved waste capacity of 5,905,200 m3. The site receives approximately 45,000 tonnes of municipal solid waste annually, and a landfill gas (LFG) collection and flaring system was installed in 2010. It is estimated that the collection system covers approximately 25-35% of the total waste mass. High-level estimates based on biogas flare consumption detailed in the OCWMFs flare gas operators 2021 annual report, provides the indication of renewable energy potential. OCWMF has a low energy demand, resulting from previous net-zero electrification and no Enbridge natural gas pipeline currently connected to the site; therefore, utilization of the energy may be an issue considering these existing site conditions, and regulatory challenges related to the distribution off-site. This study will determine the biogas potential, options for utilizing the energy and determine the overall feasibility of utilizing biogas at the OCWMF site for consideration in future iterations of this plan.

Based on the above items, as well as the execution strategy of design in Year 1 and construction in Year 2; Table 3 below identifies the proposed projects and implementation year. As a note, the heat recovery system at the Ingersoll Wastewater Treatment Plant and Woodstock Biogas Utilization projects are spread over three years, as additional time should be spent on design, installation and commissioning to ensure optimal performance. In addition, the annual budget estimate per year is included at the bottom of the figure. Figure 3 provides a summary of proposed project technologies and their impact on reducing the County's dependence on non-renewable energy by way of energy conversion or offset through renewable energy utilization. Refer to Section 3 Project Summaries for further details on specific projects.

Projects were staged in a manner to keep capital expenditures as close to $1M/year as possible to mirror sustainable investment from previous budget years. With the addition of the Woodstock WWTP Biogas project, the average capital expenditure is just under $1.5M/year. As noted, years 2025 and 2027 significantly exceed this due to the projects planned for these years. These are larger projects which can't be broken up, which is why the investment requirement is more significant in these years. Capital requirements for all projects will be validated and refined during the design phase of each project.

Table 3 – REAP Proposed Implementation

Project	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
364 Athlone Solar PV	🟦	🟦									
Thamesford WWTP Solar PV	🟦	🟦									
WDSK Biogas Utilization	🟦	🟦	🟦								
OCWFM Flare Preliminary Energy Study		🟦									
59 George Johnson Wood Pellet Boilers		🟦	🟦								
135 Carroll Solar PV		🟦	🟦								
300 Juliana GSHP*			🟦	🟦							
WDSK Patrol Wood Pellet Boilers				🟦	🟦						
Highland Patrol Solar PV				🟦	🟦						
16 George Solar PV				🟦	🟦						
415 Hunter GSHP					🟦	🟦					
410 Buller GSHP					🟦	🟦					
Ingersoll WWTP Heat Recovery					🟦	🟦	🟦				
82 Finkle Solar PV							🟦	🟦			
Springford Solar PV							🟦	🟦			
Woodstock Patrol Solar PV							🟦	🟦			
Drumbo Patrol Solar PV							🟦	🟦			
Springford Wood Pellet Boiler								🟦	🟦		
742 Pavey Solar PV								🟦	🟦		
377 Mill Street ASHP									🟦	🟦	
70 Maria Solar PV									🟦	🟦	
221 Thames Solar PV									🟦	🟦	
742 Pavey Wood Pellet Boilers										🟦	🟦
Annual Budget	**$135,000**	**$899,300**	**$1,315,290**	**$7,415,451**	**$968,989**	**$1,829,310**	**$1,589,876**	**$709,595**	**$860,136**	**$896,319**	**$657,301**

*300 Juliana GSHP project submitted an application for the Low Carbon Economy Challenge in the summer of 2022. If successful, this project will be completed earlier than identified to align with funding requirements.

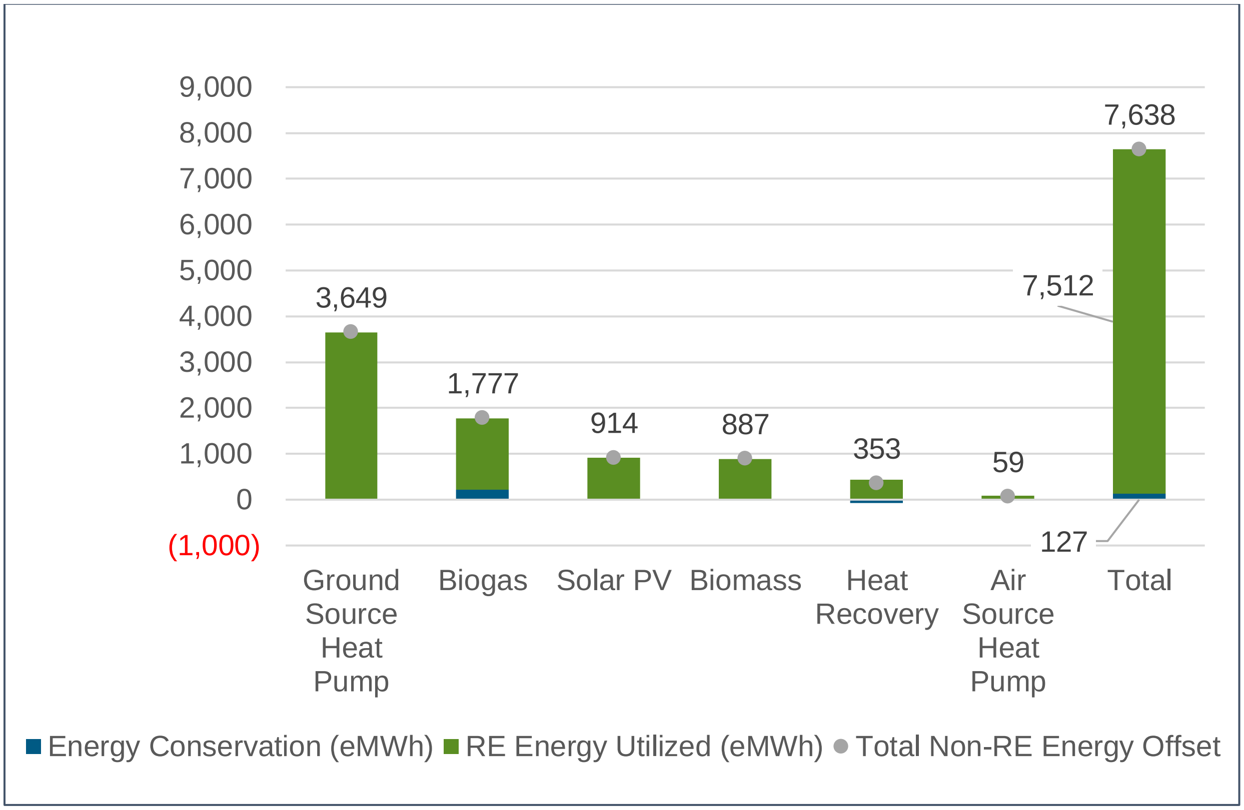

Figure 2 – Total Non-Renewable Energy Reduction by Technology

3 PROJECT SUMMARIES

This section provides an overview of each of the proposed projects. Capital Cost Estimates are based on the present value of projects adjusted for inflation to the implementation year. Financial analysis is based on the nominal discount rate, reinvestment and borrowing rate of 4.18%, annual inflation rate of 2% (adjusts capital cost and operations cost impacts), electrical and biomass fuel rate increase of 3% and natural gas rate increase of 5%. It also includes the cost of carbon based on the federal carbon tax table to 2030, with an increase of 3% for the subsequent year over year.

The Net Present Value (NPV) represents the value of the project(s) in 2022 dollars in contrast to the future value of the annual cash flow balance (cash inflow minus cash outflow) compounded at the nominal discount rate as noted above. The higher the NPV at the end of the project's life cycle, the better the investment. In fact, a project with a positive NPV at the end of its life cycle indicates that the project provided a return equal to or greater than if the capital cost was invested at the nominal discount rate compounded over the projects life cycle; with the added benefit of the renewable energy and GHG emissions reductions.

The Modified Internal Rate of Return (MIRR) is the return on the project's annual future value cash flow (cash inflow minus cash outflow), assuming positive cash inflow can be invested at the reinvestment rate noted above and negative cash flow is borrowed at the rate noted above. A project with a MIRR equal to the nominal discount rate would have a NPV of $0 (i.e., refer to Project 3.21 - 221 Thames Solar PV details).

3.1 – 364 Athlone Solar PV

Beneath the area of the proposed ground-mount system is a 24 m by 24 m reservoir cell for storing water; there is a plan to add a second cell that is 23 m in length beside it, but after talking with the operations group, no date has yet been set for this expansion. In order to make use of this site and provide long-term flexibility in the event that the reservoir expansion is needed, a ballasted foundation system would be explored for the solar PV system. Typically, ballasted systems are used for flat-roof applications, but in this case would provide a solid foundation without penetrating the ground, allowing for the system to be easily removed and reinstalled if and when the expansion work occurs.

A 192 kWAC system is proposed to be installed on this site, which is anticipated to offset the majority of the site’s current consumption; however, this will need to be validated during the design phase.

Implementation	2022/2023
Capital Cost Estimate	$578,000
GHG Reduction	7.2 tCO2e/yr
Renewable Energy Utilized	240.0 MWh/yr
Equity Payback	16 Years
30 Year NPV/ MIRR	$165,000 / 5.2%

3.2 – Thamesford WWTP Solar PV

Installation of a 90.9kWAC rooftop solar PV system at the Thamesford Wastewater Treatment Plant would result in an anticipated annual generation of 116MWh. This generation would equate to approximately 18% of the site's total electrical consumption. The system would be focused on the existing rooftop only so as to maintain ground availability for future plant expansion opportunities.

Implementation	2022/2023
Capital Cost Estimate	$246,300
GHG Reduction	3.48 tCO2e/yr
Renewable Energy Utilized	116.0 MWh/yr
Equity Payback	15 Years
30 Year NPV/ MIRR	$105,000 / 5.6%

3.3 – WDSK WWTP Biogas Utilization

Numerous County facilities are producing a form of renewable energy through biogas, and there is an opportunity to examine more efficient methods of utilizing this resource. If this energy is properly utilized, it can significantly reduce greenhouse gas (GHG) emissions, energy consumption and operational costs. If this initiative is successful, it will greatly contribute to the County's 100% renewable energy goal, have a positive impact on the environment and will free up fixed finances.

The goal of this project is to complete a Preliminary Engineering Study (PES) at the County's Woodstock WWTP, located at 195 Admiral St., for utilizing and maximizing its biogas production. Pending the recommended solution having favourable results, the subsequent engineering design, contract and construction will be undertaken, targeting completion in 2024.

