TOC0600198

RePower™ Canada Inc.

Energy Comparison Report

Sprung Structure

Versus

Traditional Method

Revision: 1.1

April 2012

RePower Canada Inc.

Report Contents

RePower Canada Inc.

Located in Barrie, RePower Canada Inc. is an energy management firm that provides audits, analysis and answers to large and small organizations in virtually every industry vertical throughout Central and Southern Ontario. Services include ASHRAE Level 2 audits, utility expense re-verification, sustainable resource management & consulting. Our firm is consistently involved in community matters; supporting environmental initiatives to promote a sustainable neighborhood, participating within a sub-committee for the Greater Barrie Chamber of Commerce and providing feedback to Georgian College to help develop their Sustainable Studies program.

1 Executive Summary

Repower Canada has been commissioned to conduct a comparison study between two different construction methods. The goal is to determine overall building performance based on similar building size and function. Using a comparison of annual energy consumption, annual carbon emission, and energy performance rating will provide insight into which method is the most efficient.

The two construction methods are based on the following:

- Traditional Structure
  - Concrete block, wood frame, R-12 Batt insulation, gypsum interior finish
- Sprung Structure
  - Aluminum frame supported tension membrane structure, R-25 fiberglass blanket insulation sandwiched between exterior and interior tension membrane panels

1.1 Summary Table

The results highlighted in GREEN indicate which construction method has the highest energy performance and/or rating from that particular area of study.

	Sprung Structure ($7,152ft^2$)	Traditional Structure ($7,500ft^2$)	
Energy Star Performance Rating	44	1	
Building Carbon Emission Rate	0.005 $MtCO_2e/ft^2$	0.014 $MtCO_2e/ft^2$	64%
Annual Energy Consumption*	31,287 kWh	136,680 kWh	77%
	8,971 m^3	12,145 m^3	26%
Annual Carbon Emission**	18.55 $MtCO_2e$/year	80.57 $MtCO_2e$/year	77%
	17.34 $MtCO_2e$/year	23.48 $MtCO_2e$/year	26%
Annual Energy Costs***	$11,110 - Electricity	$34,456 - Electricity	68%
	$4,964 - Gas	$10,296 - Gas	52%
Normalized Energy Consumption****	20.1 joules/dd/ft^2	**36.5** joules/dd/ft^2	45%

* February 2011 - January 2012

** Based on emission factors from Portfolio Manager

*** February 2011 - January 2012

**** Based on weather data from Barrie & London, Ontario weather stations

1.2 Energy Star Performance Summary

This Sprung structure achieves a rating of 44 through Energy Star Portfolio Manager.

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2 Introduction

2.1 Background

RePower Canada Inc. has conducted a comparison study between two different construction methods to determine overall building performance based on similar size and building function.

Selected for comparison is a traditional method of construction (TMC) consisting of concrete block, wood frame, and metal deck roof, and a modern method of construction (MMC) consisting of individual architectural membrane panels tensioned between a series of aluminum arched ribs.

2.2 Methodology

Report methodology shall be based on two buildings of similar size (7,100 – 7,500 square feet) and function (house of worship). While the traditional structure is located in Barrie, Ontario, the modern structure is located in Dorchester, Ontario.

Main factors assessed are:

- **Energy Performance**
  - Difference in actual energy consumption when normalized for weather and floor area. Values are given in joules/degreedays/ft^2
- **Energy Star Rating**
  - Based on Energy Star's Portfolio Manager, each building is designated a rating that compares against the national average
- **Annual Energy Consumption**
  - Differences in actual energy consumed and related carbon emissions

Buildings chosen are both houses of worship and of similar size. To create a fair comparison, floor area and geographical location have been accounted for. Weather normalization was completed using data from the nearest cities (London & Barrie). However, the Portfolio Manager uses Toronto weather data only for its calculations.

