

# Zero Net Energy Study

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Oxford County WM Facility

**Date Completed**

May 23, 2017

**Prepared for**

Marklevitz Architects  
516 Huron Street  
Stratford, ON N5A 5T7

**Prepared by**

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## 1. EXECUTIVE SUMMARY

A zero net energy study was conducted for the new Oxford County WM Facility. The energy use of the Oxford County WM Facility has been estimated by creating a building energy simulation reflective of the Issued for Permit design documents.

The energy goal for the project is to achieve a Zero Net Energy (ZNE) Building as recognized by the New Buildings Institute. A ZNE building must meet two requirements:

- Meet the Zero Energy Performance Index (zEPI) of 71.5 kWh/m<sup>2</sup> based on actual site energy use over a period of one year
- Provide on-site renewal energy generation that generates at least as much energy as the building consumes over a period of one year

Based on the modeling inputs outlined in section 3 of this report, the results from the building energy simulations are as follows:

- Total estimated annual building energy use of 60.7 kWh/m<sup>2</sup>
- Total estimated annual building energy cost of \$5,638

	Cooling	Heating	Fans	Lighting	Ext Ltg	Plugs	DHW	Total
kWh/m <sup>2</sup>	1.9	13.7	7.9	7.0	2.3	20.3	7.6	<b>60.7</b>
\$	175	1275	732	650	211	1890	704	<b>5638</b>

## 2. OVERVIEW

A zero net energy study was conducted for the new Oxford County WM Facility. The energy use of the Oxford County WM Facility has been estimated by creating a building energy simulation reflective of the Issued for Permit design documents. This report summarizes the energy modeling inputs and the results.

### 2.1 PROJECT SCOPE AND METHODOLOGY

**Project Name:**

- Oxford County WM Facility

**Project Goals:**

- Achieve a Zero Net Energy (ZNE) Building as recognized by the New Buildings Institute
  - Meet the Zero Energy Performance Index (zEPI) of 22.7 kBtu/ft<sup>2</sup> (71.5 kWh/m<sup>2</sup>) based on actual site energy use over a period of one year
  - Provide on-site renewal energy generation that generates at least as much energy as the building consumes over a period of one year

**Energy Modeling Software and Notes:**

- Software: eQuest v3.65
- All of the building components have been considered including: building envelope, lighting, plug loads, HVAC, and service water heating.
- The results shown herein are the output of the energy simulation software and are reflective of the design parameters and modeling assumptions listed herein. While the work was performed with reasonable care and in accordance with the latest professional standards, the actual energy use of the building will vary based on factors such as weather, workmanship, depreciation of the thermal resistance of building materials, building operation, maintenance, etc.

**Energy Modeling Professional:**

- Chris Hadlock, P.Eng.  
Hadlock Consulting

**Documents Referenced:**

- 3153-16 Oxford County Architectural Drawings: Issued for Tender & Permit (2017.05.12)
- Oxford County Electrical Drawings: Issued for Tender (2017.05.12)
- Oxford County Mechanical Drawings: Issued for Tender (2017.05.12)
- 3153-16 Oxford County Specifications: Issued for Tender & Permit (2017.05.12)
- 2016-11-10 – Information Request Document