This initiative was identified as part of the *EMP*, with preliminary data on potential renewable energy utilization. Capital costs and GHG reductions are estimated based on the assumed potential natural gas offset as a result of biogas utilization.

Implementation	2022-2024
Capital Cost Estimate	$457,000 ($450,000 PV) *
GHG Reduction	324 tCO2e/yr
Renewable Energy Utilized	1,555 eMWh/yr *
Energy Conservation	222 eMWh/yr *
Equity Payback	9 Years
30 Year NPV/ MIRR	$1,320,000 / 9.7%
* Pending results of PES. Capital Cost could increase to $1.7 million with energy impact noted or energy reduction reduced to only 20% of indicated with cost noted, in order to maintain a positive NPV over a 30-year life cycle, and equity payback within 20 years.	

3.4 – 59 George Johnson Wood Pellet Boilers

Wood pellet boilers can supplement natural gas boilers with a zero-GHG fuel. The GHG emissions emitted during the combustion of wood pellets is equivalent to the amount consumed during the growth stage of the tree which is used for pellet fuel. Residential wood pellet boilers can ramp up/down their heating capacities automatically and multiple units can be connected to provide staged heating in larger buildings. All of the heating sources would be controlled through the same system, prioritizing the wood pellet boilers in stages for baseload heating and the natural gas heaters for peak (and back-up).

As a retrofit, these wood pellet boilers would be installed outdoors, close to the existing mechanical room in a containerized package requiring approximately 15 m² to 30 m² of ground area, depending on the number of boilers. A wood pellet storage silo would be constructed next to this container requiring approximately 13 m² of ground area. A wood pellet delivery truck would require access to this silo approximately once a month during the heating season.

Compared to natural gas boilers, maintenance costs are higher for wood pellet boilers, as the ash box must be emptied monthly in addition to the detailed cleaning required twice per heating season. Although the operating cost of a wood pellet boiler is higher than that of a natural gas boiler, it should be noted that common natural gas is not a clean or renewable energy source, and considering that wood pellet energy is less than the cost of electricity, replacing equipment with wood pellets as the primary fuel source would provide the County organization a technology to showcase as a means toward attaining its renewable energy goals.

Three (3) 48 kW wood pellet boilers would supplement the existing natural gas heating system to provide 100% of the building's peak heating supply. The wood pellet boilers would provide heat to a new hydronic heating loop connected to new unit heaters. The wood pellet containerized system and storage silo would have a similar appearance to other buildings and structures on the sites.

Implementation	2023/2024
Capital Cost Estimate	$687,100 ($675,000 PV)
GHG Reduction	31.7 tCO2e/yr
Renewable Energy Utilized	174 eMWh/yr
Equity Payback	54 Years
30 Year NPV/ MIRR	-$590,000 / -5.8%

3.5 – 135 Carroll Solar PV

This would entail the installation of a 43.2kWAC rooftop solar PV system at the multi-unit residential site at 135 Carroll Street in Ingersoll. It is anticipated that this system will have an annual generation of approximately 60MWh, which equates to 24% of the building's current consumption. This site was selected early in the *REAP* as the roof was recently replaced in 2020, and it is ideal to install PV panels on a newer roof to avoid having to remove the system to replace an aging roofing system. In most cases to date, the County has only installed solar PV systems on new roof systems. In addition, solar PV systems can actually prolong the life of the roof system by protecting it from the elements.

Implementation	2023/2024
Capital Cost Estimate	$144,440 ($142,000 PV)
GHG Reduction	1.9 tCO2e/yr
Renewable Energy Utilized	61.9 MWh/yr
Equity Payback	15 Years
30 Year NPV/ MIRR	$45,000 / 5.4%

3.6 – 300 Juliana GSHP

Ground source heat pumps (GSHP) provide both heating and cooling to a building by transferring heat energy to and from the earth through underground fluid loops. During the winter months, the system extracts natural heat from the ground and brings it up into the building, while in the summer months, the system collects excess heat from the building and transfers it to the ground, which cools the facility space. The ground heat exchanger (GHX) can be either open or closed-loop, with closed-loop currently more common in Canada. Construction of the GHX component is a significant capital cost but has an expected useful life of 50+ years. Closed-loop systems can be constructed in almost any subsurface conditions, while open-loop – generally lower cost – require a highly productive aquifer to be feasible. For the purposes of Oxford County sites, closed-loop systems will likely be explored for Source Water Protection purposes.

For all buildings, the new GSHP would replace as much of the building's space heating and cooling supply as possible. Shifting the entire heating load to electricity may be beyond the existing capacity of the incoming electrical service for some buildings, and an upgrade may be required. No increase or decrease in maintenance costs is expected, as the maintenance requirements for GSHPs are similar to natural gas boilers, and the GSHP replace the current chillers, eliminating their maintenance.

At 300 Juliana, four (4) 140-ton ground-source heat pumps (GSHP) would replace the existing natural-gas boilers. For a closed-loop system, a borehole field area of approximately 11,000 m² would be required. The existing perimeter hydronic heating system uses hot water at temperatures that can be provided by a GSHP. New fan coils retrofitted onto the existing RTUs would be required to utilize the hot and chilled water provided by the GSHP.

Implementation	2024/2025 *(This timeline may be brought forward if Low Carbon Economy Challenge funding is granted in 2022.)*
Capital Cost Estimate	$7,538,565 ($7,250,000 PV)
GHG Reduction	713 tCO2e/yr
Renewable Energy Utilized	3,216 MWh/yr
Energy Conservation	92 eMWh/yr
Equity Payback	30 Years 23 Years (with LCEC Funding)
30 Year NPV/ MIRR	-$3.17 million / 1.9% -$635,000 / 3.6% (with LCEC Funding)

3.7 – Woodstock Patrol Wood Pellet Boilers

Implementation of a pellet boiler system at this site would be dependent on a successful deployment of the earlier project at 59 George Johnson in Ingersoll. Two (2) 48 kW wood pellet boilers would supplement the existing natural gas heating system to provide 95% of the building's peak heating supply. The wood pellet boilers would provide heat to the existing hydronic heating loop connected. The wood pellet containerized system and storage silo would have a similar appearance to other buildings and structures on the site.

Implementation	2025/2026
Capital Cost Estimate	\$540,000 (\$510,000 PV)
GHG Reduction	24.5 tCO2e/yr
Renewable Energy Utilized	134.4 eMWh/yr
Equity Payback	52 Years
30 Year NPV/ MIRR	-\$420,000 / -4.6%

3.8 – Highland Patrol Solar PV

Installation of a 37.5kWAC rooftop solar PV system at the Highland Patrol Yard. It is anticipated that this system will have an annual generation of approximately 50MWh, which equates to 100% of the building's current consumption. The majority of the main shop roof was replaced in 2020 with a new metal roof making it an ideal time to install a solar PV system.

Implementation	2025/2026
Capital Cost Estimate	\$152,500 (\$144,100 PV)
GHG Reduction	1.5 tCO2e/yr
Renewable Energy Utilized	49.9 MWh/yr
Equity Payback	18 Years
30 Year NPV/ MIRR	\$10,000 / 4.5%

3.9 – 16 George Solar PV

Installation of a 43.2kWAC rooftop solar PV system at the multi-unit residential site at 16 George Street in Norwich. It is anticipated that this system will have an annual generation of approximately 65MWh which equates to 33% of the building's current consumption.

Implementation	2025/2026
Capital Cost Estimate	$157,700 ($149,000 PV)
GHG Reduction	1.95 tCO2e/yr
Renewable Energy Utilized	65.0 MWh/yr
Equity Payback	15 Years
30 Year NPV/ MIRR	$50,000 / 5.4%

3.10– 415 Hunter GSHP

A 66-ton GSHP will replace the existing natural-gas boilers. For a closed-loop system, a borehole field area of approximately 930 m² would be required. This GSHP would provide hot and chilled water to the existing closed loop water source heat pump system. The existing hydronic perimeter heaters require inlet temperatures that are beyond the capacity of most GSHPs, requiring either a specialty heat pump or replacement of the perimeter heaters.

Implementation	2026/2027
Capital Cost Estimate	$1,297,000 ($1,200,000 PV)
GHG Reduction	56.9 tCO2e/yr
Renewable Energy Utilized	328 eMWh/yr
Energy Conservation	-56 eMWh/yr
Equity Payback	39 Years
30 Year NPV/ MIRR	-$720,000 / 0.3%

3.11– 410 Buller GSHP

A 16-ton GSHP will replace the existing natural-gas boilers. For a closed-loop system, a borehole field area of approximately 130 m² would be required. Due to the proximity of the Oxford County Courthouse, there is the potential for significant costs savings if these projects are deployed at the same time in order to share the same ground loop. This GSHP would provide hot and chilled water to the existing closed-loop water source heat pump system.

Implementation	2026/2027

Capital Cost Estimate	$584,000 ($540,000 PV)
GHG Reduction	13.9 tCO2e/yr
Renewable Energy Utilized	104 eMWh/yr
Energy Conservation	-35 eMWh/yr
Equity Payback	48 Years
30 Year NPV/ MIRR	-$375,000 / -1.2%

3.12– Ingersoll WWTP Heat Recovery

A 325 kW waste heat recovery system would largely replace the existing natural gas and electric heater systems to provide 100% of the building's space heating. 1,000 kW of waste heat is continuously available during the heating season from the plant's effluent stream. It is rarely economical to transport this low-grade heat, so it must be used on the same or an adjacent property.

Since the effluent at the end of the treatment process is largely clear of solid material, standard heat exchanger equipment can be utilized. The output of the heat exchanger is run through heat pumps to maintain the heating loop temperature utilizing the existing hydronic loop in the newer portion of the plant. This loop would be extended to the old plant, and new hydronic unit heaters would be installed. No increase or decrease in maintenance costs is expected, as conventional equipment is used, which can be maintained by trained HVAC technicians.

Implementation	2026 – 2028
Capital Cost Estimate	$1,663,000 ($1,510,000 PV)
GHG Reduction	76.0 tCO2e/yr
Renewable Energy Utilized	429 eMWh/yr
Energy Conservation	-76 eMWh/yr
Equity Payback	40 Years
30 Year NPV/ MIRR	-$900,000 / 0.2%

3.13– 82 Finkle Solar PV

Installation of a 28.8kWAC rooftop solar PV system at the multi-unit residential site at 82 Finkle Street in Woodstock. It is anticipated that this system will have an annual generation of approximately 40MWh, which equates to 23% of the building's current consumption.