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Each building's characteristics are as follows:

	Traditional Structure	Sprung Structure
Gross Floor Area:	7,500ft²	7,100ft²
Space Type:	House of Worship	House of Worship
Fuel Source:	Electricity	Electricity
	Natural gas	Natural Gas
Heating:	Packaged Outdoor Unit (80% Efficient)	Packaged Outdoor Unit (81% Efficient)
Lighting:	Fluorescent T8	Fluorescent (Linear and Compact)
Ventilation:	Dedicated Vent Fans	Packaged Outdoor Unit (81% Efficient)
Air Conditioning:	Packaged Outdoor Unit (80% Efficient)	Packaged Outdoor Unit (81% Efficient)
Controls:	Digital Programmable	Digital Programmable

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3 Design Criteria – Sprung Structure

3.1 Specific Building Data – Dorchester Community Church

Project Building Data:

Construction:	Modern method (Aluminum frame supported tension membrane structure, R-25 fiberglass blanket insulation sandwiched between exterior and interior tension membrane panels)
Exterior:	Dupont Tedlar architectural membrane
Building Type:	House of Worship
Gross Floor Area:	7,150 ft^2

Transparent Construction:

Name of Transparent Construction	Thermal Resistance
Roof Lights (Polycarbonate Panel between transluscent fabric)	0.14 U-Value* 7.00 R-Value*

*U/R Values provided by Sprung Structures Inc.

Opaque Construction:

External wall:	Tension membrane structure, consisting of aluminum sub frame with exterior architectural fabric membrane.

Name of Opaque Construction	Thermal Resistance
External Wall (Fabric)	0.18 U-Value* 5.55 R-Value*
Ground Floor (Concrete)	0.25 U-Value* 4.00 R-Value*
Insulation (Fiberglass)	0.04 U-Value* 25.0 R-Value*
Roof (Fabric)	0.18 U-Value* 5.55 R-Value*

*U/R Values provided by Sprung Structures Inc.

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4 Design Criteria – Traditional Structure

4.1 Specific Building Data – AM Shalom Synagogue

Project Building Data:

Construction:	Traditional (concrete block construction with wood frame and R-12 Batt insulation)
Building Type:	House of Worship
Gross Floor Area:	7,500 ft^2

Transparent Construction:

Name of Transparent Construction	Thermal Resistance
Roof Lights (double paned non-operable)	0.7 U-Value* 1.42 R-Value*

*U/R Values provided by All Wall System

Opaque Constructions:

External Wall:	Concrete block construction, consisting of wood frame with R-12 Batt insulation
Roof:	Standard metal deck roof with cathedral design.

Name of Opaque Construction	Thermal Resistance
External Wall (Concrete)	0.12 U-Value* 7.84 R-Value*
Ground Floor (Concrete)	0.22 U-Value 4.42 R-Value*
Insulation (Fiberglass)	0.08 U-Value* 12.0 R-Value*
Roof (Metal Deck)	0.25 U-Value* 4.00 R-Value*

*U/R Values provided by All Wall System

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5 Energy Star Performance Comparison

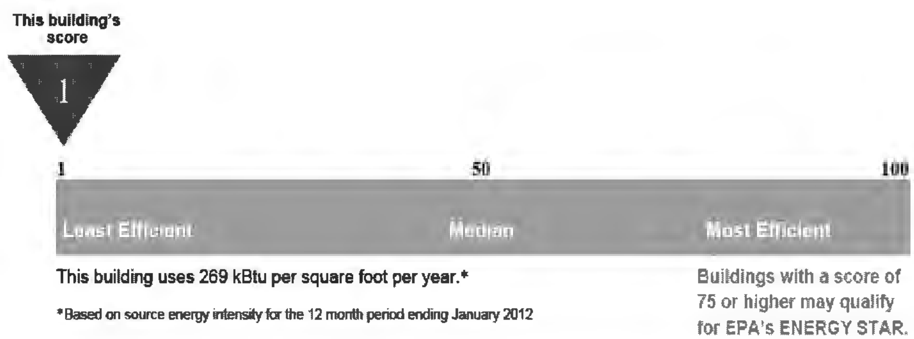
5.1 AM Shalom – Traditional Structure

Annual Carbon Emission

Below is the output data from the Portfolio Manager outlining the building's carbon emission rate. The values are based on annual utility data for the previous 12 months accounting for natural gas and purchased electricity.