## 3. SIMULATION INPUTS – PROPOSED DESIGN

### 3.1 Building Parameters

Location	384060 Salford Rd, Salford, ON				
Weather File	London, Ontario				
Building Type	Administration				
Site Orientation	Project North is aligned True North				
GFA	362.92 m <sup>2</sup> (measured to outside of exterior walls)				
Building Storeys	1				
Utility Rates	\$0.256/kWh (averaged, based on existing utility rate structure)				
Occupancy Schedules	Refer to Appendix A for detailed occupancy schedule:				
	<b>Occupied Hours</b>				
	<b>Space</b>	<b>Mon-Fri</b>		<b>Sat-Sun</b>	
	Office	7:00 – 17:00		0	
	Staff	9:30-9:45, 11:30-12:30, 14:30-15:00		0	
	Display	2 hrs per week		0	
Meeting	3 days per week for 2 hrs		0		
Lighting Schedules	<b>Lighting Hours per Week</b>				
	<b>Space</b>	<b>Mon-Fri</b>	<b>Sat-Sun</b>		
	Office	48	0		
	Staff	15	0		
	Display	14	0		
	Meeting	14	0		
	Elec, Mech, Storage	5	0		
Vestibule	48	0			
Fan Schedules	All fans are modeled in AUTO-mode on weekends and evenings:				
	<b>System</b>	<b>Mon-Fri</b>	<b>Sat-Sun</b>		
	AHU-1: Office, Staff, Locker	6:00 – 18:00	Off		
	ERV-1: Office, Staff, Locker	7:00 – 17:00	Off		
	AHU-2: Display, Meeting	6:00 – 18:00	Off		
ERV-2: Display, Meeting	7:00 – 17:00	Off			
Thermostat Setpoints	<b>Clg Setpoint (°F/°C)</b>		<b>Htg Setpoint (°F/°C)</b>		
	<b>Space</b>	<b>Day</b>	<b>Setback</b>	<b>Day</b>	<b>Setback</b>
	Office, Staff, Locker	73/23	80/26	72/22	65/18
	Display, Meeting	73/23	80/26	72/22	65/18
	Mechanical	n/a		40/4	
	Mens w/r 112	n/a		72/22	65/18
Electrical	80/27		n/a		

## 3.2 Plant Parameters

Pumps	None
Service Water Heating	<p><b>Electric Tank Water Heater serving Staff 108 and WR 112, 113, 114</b></p> <ul style="list-style-type: none"> <li>• 30 Gallons, 9000 Watts</li> <li>• Hot Water Temperature = 140°F, Mixed water temperature = 120°F</li> <li>• Tank Insulation is assumed to be R-12.5 ft<sup>2</sup>hr°F/Btu</li> </ul> <p><b>Point-of-use Electric Water Heater serving WR 102</b></p> <ul style="list-style-type: none"> <li>• 4100 Watt element</li> <li>• Hot Water Temperature = 140°F, Mixed water temperature = 120°F</li> </ul> <p><b>Load</b></p> <ul style="list-style-type: none"> <li>• Occupant water use is estimated to be 166 Litres (hot &amp; cold) per day, based on:             <ul style="list-style-type: none"> <li>• Lavatory: 1.9 L/min, 30 uses/day, 15 seconds per use (14 L/day)</li> <li>• Showers: 5.7 L/min, 5 uses/day, 5 minutes per use (143 L/day)</li> <li>• Kitchen: 3.8 L/min, 10 uses/day, 15 seconds per use (10 L/day)</li> </ul> </li> <li>• Total washing machine water usage is estimated to be 52 Litres per week, based on:             <ul style="list-style-type: none"> <li>• 4 loads per week, 13 Gallons per load</li> <li>• All washing machine water is assumed to be at 140°F</li> </ul> </li> </ul>

### 3.3 HVAC Parameters

VRV Heat Pumps	<p>VRV IV model (Daikin) with variable refrigerant flow</p> <ul style="list-style-type: none"> <li>• Heating: 48 MBH (AHU-1); 40 MBH (AHU-2); 6 kW backup electrical heater for cold temperatures ( -20°F)</li> <li>• Cooling: 36 MBH (AHU-1); 31 MBH (AHU-2)</li> <li>• Condensing Unit, Efficiency: COP of 4.27 (heating); COP of 3.7 (cooling)</li> <li>• Airflow: 1400 cfm (AHU-1); 1050 cfm (AHU-2)</li> <li>• Ventilation: provided by enthalpy wheel, no direct economizing</li> <li>• Fan Power, Heat Pump: TSP = 0.6 in w.g.; impeller/motor efficiency = 40%</li> <li>• Controls – AHU-1: fans operate at high speed during occupied hours and low speed intermittently during unoccupied hours</li> <li>• Controls – AHU-2: fans operate at high/low speed during occupied hours based on CO<sub>2</sub> reading, and low speed intermittently during unoccupied hours</li> </ul>
Enthalpy Wheel	<p><b>Dual core enthalpy wheel provides ventilation to return-side of VRV units</b></p> <ul style="list-style-type: none"> <li>• Effectiveness: 85% winter, 76% summer</li> <li>• Ventilation Airflow: 320 cfm (ERV-1) &amp; 335 cfm (Hi)/167 cfm (Low) (ERV-2)</li> <li>• Fan Power: 307 Watts (ERV-1); 321 Watts (ERV-2) based on core pressure drop = 0.64 in w.g., ESP of 0.25" S/A &amp; 0.4" E/A</li> <li>• Controls – ERV-1: fans operate continuously during occupied hours and is off during unoccupied hours; free cooling mode (i.e. no energy recovery) when exhaust or supply air temperature above setpoint</li> <li>• Controls – ERV-2: fans operate at high/low speed during occupied hours based on CO<sub>2</sub> reading and/or washroom occupancy sensor, and is off during unoccupied hours (unless turned on by washroom occupancy sensor; free cooling mode (i.e. no energy recovery) when exhaust or supply air temperature above setpoint</li> <li>• Defrost: none due to dual core</li> </ul>
Electrical Baseboards	<p><b>Electrical baseboard heating in mechanical 109 &amp; Mens 112</b></p> <ul style="list-style-type: none"> <li>• Heating: 0.75 kW in Mens 112, 0.5 kW in mechanical 109</li> </ul>
Exhaust Fan	<p><b>Ceiling exhaust fan serving electrical 103</b></p> <ul style="list-style-type: none"> <li>• Exhaust Airflow: 100 cfm (exhausted to meeting 104)</li> <li>• Fan Power: TSP = 0.25 in w.g.; impeller/motor efficiency = 40%</li> <li>• Controls: fan controlled with reverse acting thermostat set to 80°F</li> </ul>