Implementation	2028/2029
Capital Cost Estimate	$149,000 ($132,600 PV)
GHG Reduction	1.35 tCO2e/yr
Renewable Energy Utilized	42.2 MWh/yr
Equity Payback	19 Years
30 Year NPV/ MIRR	$5,000 / 4.3%

3.14– Springford Patrol Solar PV

Installation of a 25kWAC rooftop solar PV system at the Springford Patrol Yard. It is anticipated that this system will have an annual generation of 34MWh, which equates to 100% of the building's current consumption. The site already includes a 10kW MicroFIT system, and this system would offset the total site consumption through the Net-Meter program. Panels would be installed on the main shop facility, as well as a new storage facility that was constructed in 2021.

Implementation	2028/2029
Capital Cost Estimate	$172,000 ($152,300 PV)
GHG Reduction	1.04 tCO2e/yr
Renewable Energy Utilized	34.7 MWh/yr
Equity Payback	24 Years
30 Year NPV/ MIRR	-$30,000 / 3.2%

3.15– Woodstock Patrol Solar PV

Installation of a 50kWAC rooftop solar PV system at the Woodstock Patrol Yard. It is anticipated that this system will have an annual generation of approximately 60MWh, which equates to 83% of the building's current consumption. The site already includes a 10kW MicroFIT system, and this system would offset the majority of site consumption through the Net-Meter program. As part of the design stage, the overall site consumption would be re-evaluated to take into consideration the implementation of the wood pellet boiler system.

Implementation	2028/2029

Capital Cost Estimate	$212,000 ($188,400 PV)
GHG Reduction	1.8 tCO2e/yr
Renewable Energy Utilized	60.1 MWh/yr
Equity Payback	19 Years
30 Year NPV/ MIRR	$5,000 / 4.3%

3.16– Drumbo Patrol Solar PV

Installation of a 45kWAC rooftop solar PV system at the Woodstock Patrol Yard. It is anticipated that this system will have an annual generation of approximately 53MWh, which equates to 100% of the building's current consumption. The current *Asset Management Plan* identifies this roof to be replaced in 2025, making an implementation in 2029 on a newer roof system ideal to avoid unnecessary costs related to system removal.

Implementation	2028/2029
Capital Cost Estimate	$170,500 ($151,800 PV)
GHG Reduction	1.6 tCO2e/yr
Renewable Energy Utilized	53.6 MWh/yr
Equity Payback	18 Years
30 Year NPV/ MIRR	$15,000 / 4.6%

3.17– Springford Patrol Wood Pellet Boilers

As with the project at 59 George Johnson, three (3) 48 kW wood pellet boilers would supplement the existing natural gas heating system to provide 100% of the building's peak heating supply. The wood pellet boilers would provide heat to a new hydronic heating loop connected to new unit heaters. The wood pellet containerized system and storage silo would have a similar appearance to other buildings and structures on the site.

Implementation	2029/2030
Capital Cost Estimate	$722,000 ($630,000 PV)
GHG Reduction	28.0 tCO2e/yr
Renewable Energy Utilized	154 eMWh/yr
Equity Payback	51 Years
30 Year NPV/ MIRR	-$460,000 / -2.9%

3.18– 742 Pavey Solar PV

Installation of a 28.8kWAC rooftop solar PV system at the multi-unit residential site at 742 Pavey Street in Woodstock. It is anticipated that this system will have an annual generation of approximately 40MWh which equates to 15% of the building's current consumption. The current *Asset Management Plan* identifies this roof to be replaced in 2028, making an implementation in 2030 ideal.

Implementation	2029/2030
Capital Cost Estimate	$148,000 ($128,800 PV)
GHG Reduction	1.27 tCO2e/yr
Renewable Energy Utilized	42.2 MWh/yr
Equity Payback	18 Years
30 Year NPV/ MIRR	$5,000 / 4.5%

3.19– 377 Mill ASHP

Four (4) 5-ton air-source heat pump (ASHP) rooftop units (RTUs) would replace the existing natural gas RTUs to provide 100% of the buildings heating and cooling supply. A back-up electric resistance heater is built into these RTUs for use in extreme cold winter temperatures when the heat pump becomes ineffective, typically only a few hours a year. Shifting the entire heating load to electricity may be beyond the existing capacity of the incoming electrical service and an upgrade may be required. No increase or decrease in maintenance costs are expected as the maintenance requirements for ASHP RTUs are like natural gas RTUs. The project is planned for 2031 to align with the anticipated replacement of the existing RTUs.

Implementation	2030/2031
Capital Cost Estimate	$407,000 ($348,000 PV)
GHG Reduction	16.8 tCO2e/yr
Renewable Energy Utilized	80 MWh/yr
Energy Conservation	-20.7 eMWh/yr
Equity Payback	51 Years
30 Year NPV/ MIRR	-$250,000 / -2.9%

3.20– 70 Maria Solar PV

Installation of a 100.8kWAC rooftop solar PV system at the multi-unit residential site at 70 Maria Street in Tavistock. It is anticipated that this system will have an annual generation of approximately 120MWh, which equates to 47% of the building's current consumption. The local grid currently does not have capacity to support this system, so it is being included later in the *REAP* with the hope that additional system capacity is freed up, which would allow this project to proceed. Validation of grid capacity will be completed as part of the design phase. In addition, the current *Asset Management Plan* identifies this roof to be replaced in 2030, making an implementation in 2031 ideal.

Implementation	2030/2031
Capital Cost Estimate	$400,200 ($342,000 PV)
GHG Reduction	3.6 tCO2e/yr
Renewable Energy Utilized	121 MWh/yr
Equity Payback	17 Years
30 Year NPV/ MIRR	$55,000 / 4.8%

3.21– 221 Thames Solar PV

Installation of a 17.3kWAC rooftop solar PV system at the multi-unit residential site at 221 Thames Street in Ingersoll. It is anticipated that this system will have an annual generation of 27MWh, which equates to 34% of the building's current consumption. The current *Asset Management Plan* identifies this roof to be replaced in 2030, making an implementation in 2031 ideal.

Implementation	2030/2031
Capital Cost Estimate	$105,100 ($90,600 PV)
GHG Reduction	0.83 tCO2e/yr
Renewable Energy Utilized	27 MWh/yr
Equity Payback	20 Years
30 Year NPV/ MIRR	$0.00 / 4.1%

3.22– 742 Pavey Wood Pellet Boilers

Four (4) 48 kW wood pellet boilers would supplement the existing natural gas boilers to provide 50% of the buildings peak heating supply. The wood pellet boilers would provide heat to the existing hydronic loop system. With this being a non-industrial application, implementation will be dependent on successful implementation of previous wood pellet systems included earlier in the *REAP*. There are also additional considerations for storage and supply accessibility at this site which is why it is later in the *REAP*.

Implementation	2031/2032
Capital Cost Estimate	$728,000 ($610,000 PV)
GHG Reduction	77.6 tCO2e/yr
Renewable Energy Utilized	425 eMWh/yr
Equity Payback	35 Years
30 Year NPV/ MIRR	-$340,000 / 0.6%

3.23– OCWMF Biogas Utilization Study

The Oxford County Waste Management Facility is a potential source of biogas renewable energy. High-level estimates based on current biogas flare consumption show substantial renewable energy potential; however, utilization of the energy may be an issue considering low energy requirements on-site resulting from previous net-zero electrification and regulatory challenges of distribution off-site. The County has budget costing to complete a high-level feasibility study to determine the quality and characteristics of the biogas, the life cycle of the biogas considering methane depletion on site and how the energy could be utilized; whether there is demand on-site for utilization or if it can be distributed. Further investigation will be required to determine if future development is viable, and identify any existing regulatory constraints. Subsequent design and implementation will be included as part of the annual budget process.

Implementation	2023
Feasibility Study Cost Estimate	$20,000

4 TARGET PERFORMANCE

This section provides an overview of the cumulative performance of the proposed systems and technology once they are implemented. The performance is measured against both the 2015 baseline, as well as a 2019 baseline which is the most recent year that data is available. This additional metric is important to consider, as steps have been taken by the County organization to progress these goals since 2015.

4.1 – GHG Reduction

Through the implementation of this *REAP*, the projected GHG emissions reduction is outlined in Figure 4 below. Further to this, Table 4 quantifies the annual GHG reduction for each year, and also provides a percentage in relation to the 2015 and 2019 baselines. As noted, the performance is anticipated to exceed the 2030 goal of 25% reduction over 2015 levels set out in the *100% RE Plan*.

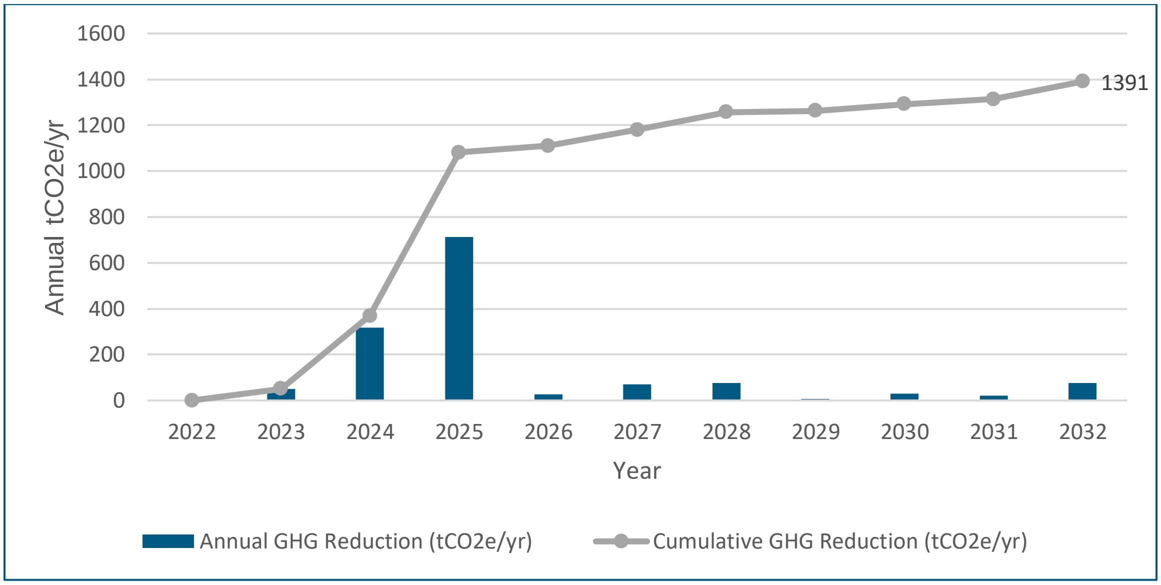

Figure 3 – GHG Reduction by Year and Cumulative

Table 4 – Cumulative GHG Reduction Target

Year	Annual GHG Reduction (tCO2e/yr)	Cumulative GHG Reduction (tCO2e/yr)	% Reduction from 2015 Baseline (4,044 tCO2e)	% Reduction from 2019 Baseline (3,648 tCO2e)
2022	0	0	0.0%	0.0%
2023	51	51	1.3%	1.4%
2024	318	369	9.1%	10.1%
2025	713	1082	26.8%	29.7%

2026	28	1110	27.4%	30.4%
2027	71	1181	29.2%	32.4%
2028	76	1257	31.1%	34.4%
2029	6	1262	31.2%	34.6%
2030	29	1292	31.9%	35.4%
2031	21	1313	32.5%	36.0%
2032	78	1391	34.4%	38.1%
Totals	1391		34.4%	38.1%

In Table 4 above, comparisons are made against baselines from both 2015 and 2019 (2019 was selected as it is the last year of data not impacted by the COVID-19 pandemic). This was done as a comparison to the 2015 targets set out in the initial *100% RE Plan* document, but also to compare against the 2019 baseline which takes into account conservation work that has been implemented through the *EMP*. Since the *100% RE Plan* targets are not simply about implementing renewable energy systems, but also about reduced consumption and conservation, it is important to take these measures into account. Essentially, this demonstrates how the various County plans work together to maximize performance targets.