12 Months Ending	Current Total Site Energy Use (kBtu)	Current Direct GHG Emissions (MtCO2e)	Current Indirect GHG Emissions (MtCO2e)	Current Total GHG Emissions (MtCO2e)
January 2012	907,689.32	23.48	80.57	104.05

Traditional – Energy Performance Rating



A rating of 1 indicates that the building, from an energy consumption standpoint, performs better than 1% of all similar buildings nationwide.

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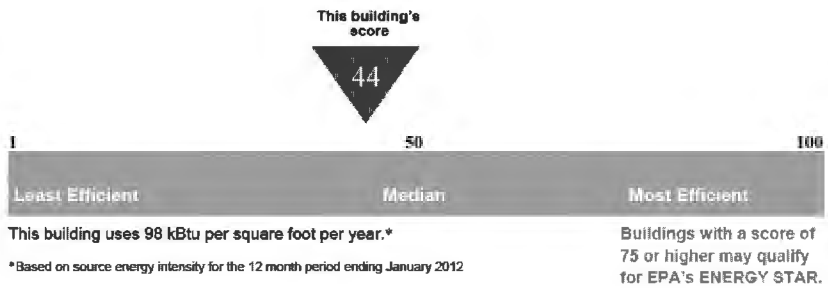
5.2 Dorchester Community Church – Sprung Structure

Sprung – Annual Carbon Emission

Below is the output data from the Portfolio Manager outlining the building's carbon emission rate. The values are based on annual utility data for the previous 12 months accounting for natural gas and purchased electricity

12 Months Ending	Current Total Site Energy Use (kBtu)	Current Direct GHG Emissions (MtCO2e)	Current Indirect GHG Emissions (MtCO2e)	Current Total GHG Emissions (MtCO2e)
January 2012	433,356.52	17.34	18.55	35.89

Sprung – Energy Performance Rating



A rating of 44 indicates that the building, from an energy consumption standpoint, performs better than 44% of all similar buildings nationwide.

Although a rating of 44 is very good, much higher ratings can be achieved within the Sprung structure by implementing controls, passive and renewable technologies. For example, triple-pane windows combined with a geothermal heat/cool system (using variable speed drives), subsidized by solar-thermal hot-air, all controlled and monitored by a building automation system, would place the facility much closer to, if not inside, the "Energy Star Approved" rating of 75 or above.

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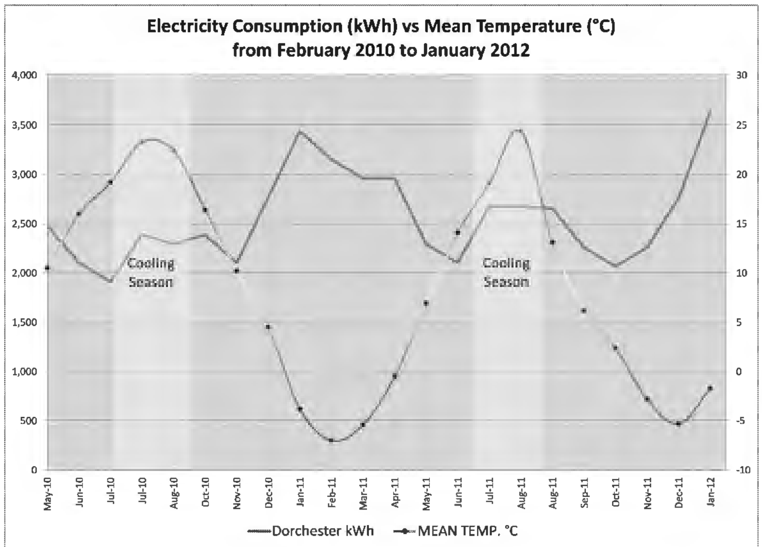
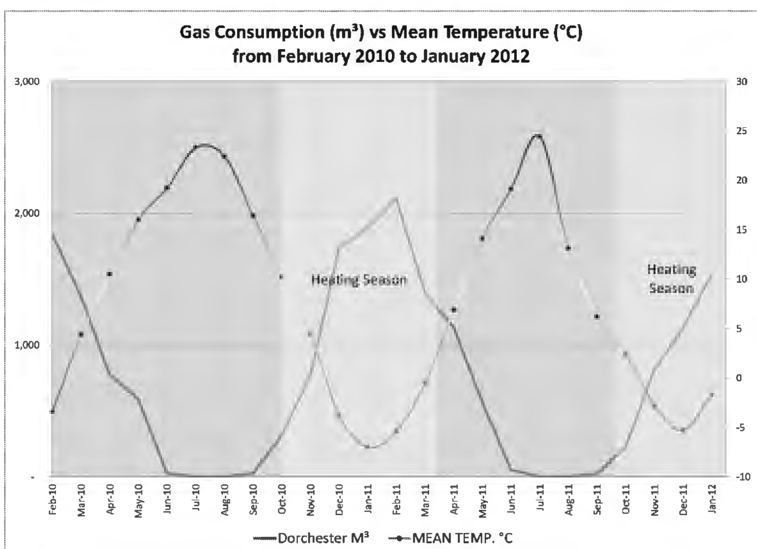
6 Comparison - Annual Energy Consumption