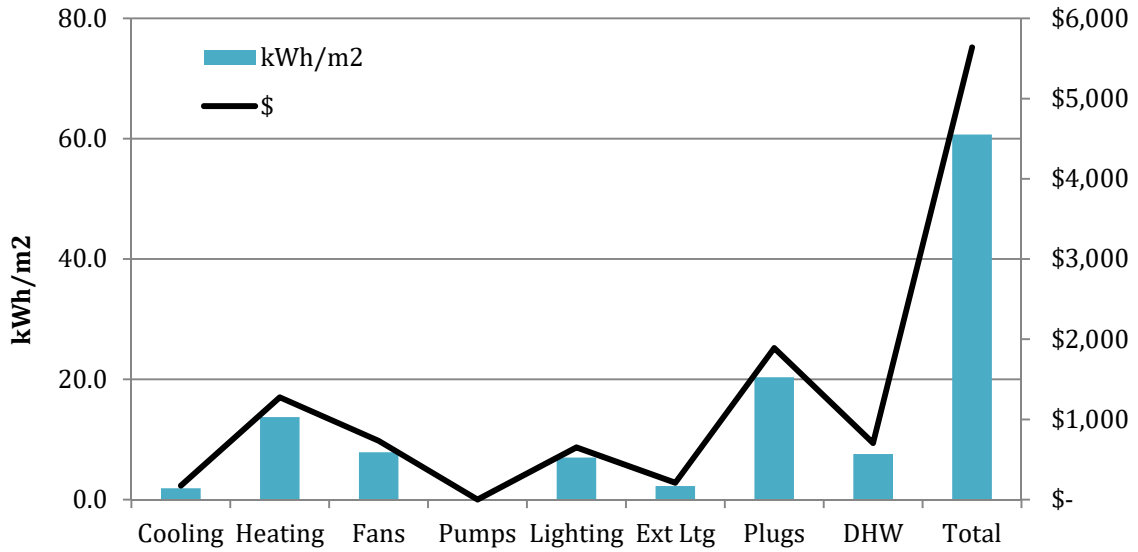
**3.4 Load Parameters**

Envelope	<p>Underground floors</p> <ul style="list-style-type: none"> <li>4" rigid (EPS) insulation below 4" concrete slab             <ul style="list-style-type: none"> <li>R-15 ft<sup>2</sup>hr°F/Btu (effective)</li> </ul> </li> </ul> <p>Exterior walls</p> <ul style="list-style-type: none"> <li>6" concrete, 8" polyisocyanurate, 8" concrete             <ul style="list-style-type: none"> <li>R-50 ft<sup>2</sup>hr°F/Btu (effective)</li> </ul> </li> </ul> <p>Interior Walls</p> <ul style="list-style-type: none"> <li>6" fiberglass acoustic batt insulation             <ul style="list-style-type: none"> <li>R-20 ft<sup>2</sup>hr°F/Btu (effective)</li> </ul> </li> </ul> <p>Roofs</p> <ul style="list-style-type: none"> <li>2 layers of 2" polyisocyanurate, ¾" roof sheathing, 14" TJI at 16" O.C. filled with batt, 5/8" gypsum board             <ul style="list-style-type: none"> <li>R-68 ft<sup>2</sup>hr°F/Btu (effective)</li> </ul> </li> </ul> <p>Glazing</p> <ul style="list-style-type: none"> <li>Wood Windows: triple glazed, low-e (Solarban 60) coating on surface 2, 13 mm argon gas             <ul style="list-style-type: none"> <li>Centre-of-glass: U-0.179 Btu/ft<sup>2</sup>hr°F; SHGC-0.338; Tvis-0.62</li> <li>Effective (based on width 1.2m x height 1.5m): U-0.26 Btu/ft<sup>2</sup>hr°F; SHGC-0.29; Tvis-0.50</li> </ul> </li> <li>Window Area (%): South = 33%, North = 18%, East = 35%, West = 16%</li> </ul> <p>Infiltration</p> <ul style="list-style-type: none"> <li>0.05 cfm/ft<sup>2</sup> of wall area (equivalent to 1.14 AC/H at 50 Pa)</li> </ul>