4.2 – Renewable Energy Mix

To date, the majority of the renewable energy systems implemented by the County organization have been solar PV systems. Due to regulatory constraints, this technology can only go so far in achieving the desired renewable energy mix. Table 5 shows how the REAP will expand the current solar PV portfolio, as well as the projected impact on the renewable electricity mix percentage. As shown in the table, even with EMP impacts to the baseline between 2015 and 2019, solar alone falls short on achieving the targets set out in Table 2.

Table 5 – Solar PV Generation and Electrical Mix

Year	Solar Portfolio Increase (kW)	Solar Generation (MWh)	Cumulative Solar Generation (MWh)	Renewable Energy Mix from 2015 Electrical Baseline	Renewable Energy Mix from 2019 Electrical Baseline
2022	N/A	N/A	1,781	6.06%	7.10%
2023	283	356	2,137	7.27%	8.52%
2024	43	62	2,199	7.48%	8.77%
2025	0	-	2,199	7.48%	8.77%
2026	80	115	2,314	7.88%	9.23%
2027	0	-	2,314	7.88%	9.23%
2028	0	-	2,314	7.88%	9.23%

2029	149	191	2,504	8.52%	9.99%
2030	29	42	2,547	8.67%	10.16%
2031	118	148	2,695	9.17%	10.75%
2032	0	-	2,695	9.17%	10.75%
Totals	**702**	914			

In order to expand the renewable energy portfolio beyond solar PV, and further reduce GHG emissions and increase the renewable energy mix, the REAP will look to deploy additional energy utilization technologies. Through the holistic implementation of the REAP, renewable energy utilization and the associated mix percentage in terms of total consumption are outlined in Table 6. Table 6 identifies the quantity of renewable energy generated or harvested on an annual basis through the implementation of this plan. This number is then compared to the estimated energy consumption across all County facilities to determine the renewable energy mix percentage. Energy estimates are based on 2019 actuals to exclude COVID-19 impacts, plus a 1% annual increase, while also taking into account projected impacts from the current EMP. This is a conservative approach as the current EMP only goes to 2024, and subsequent plans will produce overall reductions in consumption. Further to that, Figures 5 and 6 also demonstrate this year-over-year growth.

Table 6 - Projected Total RE Mix

Year	Total Energy Consumption (eMWh/yr)*	RE Utilization (eMWh/yr)	RE Mix %**
2022	39,707	1,781	4.5%
2023	39,840	2,137	5.4%
2024	39,800	3,928	9.9%
2025	40,132	7,144	17.8%
2026	40,559	7,393	18.2%
2027	41,082	7,825	19.0%
2028	41,594	8,254	19.8%
2029	42,035	8,444	20.1%
2030	42,480	8,640	20.3%
2031	42,950	8,868	20.6%
2032	43,404	9,293	21.4%

* Total Energy Consumption is based on 2019 actuals plus 1% Year over Year Growth and energy conservation measures identified in the EMP.
** RE Mix % is based on RE Utilization over Total Energy Consumption

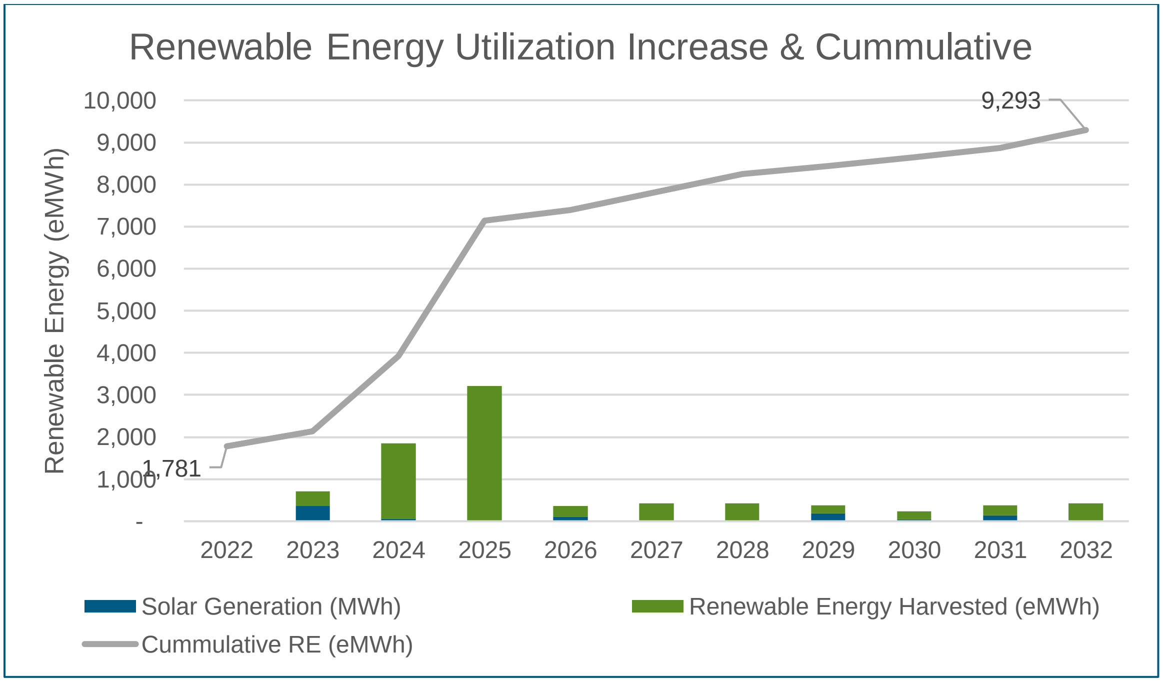

Figure 4 – Renewable Energy Utilization Increase & Cumulative

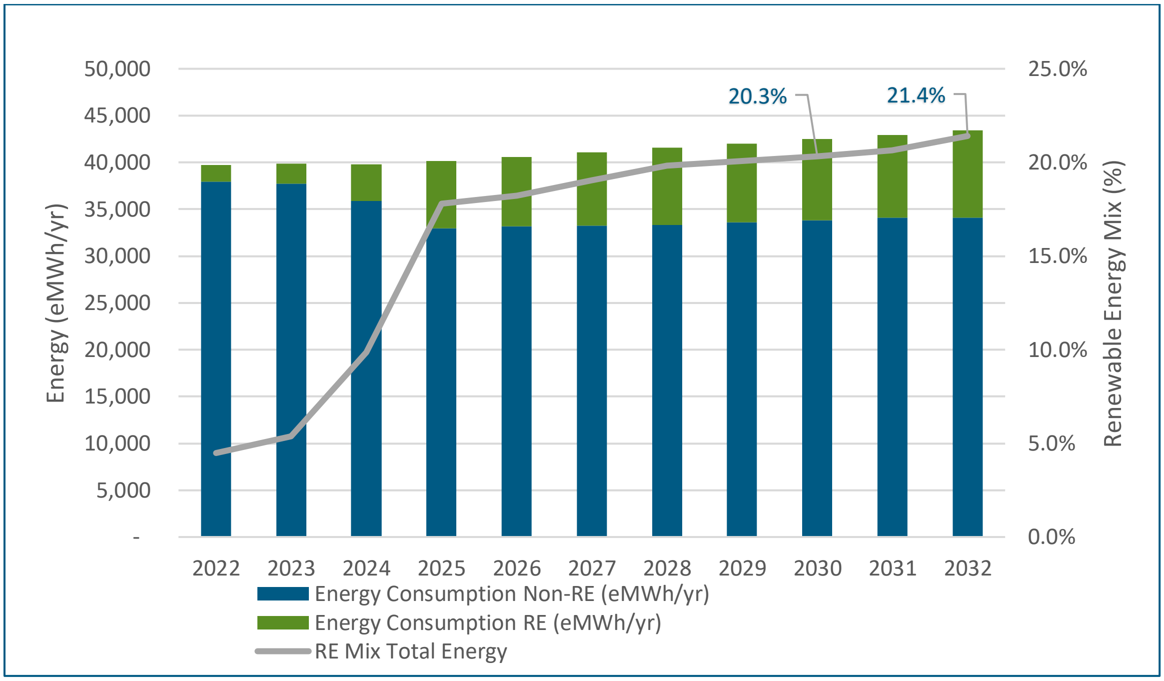

Figure 6 – RE versus NON-RE Energy Consumption Mix

As noted, the renewable energy generation through solar PV alone does not meet the 2030 target for renewable energy mix of 19.5% of total energy; however, by including other renewable energy utilization technologies, and including planned energy conservation initiatives, this mix increases to 20.3% by 2030. The County’s goals through the *REAP* will only be met with an integrated approach of expanding renewable energy utilization and generation, while at the same time improving energy conservation through the *EMP*. This is evident in the increase of the renewable electricity mix between the 2015 baseline and the 2019 baseline, which includes a lower overall electricity consumption due to conservation initiatives that were put in place.

Although the projects implemented as part of this *REAP* will reduce overall energy dependence, this will result in an increase to the County’s net electrical consumption. This increase is crucial to allow renewable energy utilization and reducing the GHG emissions through electrification and other technologies. Overall, energy conservation and reduction across the portfolio is still projected to be achieved through this *REAP* and the *EMP* initiatives.