6.1 Dorchester Community Church – Sprung Structure

22 months of electrical data and 24 months of natural gas to data have been analyzed for this study, while accounting for weather and floor area.



The above graph displays electricity consumption relative to average outdoor temperature. An increase in consumption is evident during the summer months, indicating an electric air conditioning unit. Additionally, spikes in consumption that occur during the winter months can be attributed to electric space heaters.



Above, displays natural gas consumption relative to average outdoor temperature. An increase in consumption during the winter months is attributed to gas-fired heating equipment. Consumption does not occur during the summer months.

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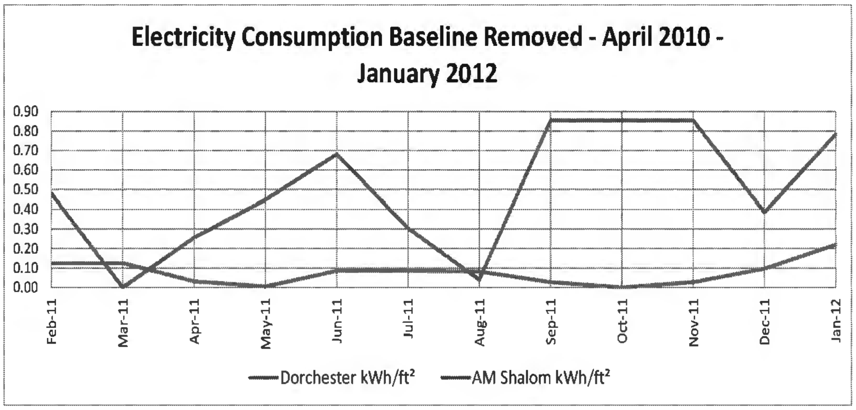
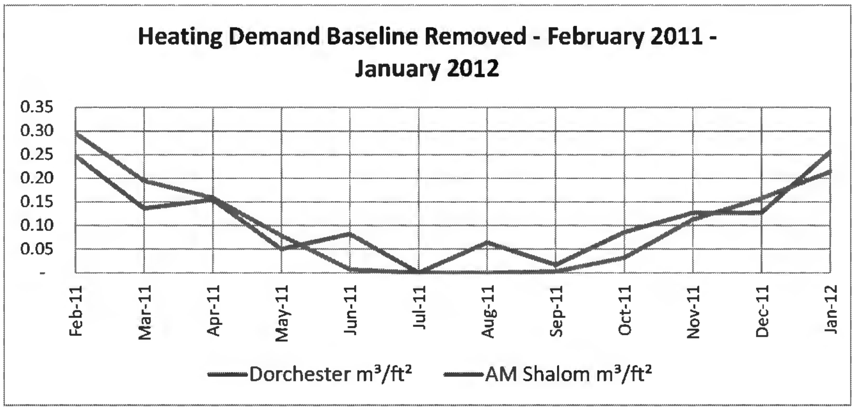
6.2 Annual Energy Comparison



The above graph illustrates electricity consumption per square foot for both structures. Baseline data has been removed to isolate consumption attributed to outdoor weather conditions. Consumption is considerably higher in the traditional structure. Electricity usage is consistent throughout the Sprung facility.