Lighting	<p><b>Interior Lighting</b></p> <ul style="list-style-type: none"> <li>Occupancy/Vacancy sensors used throughout – lighting reduction due to sensors applied as follows (see section 2.1 for Lighting Schedules):             <ul style="list-style-type: none"> <li>30% reduction applied to office lighting,</li> <li>60% reduction applied to washroom and vestibule lighting,</li> <li>10% reduction applied to staff, locker, display and meeting lighting</li> </ul> </li> <li>Building average design LPD - 0.73 W/ft<sup>2</sup> (before reductions for sensors)</li> </ul> <p><b>Exterior Lighting</b></p> <ul style="list-style-type: none"> <li>225 Watts, running 10 hours per day (on average)</li> </ul>
Other Internal Loads	<p><b>Peak Occupants</b> (see Appendix A for occupancy schedules)</p> <ul style="list-style-type: none"> <li>Office: 7 occupants</li> <li>Lunch &amp; Locker room: 10 occupants</li> <li>Educational space: 30 occupants</li> </ul> <p><b>Electrical Plug and Process Loads</b></p> <ul style="list-style-type: none"> <li>See Appendix B for detailed breakdown of electrical plug and process loads</li> </ul>

## 4. SIMULATION RESULTS – BASELINE PERFORMANCE

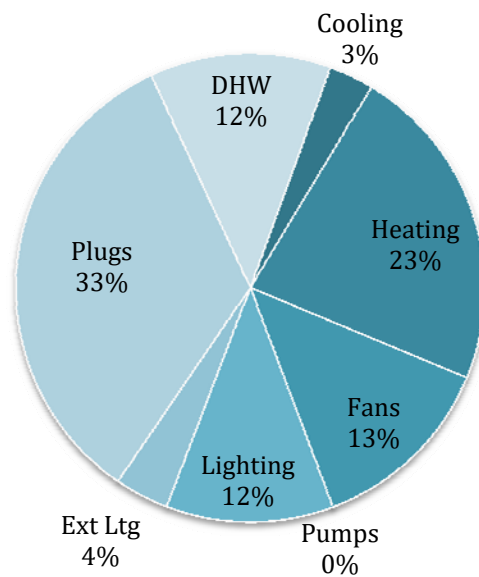
### 4.1 Energy Analysis

**Figure 4.1: Energy and Cost by End Use**



	Cooling	Heating	Fans	Pumps	Lighting	Ext Ltg	Plugs	DHW	Total
kWh/m <sup>2</sup>	1.9	13.7	7.9	0	7.0	2.3	20.3	7.6	<b>60.7</b>
\$	175	1275	732	0	650	211	1890	704	<b>5638</b>