5 FINANCIAL

To date, the County has been attempting to invest approximately $1M per year into renewable energy systems in an effort to progress its portion of the larger community goal. Through the development of a longer-term *REAP*, there is a better understanding of not only what projects should be implemented along with expected performance but also a quantifiable capital expenditure impact to execute the projects.

5.1 – Capital Costs

Table 7 outlines the estimated annual capital requirements, along with possible operational cost impacts to implement the above-noted projects. All capital costs are shown as future value (FV) using 2022 present value (PV) dollars plus an annual inflation rate of 2%, and future project costs will be validated through the design phases and updated with current costing for annual budget approvals.

Table 7 – Annual Financial Impacts

Year	Capital Cost (FV)	Capital Cost (PV)	Operational Impact (FV)
2022	$135,000	$135,000	$0
2023	$899,300	$899,300	($45,052)
2024	$1,315,290	$1,289,500	($77,853)
2025	$7,415,451	$7,127,500	($154,523)
2026	$968,989	$913,100	($188,449)
2027	$1,829,310	$1,690,000	($227,844)
2028	$1,589,876	$1,440,000	($271,969)
2029	$709,595	$630,100	($337,354)
2030	$860,136	$748,800	($389,078)
2031	$896,319	$765,000	($430,611)
2032	$657,301	$550,000	($451,086)
Total	$17,276,567	$16,188,300	($2,573,818)
Future value (FV) costs are based present value (PV) costs plus annual inflation rate of 2% (adjusts capital cost and operations cost impacts), electrical and biomass fuel rate increase of 3% and natural gas rate increase of 5%. It also includes cost of carbon based on federal carbon tax table to 2030 with an increase of 3% for subsequent year over year.			

Further to the above-noted costing, County staff will continue to seek funding opportunities to support the implementation of this plan in order to reduce the Facilities Reserve impact as much as possible. As an example, the County is currently seeking funding for the GSHP Loop initiative at 300 Juliana under the *Low Carbon Economy Challenge* (LCEC) fund, which covers 40% of the project's capital cost.

5.2 – Return on Investment

Overall, the projects identified in this *REAP* will cost $17.3 million (FV) with overall operational cost avoidances of $15.8 million. Overall operational cost avoidance is the sum of each year's future value annual cash flow balance (avoided utilities costs plus increased maintenance costs) to 2050[1].

This represents an equity balance[2] of -$1.5 million ($1.5 million with LCEC) and NPV[3] of -$6.6 million (-$4.0 million with LCEC) by year 2050. The projects as a whole, will pay for themselves within 30 years (27 years with LCEC), which is within the projects average useful life.

Figure 7 and Figure 8 show NPV and Equity balance of the projects, with and without LCEC grant funding, respectively.

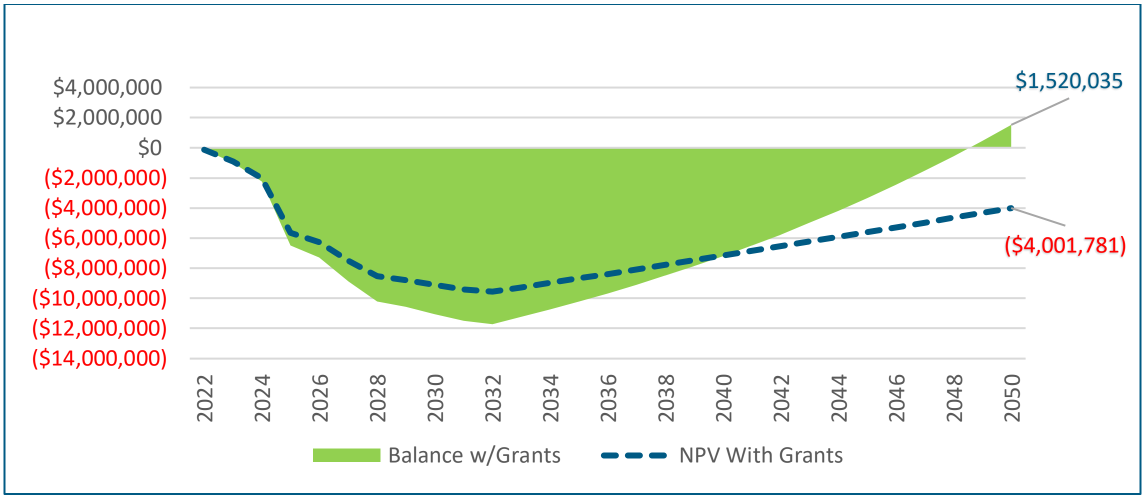

Figure 7 – NPV and Equity Balance (with Grant Funding)

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[1] Refer to Table 7 which indicates annual operational (utilities costs and maintenance) avoidances related to the projects included in this plan increasing year over year as new projects come online and to match projected inflation, energy and carbon tax rates through to year 2050.

[2] Equity balance the is sum of each years future cash flow including cash inflows (avoided energy costs, grant funding, etc.) minus cash outflows (capital cost, increased maintenance, etc.).

[3] Based on nominal discount rate, reinvestment and borrowing rate of 4.18%, annual inflation rate of 2%, electrical rate, and biomass rate increase of 3% and natural gas rate increase of 5%. Includes cost of carbon based on federal carbon tax table to 2030, plus increase of 3% year over year.

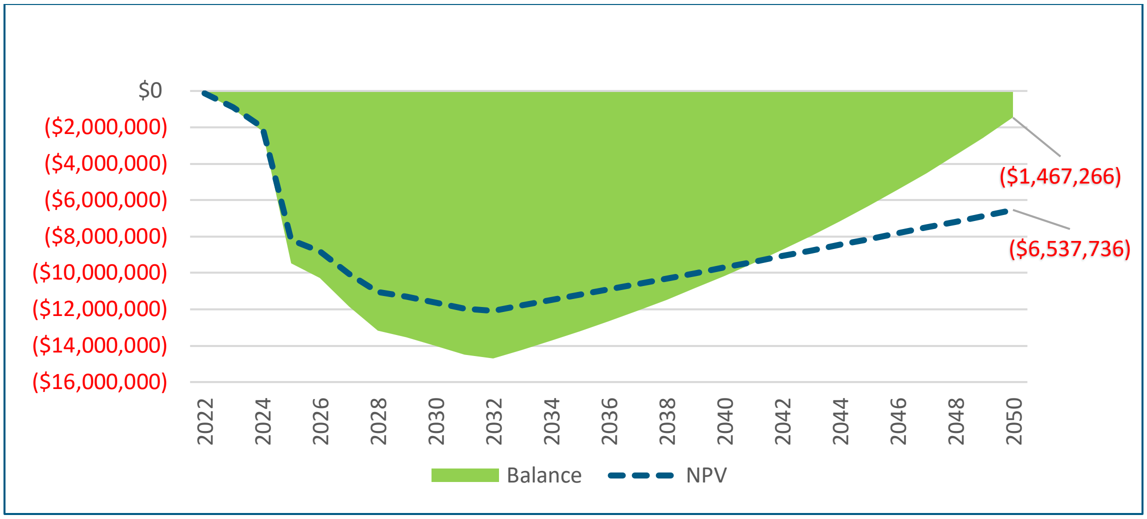

Figure 8 – NPV and Equity Balance (No Grant Funding)

6 PLAN UPDATES

The *REAP* has been set out with a 10-year planning horizon. Based on the screening completed, the target investments and performance targets, a 10-year plan was viable to progress the County's goals in a meaningful way. This timeline was also deemed a reasonable period, as technology in the renewable energy sector over the next decade will likely advance significantly, and a renewal of the *REAP* within 10 years will allow the County to leverage that advancement. It is also the intent to learn and adjust from findings learned through the implementation of the projects identified in this *REAP*.

Further to technological advancements, regulatory changes are also likely to occur as the renewable energy sector expands, and governments of various levels look to progress their own renewable energy goals. This may open additional opportunities that do not exist today. Oxford County has and will continue to discuss new opportunities with regulatory bodies and also look for opportunities to partner in demonstration-style projects. While these aren't identified specifically in this *REAP*, opportunities may be pursued with the intent to explore how they can be incorporated into the new plan revision, or executed during this plan period through the annual budget approval process.

In future iterations of this REAP, new technologies and opportunities for procurement should be considered as they become available to further accelerate the County's RE mix to line up with the *100% RE Plan*'s renewable energy goal by 2050. Figure 9 and Figure 10 below show scenario for 2033 through 2050 impacts on renewable energy utilization, renewable energy purchase requirements, as well as reduction of total energy usage through energy conservation, in order to reach 100% renewable energy by 2050.