Above, shows natural gas consumption (per square foot) for both structures. Baseline data has been removed to isolate consumption attributed to outdoor weather conditions. Consumption is similar in most building during the winter months; however, the traditional structure uses gas-fired equipment throughout the year resulting in higher annual values.

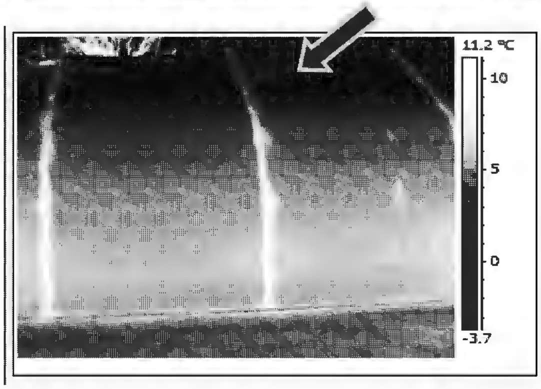
7 Comparison – Thermographic Scan

7.1 Entrance

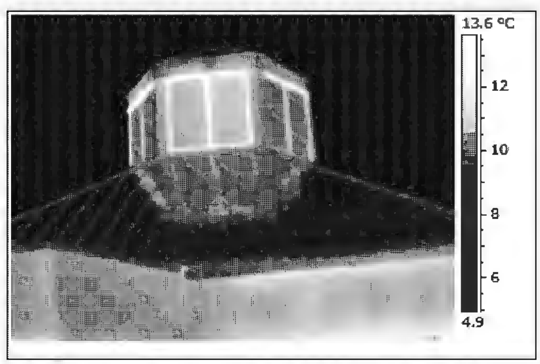
Based on the thermal images taken of both facilities, we can isolate areas that help explain the difference in energy performance. Ideal conditions show smooth zones with consistent changes of temperature from area to area.

Considering both facilities utilitize interior vestibules, thermal imaging shows the better performing entrance doors by the Sprung structure. While the traditional build has "hot-spots" or concentrated areas of air infiltration.

7.2 Natural Lighting



Above, the Sprung structure allows sunlight though a semi-translucent panel section, running the length of the building. MMC uses semi-translucent membrane panels that allow natural daylight into the facility without having the heat loss associated with glazing and framing, shown in the second image.



Conversely, the above traditional structure is experiencing intense heat loss through the rooftop window assembly while letting in less light.

8 Conclusion

It is apparent from the results of this study that the Sprung Structure using the modern method of construction is more efficient when compared with a traditional construction method. Both buildings are of similar function and size. These advantages are due to:

- Use of two translucent membrane panels along the roof greatly reduces heat loss associated with glass and roof fenestration.
- More daylight entering the facility compared to the traditional structure. The result is lower lighting demand which reduces energy consumption from artificial lighting and reduced cooling load (in summer from lamp heat).
- Use of an electric hot water heater instead of a gas-fired unit.
- Higher R-Values for the roof assembly reduces heat loss, decreasing consumption.
- Higher R-Values for the roof fenestration reduces heat loss, decreasing consumption.

Overall the Sprung structure is considerably more efficient when compared to traditional methods.

- **Consumes 45% less energy** than a facility of similar size and function using the traditional construction method
- **Produces 65% less greenhouse gas** emissions than a facility of similar size and function
- **Operating costs are 62% less** than a facility of similar size and function using the traditional construction method

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Appendix

A. Energy Star Rating

i. What is Energy Star – Portfolio Manager

Portfolio Manager is an interactive energy management tool that allows you to track and assess energy and water consumption across your entire portfolio of buildings in a secure online environment.