**Figure 4.2: Energy Use Distribution**





## Appendix A – Occupancy Schedule

Meeting Room												
	6-7 am	7-8 am	8-9 am	9-10 am	10-11 am	11-12 pm	12-1 pm	1-2 pm	2-3 pm	3-4 pm	4-5 pm	5-6 pm
Mon	0	0	6	6	0	0	0	0	0	0	0	0
Tue	0	0	0	0	0	0	0	0	0	0	0	0
Wed	0	0	6	6	0	0	0	0	0	0	0	0
Thu	0	0	0	0	0	0	0	0	0	0	0	0
Fri	0	0	6	6	0	0	0	0	0	0	0	0
Sat	0	0	0	0	0	0	0	0	0	0	0	0
Sun	0	0	0	0	0	0	0	0	0	0	0	0

Display Room												
	6-7 am	7-8 am	8-9 am	9-10 am	10-11 am	11-12 pm	12-1 pm	1-2 pm	2-3 pm	3-4 pm	4-5 pm	5-6 pm
Mon	0	6	0	0	0	0	0	0	0	0	0	0
Tue	0	0	30	0	0	0	30	0	0	0	0	0
Wed	0	0	0	0	0	0	0	0	0	0	0	0
Thu	0	0	0	0	0	0	0	0	0	0	0	0
Fri	0	0	0	0	0	0	0	0	0	0	0	0
Sat	0	0	0	0	0	0	0	0	0	0	0	0
Sun	0	0	0	0	0	0	0	0	0	0	0	0

Offices (Sep 1 - April 30)												
	6-7 am	7-8 am	8-9 am	9-10 am	10-11 am	11-12 pm	12-1 pm	1-2 pm	2-3 pm	3-4 pm	4-5 pm	5-6 pm
Mon	0	5	0	0	5	5	5	5	5	5	5	0
Tue	0	5	5	5	5	5	5	5	5	5	5	0
Wed	0	5	0	0	5	5	5	5	5	5	5	0
Thu	0	5	5	5	5	5	5	5	5	5	5	0
Fri	0	5	0	0	5	5	5	5	5	5	5	0
Sat	0	0	0	0	0	0	0	0	0	0	0	0
Sun	0	0	0	0	0	0	0	0	0	0	0	0

## Offices (May 1 - Aug 31)

	6-7 am	7-8 am	8-9 am	9-10 am	10-11 am	11-12 pm	12-1 pm	1-2 pm	2-3 pm	3-4 pm	4-5 pm	5-6 pm
Mon	0	5	1	1	7	3	3	7	7	7	6	0
Tue	0	5	7	7	7	3	3	7	7	7	6	0
Wed	0	5	1	1	7	3	3	7	7	7	6	0
Thu	0	5	7	7	7	3	3	7	7	7	6	0
Fri	0	5	1	1	7	3	3	7	7	7	6	0
Sat	0	0	0	0	0	0	0	0	0	0	0	0
Sun	0	0	0	0	0	0	0	0	0	0	0	0

## Lunch Room

	6-7 am	7-8 am	8-9 am	9-10 am	10-11 am	11-12 pm	12-1 pm	1-2 pm	2-3 pm	3-4 pm	4-5 pm	5-6 pm
Mon	0	0	0	3	0	5	5	0	5	0	0	0
Tue	0	0	0	3	0	5	5	0	5	0	0	0
Wed	0	0	0	3	0	5	5	0	5	0	0	0
Thu	0	0	0	3	0	5	5	0	5	0	0	0
Fri	0	0	0	3	0	5	5	0	5	0	0	0
Sat	0	0	0	0	0	0	0	0	0	0	0	0
Sun	0	0	0	0	0	0	0	0	0	0	0	0

## Appendix B – Electrical Plug and Process Loads

Equipment	Full Load Watts	Count	Operating hrs/wk	Energy kWh/y	Equipment Location
HP Color LaserJet M476	397	1	4	83	offices
desktop computer	65	5	50	845	offices
laptop computer	65	2	50	338	offices
monitors	25	13	50	845	offices
phones	2	6	168	105	offices
two way radio	1	6	168	52	offices
toaster	1800	1	1	94	staff
microwave	1000	1	0.83	43	staff
fridge		1		550	staff
Washer	500	1	5	130	locker
Dryer	3000	1	5	780	locker
water cooler	12.5	1	168	109	staff
TV, LED	171	1	40	356	display
phone	2	1	168	17	meeting room
projector	270	1	2	28	meeting room
boot cleaner	249	0	2	0	vestibule
boot dryer	1550	1	20	1612	vestibule
IT equipment	160	1	168	1398	elec rm