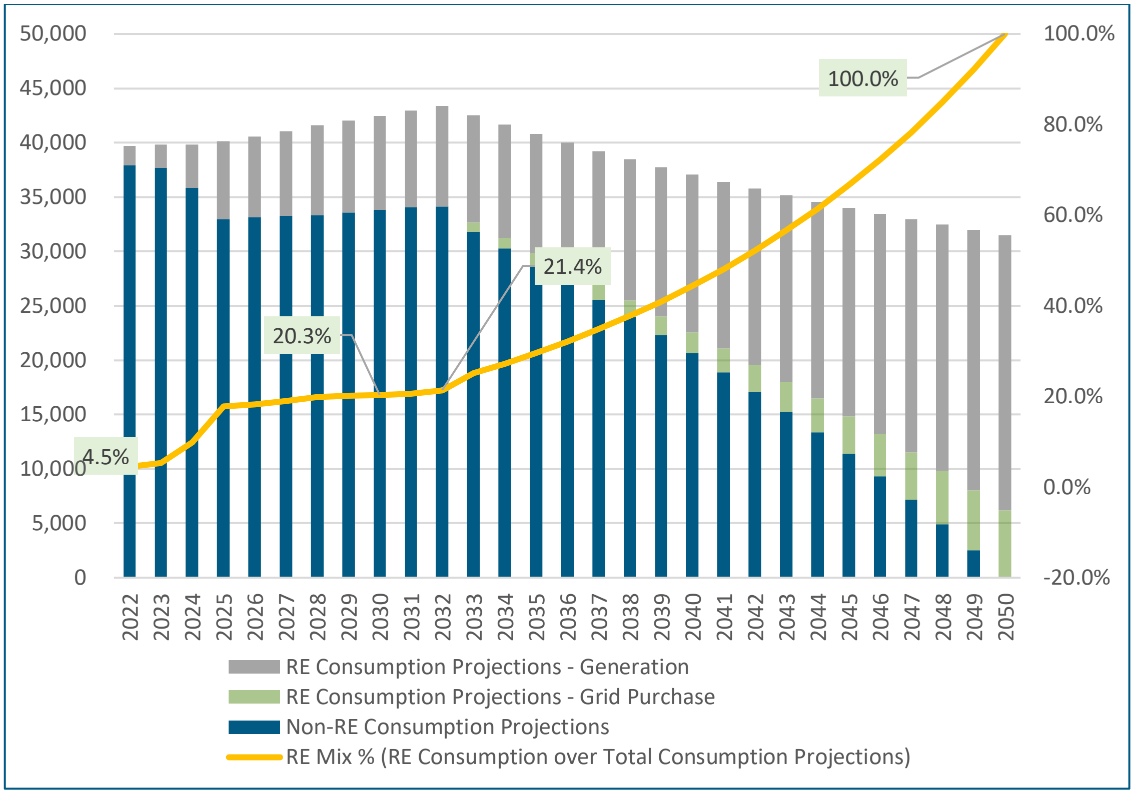

Figure 9 – Energy Usage & RE Mix to 2050

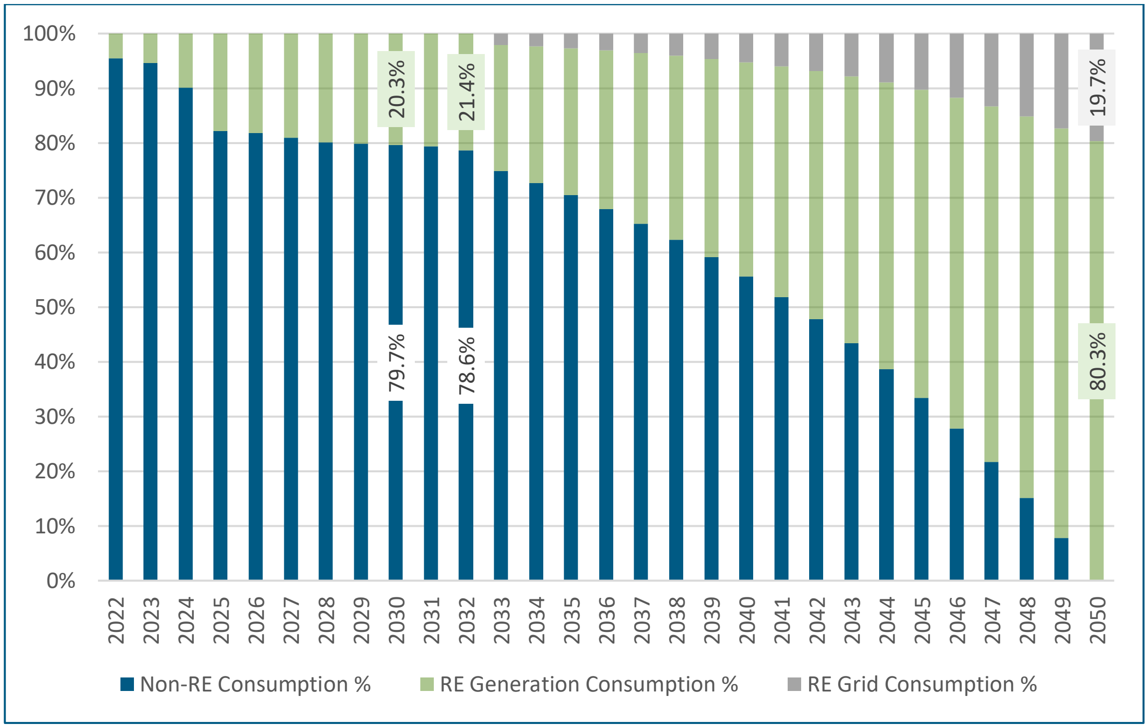

Figure 5 – Energy Usage & RE Mix % to 2050

7 APPROVAL

The implementation of this *REAP* is subject to annual Business Plan and Budget approval. It is the intent that each project will be validated for construction and regulatory constraints, as well as for confirmation of costing and performance during the detailed design phase. This work will be used to inform the update to the annual budget each year.

Should annual budget approval is not granted in accordance with this plan, the performance projections noted within the REAP will not be met within the identified time period.

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Renewable Energy Screening Study Background Information

Oxford County

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ENGINEERS · ARCHITECTS · PLANNERS

Value through **service** and **commitment**

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List of Abbreviations

ASHP	Air source heat pump
COP	Coefficient of performance
DHW	Domestic hot water
DWHX	Drain water heat exchanger
EUI	Energy use intensity, that is, energy consumption per floor area
GHG	Greenhouse gas
GSHP	Ground source heat pump
IESO	Independent Electricity System Operator (of Ontario)
kW and kWh	Kilowatt and kilowatt-hour
PV	Photovoltaic
RTU	Rooftop unit
tCO2e	Tonnes of carbon dioxide equivalent
WHR	Waste heat recovery

1.0 Introduction

This report is a companion document to the renewable energy screening studies for 41 Oxford County properties completed by J.L. Richards. This background information provides additional details on the methodology used in the energy analysis as well as a description of the renewable energy technologies considered. The purpose of this report is to provided Oxford County personnel with a description of the assumptions and methods used to screen renewable energy on County-owned properties, while not repeating this. This document should be read in parallel with one of the screen reports. Tables and figures listed in this document refer to those in the screen reports.

The focus of the review was on the technical feasibility of various technologies, although known regulatory and cost factors were then considered they are highlighted in case future changes warrant a reassessment of the renewable energy technology. The renewable technologies considered can be found in section 4.1.

These screening reports were prepared by reviewing two years of historical energy consumption data, including hourly electricity consumption, provided by Oxford County, by reviewing satellite and street level images of the property, and by reviewing building drawings.

Please note that mutually exclusive solutions may have been proposed, when more than one technology is feasible, but they should not all be implemented, at least at the capacities provided in this report. As an example, a wood pellet boiler, an air-source heat pump and a ground source heat pump may all be identified as viable heating solutions, each sized to provide 100% of the required building heat load. Any such overlap will need to be considered in subsequent phases.

2.0 Site Listing

Table 1: List of Sites Included in Study

No.	Building ID	Building Name	Street Address	Hourly Electric Data	Type
1	01_300_Julian	Woodstock Woodingford Lodge	300 Juliana Drive	Yes	Long Term Care
2	02_195_Admira	Woodstock WWTP	195 Admiral Street	Yes	WWTP
3	03_56_McKeand	Ingersoll WWTP	56 McKeand Street	Yes	WWTP
4	04_52_Venison	Tillsonburg Woodingford Lodge	52 Venison Street West	Yes	Long Term Care
5	05_325_Thames	Ingersoll Woodingford Lodge	325 Thames Street South	Yes	Long Term Care
6	06_19_Van	Tillsonburg WWTP	19 Van Street	Yes	WWTP
7	07_381_Willia	Tavistock Lagoon	381 William Street South	Yes	WWTP

No.	Building ID	Building Name	Street Address	Hourly Electric Data	Type
8	08_21_Reeve	Oxford County Administration Building	21 Reeve Street	Yes	Administration
9	09_742_Pavey	N/A	742 Pavey Street	Yes	Apartment
10	10_161_Fyfe	N/A	161 Fyfe Avenue	Yes	Apartment
11	11_484981_Swe	Thornton WTF	484981 Sweaburg Road	Yes	Water
12	12_415_Hunter	Oxford County Courthouse	415 Hunter Street	Yes	Administration
13	13_5_Thompson	Thompson Road WTF	5 Thompson Road	No	Water
14	14_10_Middlet	Thamesford WWTP	10 Middleton Street	No	WWTP
15	15_816_Alice	N/A	816 Alice Street	Yes	Apartment
16	16_1322_Bell	Bell Mill Side Road WTF	1322 Bell Mill Side Road	No	Water
17	17_901_James	N/A	901 - 905 James Street	No	Townhouse
18	18_135_Carrol	N/A	135 Carroll Street	Yes	Apartment
19	19_178_Earl	N/A	178 Earl Street	Yes	Apartment
20	20_174_Lisgar	N/A	174 Lisgar Avenue	Yes	Apartment
21	21_215_Lisgar	N/A	215 Lisgar Avenue	Yes	Apartment
22	22_738_Parkin	N/A	738 Parkinson Road	Yes	Apartment
23	23_200_Mall	Mall Road WTF	200 Mall Road	Yes	Water
24	24_70_Maria	N/A	70 Maria Street	Yes	Apartment
25	25_82_Finkle	N/A	82 Finkle Street	Yes	Apartment
26	26_202_Stanle	Thamesford WTP	202 Stanley Street North	No	Water
27	27_235_Thames	N/A	235 Thames Street North	No	Townhouse
28	28_93_Graham	Public Health - Dental Clinic	93 Graham Street	Yes	Administration
29	29_154_Canter	Canterbury Street WTF	154 Canterbury Street	No	Water
30	30_410_Buller	Public Health	410 Buller Street	Yes	Apartment
31	31_6_Pitcher	Pitcher Street WTF	6 Pitcher Street	Yes	Water
32	32_16_George	N/A	16 George Street	Yes	Apartment
33	33_464852_Riv	Tabor Well 2 & 4 Pumphouses	464852 Rivers Road	No	Water
34	34_59_George	N/A	59 George Johnson Boulevard	Yes	Water
35	35_432594_Zen	Springford Patrol Yard	432594 Zenda Line	Yes	Roads Shop
36	36_377_Mill	EMS Headquarters	377 Mill Street	Yes	EMS Base
37	37_515165_11t	Woodstock Patrol Yard	515165 11th Line	Yes	Roads Shop

No.	Building ID	Building Name	Street Address	Hourly Electric Data	Type
38	38_18_Henders	Tavistock WTF	18 Hendershot Street	Yes	Water
39	39_364_Athlon	Athlone Booster Station	364 Athlone Avenue	Yes	Water
40	40_895939_Oxf	Drumbo Patrol Yard	895939 Oxford Road 3	Yes	Roads Shop
41	41_221_Thames	N/A	221 Thames Street North	Yes	Apartment

3.0 Energy Analysis Methodology

This section of the report provides an explanation of the methodology behind the analysis of the historical energy consumption of the building, including deriving some peak load sizes from this data.

3.1 Building Equilibrium Temperature (BET)

For the purpose of this study, the BET is the ambient temperature at which the building requires neither heating nor cooling. The BET for most buildings is expected to fall in the range of 10-18°C. Only normal working hours on weekdays are considered for this analysis, when it is assumed that the building is fully occupied and fully heated or cooled. Note that, in each screening study, an error value is associated with the BET. For buildings where electricity consumption is strongly dependant on ambient temperature, the error typically does not exceed 3°C. Buildings with a higher error value may indicate a building with no space cooling and minimal electricity use for heating, or buildings where the heating and cooling needs are inconsistent. When a reasonable BET could not be calculated from the hourly electricity data “no BET” is displayed.

3.2 Heating & Cooling Loads

Most buildings with gas heating systems do also consume more electricity for heating, due to increased blower or pump usage to circulate the heat, as well as possible use of supplementary heaters (e.g. entrances, cooler locations). In most buildings, the extreme temperatures, at -40°C and +40°C, are reasonable estimates of the highest electrical load the building will draw, as such temperatures are somewhat beyond what buildings in southern Ontario are exposed to, even with expected increased global warming.

3.3 Peak Loads

The peak electrical load was estimated from the hourly electricity data and is found in Table 3. It is the estimated load during extreme weather (either -40°C or +40°C, whichever causes the highest load) with typical plug and equipment loads for when the building is occupied. This load could also be reached at more moderate temperatures, but with high plug and equipment loads. Please note that even higher loads of shorter duration (less than one hour) may also occur.

The peak heating load, also found in Table 3 was estimated from the monthly gas consumption, our understanding of the building, and our experience with detailed energy modeling of numerous buildings. Based on this, we assumed the peak heating load by applying a factor of 3 to the average heating load during January. Again, higher peak loads of shorter duration could be experienced.

The average domestic hot water load (see Table 3) was estimated from the summer natural gas consumption, when DHW is assumed to be the only load. This average value represents a constant load throughout each day, and throughout the year. In fact, the DHW load will vary with the level of occupancy and the activities, which typically follow a daily pattern (with little seasonal variation). Because the DHW load is relatively small compared to the overall building load, no attempt was made to estimate the peak DHW load.

3.4 Buildings Without Hourly Electricity Data

For buildings that hourly electricity data was not provided, BET, heating and cooling loads, and electrical peak loads could not be estimated.

4.0 Background on Renewable Technologies

This section contains background information on each of the fourteen renewable energy technologies evaluated during this study.

4.1 Solar PV (rooftop)

Rooftop PV systems are generally technically practical on most buildings, whether they have flat or pitched roofs. Some few buildings may lack structural strength, but there are lightweight PV array designs which may be acceptable. As PV systems currently generate electricity at the approximate retail value of electricity in Oxford County, economic viability is also generally good, although economics improve with system size. Roofs with many different levels or large amounts of existing rooftop “furniture” (e.g. fresh air intakes, air conditioning units, vents, skylights) may not be able to accommodate rooftop PV systems.

Rooftop PV systems are considered Class 1 (<10 kW) or Class 2 (>10 kW) solar facilities systems under O. Reg. 359/09 and are therefore exempt from the Renewable Energy Approval (REA) process.

Rooftop PV system sizes are estimated on a kW DC power rating basis by considering the available roof as show on site images provided by Oxford County cross referenced with the latest satellite imagery from Google Earth. For properties with recently installed rooftop PV systems not shown, the south facing roofs are assumed to be in use. A 80% ground coverage ratio and 20% module efficiency was assumed. Estimated capital costs are based on 2019 installation costs as a turn-key system direct from an Ontario based solar PV EPC firm.

4.2 Solar PV (ground mount)

Ground mount PV systems are generally technically and economically viable throughout Oxford County, providing there is sufficient cleared land available. (Clearly wooded land to accommodate PV system is certainly possible, but was not considered in this study.) Given the local climate and current costs, we will assume 2,000 m² (0.2 ha) of available land as a minimum land area considered in this study.

Ground mount PV systems greater than 10 kW in size are considered Class 3 solar facilities systems under O. Reg. 359/09 and are therefore required to obtain the Renewable Energy Approval (REA), as of August 31, 2019. (They no longer fall under the old requirements of O. Reg. 274/18 which, among other things, required a 15 m setback from property boundaries.). As part of there application, Class 3 solar facilities are required to submit: a project plan, consultation report (including public meetings, municipal and aboriginal consultation) and various assessment (heritage, archaeological, natural heritage and water).

In this study, ground mount PV system sizes are estimated on a kW DC power rating basis by considering the available ground as shown on site images provided by Oxford County (within the property lines indicated), cross referenced with satellite imagery from Google Earth. Design parameters typical of many plants in Ontario were assumed (e.g. fixed tilt racking with a 35% ground coverage ratio, 20% PV module efficiency). Estimated capital costs were estimated as a turn-key system design and installation costs, from available data.

4.3 Solar PV (parking lot canopy)

PV parking lot canopies perform similar to rooftop PV systems, but are somewhat more costly due to the need to build a structure from the ground up. Canopies can be built that cover only the parking spaces, or the parking spaces and driving aisles. Covering the entire parking and driving areas has the obvious advantage of providing space for more PV modules; it may also provide benefits with respect to protecting users from snow and rain and reducing the amount of snow to be cleared. In the screening studies, all capacity estimates are for the smaller style systems that cover only the actual parking spaces.

It is unclear if PV parking lot canopies would be considered as Class 2 (buildings) or Class 3 (ground mount) systems under O. Reg. 359/09, If Class 2, they would be exempt from the Renewable Energy Approval (REA) process. This should be confirmed in subsequent phases if a PV parking lot canopy is considered for any of the properties.

PV parking lot canopy system sizes are estimated on a kW DC power rating basis by considering the parking lot area suitable for a PV system as show on site images provided by Oxford County cross referenced with the latest satellite imagery from Google Earth. The PV canopy was estimated to cover the entire parking spot but driving lanes were not covered. A 20% module efficiency was assumed. Estimated capital costs are based on 2019 installation costs as a turn-key system direct from an Ontario based solar PV EPC firm.

(*Note that all types of PV systems in Oxford County require permission from the local distribution company to connect to the grid, and a contractual means of compensating the owner for electricity generated. Currently the "net metering" program is the most widely available, but regulations have been changing rapidly in recent years. Net-metering projects that generate less than 90% of the annual on-site electricity load are exempt from the REA process.*)

4.4 Solar Thermal for DHW

Solar water heating collectors can be used to heat domestic hot water and are typically limited to the size needed to meet a high fraction of the DHW load during summer weather (and thus a smaller fraction during winter weather). While solar water heating systems often appear financially viable on paper, the market in Canada has been neither robust nor consistent. As a result, it can be challenging to find local contractors to design, install and provide long-term service to solar thermal installations, thus making them less economic than expected. Larger installations – or a collection of smaller ones – where it is reasonable for the system owner to train their own personnel to undertake much of the maintenance are likely to prove more cost-effective, simply by having a longer life. Solar water heating systems generally increase in financial attractiveness along with the size of the building's DHW load. Because insulated pipes or hoses must run between the existing hot water tanks and the location of the solar collectors, the solar collectors must normally be mounted close to the mechanical room. The area required for the solar collectors is typically a small fraction of a buildings total roof area.

Solar water heating collector sizes are estimated on a kW power rating basis by considering a portion of the estimated peak DHW demand that a solar thermal system could meet. The collector area (in m²) assumed a 70% collector nameplate efficiency (a typical value). Annual average efficiency is typically no more than half of this nameplate efficiency. Estimated capital costs assume a turn-key system installation by a competent installer.

4.5 Solar Thermal, Ventilation Air

These systems are most commonly mounted on generally south-facing walls, and work by preheating incoming ventilation air for a building. Most common on industrial and agricultural buildings with high ventilation requirements, they can be viable on commercial and residential buildings with suitable wall space and ventilation systems. Ventilation systems that have a centralized fresh air intake located near the top of any south-facing wall allow for easier integration of these systems.

Solar thermal air system sizes are estimated on a kW power rating basis by considering a 70% collector efficiency and the available southwest and southeast facing wall area. Estimated capital costs assume a turn-key system installation by a competent installer, for a project of substantial size. Any required modifications to the building or its HVAC system are excluded.

4.6 Geothermal Heat Pumps for Space Heating and Cooling

Geothermal heat pumps provide both heating and cooling at high efficiency (more correctly, high COP) from electricity. The ground heat exchanger (GHX) can be either open- or closed loop, with closed-loop currently more common in Canada. Construction of the GHX component is a significant capital cost but has an expected useful life in the range of 50 years. Closed loop systems can be constructed in almost any subsurface conditions, while open loop – generally lower cost, where they are feasible – require a highly productive aquifer.

For closed loop geothermal systems, the balance between heating and cooling loads must be considered. Since GSHP systems withdraw heat from the ground in winter, and then send heat into the ground during summer, a strong imbalance can lead to gradually shifting ground temperatures over a few years, impairing operation of the system. Balance is not an issue in some soil conditions, nor is it an issue for open loop systems.

For these studies geothermal heat pumps system capacities were chosen to meet 100% of the estimated peak heating load. Estimated capital costs are based on installation costs for a closed loop ground-source heat pump system with vertical boreholes. Costs exclude any costs to retrofit the building to utilize the lower temperature water produce by heat pumps vs. boilers.

4.7 Air Source Heat Pumps for Space Heating and Cooling

ASHP systems are essentially a chiller than can run in reverse to provide heating during winter. While previous generations of heat pumps could not operate during very cold weather (requiring a backup heating system), current commercial units can operate during almost all winter temperatures experienced in Oxford County, and cold operation performance continues to improve.

For these studies, air source heat pumps system capacities were chosen to meet 100% of the estimated peak heating load. Estimated capital costs are based on estimated turnkey design and installation costs. Costs exclude any costs to retrofit the building to utilize the lower temperature water produce by heat pumps vs. boilers.

(*While heat pump technology has been advancing quickly, currently available commercial units (both air- and ground-source) are currently limited to providing a maximum supply temperature in the range of 60°C. Because this is lower than the 80 – 90°C commonly supplied by boilers, the heat distribution equipment inside a building may need to be modified when switching from a boiler to heat pump (e.g. larger coils in air handlers). No changes should be required to cooling distribution equipment.*)

4.8 Air Source Heat Pumps for DHW (from indoor air)

These units directly replace a gas or electric hot water tank; they use heat from indoor air (~20°C) to heat the incoming cold water from approximately 10°C to ~45°C. They are purpose-built, packaged units that serve a single purpose. In summer, they can draw excess heat from the indoor air, reducing the load on the building's air-conditioning system. Conversely, in winter the building heating system must produce slightly more heat to compensate for the heat being drawn for use to heat water.

For these studies, these units were sized to meet 100% of the estimated peak DHW load.

4.9 Rooftop Units with Heat Pumps

These are "drop in" replacements for packaged RTU's that provide heated and cooled fresh air for a building. Standard units include a chiller to cool and either a gas burner or electric resistance heater to heat the fresh air. The RTU's being suggested in the screening studies have a bidirectional heat pump (air-source) to both heat or cool the incoming fresh air. Normally they also retain the gas burner or electric resistance heater, for use in extreme cold winter temperatures when the heat pump becomes ineffective. Typically, this backup heater would be used for only a few dozen hours per year, in Oxford County. They are usually both technically and economically viable as end-of-life replacements for conventional units.

These RTU units work well as a stand-alone retrofit project for replacing an existing RTU that has reached it's end of life. For costing purposes, this study assumes that the RTU being replaced uses gas for heating; the economics would be substantially more attractive if the existing RTU uses electric heat. As these replacements are being considered at ***equipment end of life***, the capital cost estimates only include the incremental cost of a new RTU with heat pump over a new gas-fired RTU. The installation, engineering and other costs would be very nearly identical for an RTU heat pump compared to a gas RTU.

The RTU heat pump will consume less energy to deliver the same amount of heat but it will be fuel switching from natural gas to electricity, which is currently more expensive although with much lower GHG content. At this stage we have assumed these differences will balance out, such that annual utility costs will be unchanged.

4.10 Wind

Small (5 – 200 kW) "urban" wind turbines for use on buildings and in built-up areas have been repeatedly introduced to the market for more than 25 years, but with limited success. Both costs and useful life are uncertain, and regulatory barriers exist. Alternatively, large wind turbines (>1 MW) have become common in rural areas, typically installed in clusters of 25+ turbines. Some large wind farms are currently operational in Oxford County and neighbouring municipalities.

Wind systems greater than 3 kW in size are considered as Class 2-5 wind facilities systems under O. Reg. 359/09 and are therefore required to obtain the Renewable Energy Approval (REA). All renewable energy generation facilities that complete construction after August 31, 2019 no longer fall under the old requirements of O. Reg. 274/18 Siting Restriction for Renewable Energy Generation Facilities (e.g. 15 m setback from property boundary), instead they must obtain a REA. Class 3 (>50 kW < 70 m) wind facilities are required to submit as part of their application: a project plan, consultation report (including public meetings, municipal and aboriginal consultation), various assessment (heritage, archaeological, natural heritage and water), noise report and a setback plan. The complete REA process can take over 12 months to complete.

Wind system sizes assumed that the local utility would permit half of the interface transformer size without substantial upgrades. Cost estimates were based on deployment of pole mounted 10 kW turbines.

4.11 Biogas

This technology, sometimes referred to as renewable natural gas (RNG) involves creating and burning a gaseous fuel from organic matter, often waste material. Creating and capturing biogas is increasingly common at landfills and wastewater treatment plants, typically used only on-site. Biogas can be burned directly for space and/or process heating as well as cleaned for us in co-generation systems to produce electricity as well as heat. There are expectations (and some facilities) where biogas will be injected into lines – including the existing natural gas distribution network – for distribution to any customer. However, there are regulatory and technical challenges associated with biogas in the natural gas distribution network which are currently limiting this practice.

Anaerobic digestion facilities that utilize biogas to generate electricity and are not located on a farm are considered as Class 3 anaerobic digestion facilities systems under O. Reg. 359/09 and are therefore required to obtain the Renewable Energy Approval (REA). Note that a REA is not required if the biogas on site is not used to generate electricity. Class 3 bio-energy facilities are required to submit as part of there application: a project plan, consultation report (including public meetings, municipal and aboriginal consultation), various assessment (heritage, archaeological, natural heritage and water), and additional technical reports (emissions dispersion modelling, noise study, effluent management plan, hydrogeological assessment, surface water assessment, financial assurance estimate). The complete REA process can take over 12 months to complete.

Biogas system sizes were estimated based on the average daily flow values from Oxford County's 2019 Annual Wastewater Treatment System Summary Report. Cost estimates for biogas systems vary significantly depending on the existing infrastructure and intended end use of the gas. As a result, no estimates were provided at this stage.

4.12 Wood Pellet Boiler

Generally, biomass refers to the combustion of any solid organic material; for the purposes of this study, only manufactured wood pellet fuel is considered, as a fuel for wood pellet boilers, which effectively directly replace natural gas boilers, but with a zero-GHG fuel. Pellet boilers are generally technically viable wherever gas boilers are currently in use but can be limited due their physical size (larger than gas boilers) and fuel delivery and the requirement for on-site fuel storage, typically in an outdoor silo or bin.

Pellet boilers are not required to obtain a Renewable Energy Approval (REA) under O. Reg. 359/09, as they do not generate electricity. (A wood pellet cogeneration system would require a REA, but these are not considered in the screening studies.)

For these studies, pellet boiler systems are estimated to meet approximately 50% of the peak heating load. In turn, this enable them to meet approximately 80% of a building's annual heating load. The existing equipment (gas or electric) is assumed to provide the balance of the needed heat.

4.13 Waste Heat Recovery

There is potential to recover low grade waste heat from sources, especially from water and wastewater treatment plants and arenas, but even from simple devices such as drain water heat recovery units in residential buildings. It is rarely economical to transport heat, so it usually is used on the same or an adjacent property, and may be useful in conjunction with heat pumps.

System sizing and costing is highly dependent on the source and on-site uses available. Waste heat was assumed to only be recovered during the heating season as for space heating. For water treatment plants, waste heat was estimated as 2% of pumping energy. For wastewater treatment plants, waste heat was on the average daily flow values from Oxford County's 2019 Annual Wastewater Treatment System Summary Report. Cost estimates for waste heat recovery systems are entirely dependent on the existing infrastructure and vary drastically from site to site. As a result, they are not provided at this stage.

4.14 Small Hydro

Small “run of river” hydro generators can be very economical, as they can reliably produce electricity 24/7/365, but require unique site condition. Essentially, they require a river that flows at speed, year-round. None of the properties screened during this study met the unique site conditions required for a technically feasible small hydro system.

Facilities that utilize waterpower to generate electricity are not required to obtain the Renewable Energy Approval (REA) under O. Reg. 359/09.

5.0 Utility Costs

5.1 Electricity

For these studies we have used $0.139/kWh as the costs for electricity at all sites. This rate reflects the upper tier rate for non-residential customers set by the Ontario Energy Board effective May 1, 2020. This rate assumes that all sites are billed as delivery demand-based customers where their delivery charges are calculated based on their monthly peak demand. At this stage we have not considered what effect these technologies could have on monthly peak demand. The electricity rates for each specific site will differ depending on the local utility delivery charges and customer rate class.

5.2 Natural Gas

For these studies we have used \$0.22/m^3 (\$0.027/kWh) as the cost for natural gas at all sites. This rate reflects the Union Gas Rate M2 – Union South set for April 2020. This rate assumes that any change in natural gas consumption will be an incremental effect is the 13,000 m^3 to 20,000 m^3 deliver class. This rate does not consider the additional savings such as eliminating the fixed monthly charge that could be realized by completely removing natural gas service at a site. As well, this rate is based on the current price of natural gas, while it is difficult to predict what this rate will be in the future, we do know that the federal carbon tax portion will increase. This rate includes the current federal carbon charge on natural gas of \$0.059/m^3, this is expected to increase to \$0.098/m^3 by 2022. Further consideration of technologies that reduce natural gas consumption should escalate this rate to include the federal carbon tax forecasted for when the project is implemented.

5.3 Wood Pellets

For these studies we have used $220/ton ($0.044/kWh) as the cost for wood pellets at all sites. This rate reflects the current pricing from Southwestern Ontario wood pellet distributors and is inline with historical wholesale pricing.

5.4 Fuel Cost Comparison

From the above, we note that we have assumed electricity costs approximately five times that of natural gas, and wood pellets approximately 60% higher than natural gas:

- 2.7 ¢/kWh, natural gas
- 4.4 ¢/kWh, wood pellets; 163% of gas price
- 13.9 ¢/kWh, electricity; 515% of gas price

These prices were derived from local rate structures (gas and electricity) or from a local supplier (Gildale Farms for wood pellets). However, they are all equivalent. Specifically, when used for heating gas and wood pellets tend to be around 80% efficient, while electric resistance heaters are 100% efficient. Thus the effective cost of both gas and wood pellets is about 25% higher than this listed price. Also, these prices are based on the current federal carbon tax rate of $30/ton of CO_{2e}. This rate will very soon be $50/ton, and will have a substantial impact on natural gas pricing, with minimal impact on the pricing of wood pellets or electricity (in Ontario). With these two considerations, and a longer outlook, it would be **more appropriate to assume that wood pellets and electricity cost approximately 125% and 320%, respectively, of the cost of natural gas.** In effect, by using current pricing for these three fuels, and ignoring the efficiency differences, we have effectively biased the economics away from electricity and wood pellets, toward natural gas.

It should also be noted that any renewable energy project can be expected to operate for many years, and thus those that consume a “fuel” will be subject to any price fluctuations of natural gas, electricity and wood pellets. We have not attempted to define future pricing of these energy commodities, but we do note that natural gas prices are widely reported as being near historic lows, and that wood pellet pricing has been volatile, both substantially higher and lower than the current price of $220/ton.

6.0 Limitations

Please note that, in this high-level study, there is potential for a substantial impediment to have remained unidentified. Examples could include zoning restrictions, unknown underground conditions which would made a GSHP untenable, or inadequate roof structural capacity that would make rooftop PV more costly than expected. Also, two or more technologies that are mutually exclusive may receive high feasibility ratings, but not all would be implemented (e.g. ground source heat pumps, air source heat pumps and wood pellet boilers).

The accompanying reports contain findings from a preliminary overview of the buildings and their energy consumption. Costing information is based on general costs for services and goods in Ontario, rather than on specific cost information from local suppliers. Further study of the technical and pricing conclusions are recommended before investment decisions are finalized.

The findings in these reports are based on information provided to us by Oxford County and was not verified by JLR; any inaccuracy or incompleteness in the data provided could lead to inaccurate conclusions. Furthermore, the findings of this report are based on technical and cost considerations at the time the report was prepared. The field of renewable energy has experienced rapid changes in both technology and costs; should such rapid changes continue, the findings in this report will be impacted.

This report has been prepared for the exclusive use of Oxford County, for the stated purpose, for the named facilities. Its discussions and conclusions are summary in nature and cannot be properly used, interpreted or extended to other purposes without a detailed understanding and discussions with the client as to its mandated purpose, scope and limitations. This report was prepared for the sole benefit and use of Oxford County and may not be used or relied on by any other party without the express written consent of J.L. Richards & Associates Limited.

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