Building Energy Performance Rating

For many facilities, you can rate their energy performance on a scale of 1–100 relative to similar buildings nationwide. Your building is *not* compared to the other buildings entered into Portfolio Manager to determine your ENERGY STAR rating. Instead, statistically representative models are used to compare your building against similar buildings from a national survey conducted by the Department of Energy's Energy Information Administration. This national survey, known as the Commercial Building Energy Consumption Survey (CBECS), is conducted every four years, and gathers data on building characteristics and energy use from thousands of buildings across the United States. Your building's peer group of comparison is those buildings in the CBECS survey that have similar building and operating characteristics. A rating of 50 indicates that the building, from an energy consumption standpoint, performs better than 50% of all similar buildings nationwide, while a rating of 75 indicates that the building performs better than 75% of all similar buildings nationwide.

EPA's energy performance rating system, based on source energy, accounts for the impact of weather variations as well as changes in key physical and operating characteristics of each building. Buildings rating 75 or greater may qualify for the ENERGY STAR label.

Estimate Carbon Footprint

Portfolio Manager calculates your building's greenhouse gas emissions (including carbon dioxide, methane, and nitrous oxide) from on-site fuel combustion and purchased electricity and district heating and cooling. While the emissions calculations are based on the amount of energy your building consumes, they have no bearing on its energy performance rating. The methodology for calculating greenhouse gas emissions in Portfolio Manager was designed to be consistent with the Greenhouse Gas Protocol developed by the World Resources Institute and World Business Council for Sustainable Development, and is compatible with the accounting, inventory and reporting requirements of EPA's Climate Leaders program, as well as other state and NGO registry and reporting programs.

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ii. AM Shalom – Traditional Structure

Facility
AM Shalom
767 Huronia Street
Barrie,

General Information

AM Shalom	
Gross Floor Area Excluding Parking: (ft^2)	7,500
Year Built	2005
For 12-month Evaluation Period Ending Date:	January 31, 2012

Facility Space Use Summary

AM Shalom	
Space Type	House of Worship
Gross Floor Area (ft^2)	7,500
Seating Capacity	220
Weekday Operation	5
Weekly operating hours	60
Number of PCs	3
Presence of cooking facilities	No
Number of Commercial Refrigeration/Freezer Units	0

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 01/31/2012)	**Baseline** (Ending Date 02/28/2011)	**Rating of 75**	**Target**	**National Median**
Energy Performance Rating	1	1	75	N/A	50
Energy Intensity					
Site (kBtu/ft^2)	121	114	32	N/A	43
Source (kBtu/ft^2)	269	256	70	N/A	97
Energy Cost					
$/year	$ 24,140.98	$ 22,119.34	$ 6,297.04	N/A	$ 8,662.67
$/ft^2/year	$ 3.22	$ 2.95	$ 0.84	N/A	$ 1.16

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iii. Dorchester Community Church – Sprung Structure

Facility
Dorchester Church
3912 Catherine Street
N0L 1G0
Dorchester,

General Information

Dorchester Church	
Gross Floor Area Excluding Parking: (ft^2)	7,152
Year Built	2009
For 12-month Evaluation Period Ending Date:	January 31, 2012

Facility Space Use Summary

House of Worship	
Space Type	House of Worship
Gross Floor Area (ft^2)	7,152
Seating Capacity	215
Weekday Operation	5
Weekly operating hours	65
Number of PCs	1
Presence of cooking facilities	No
Number of Commercial Refrigeration/Freezer Units	0

Energy Performance Comparison

	Evaluation Periods		Comparisons		
Performance Metrics	**Current** (Ending Date 01/31/2012)	**Baseline** (Ending Date 04/30/2011)	**Rating of 75**	**Target**	**National Median**
Energy Performance Rating	44	46	75	N/A	50
Energy Intensity					
Site (kBtu/ft^2)	61	65	41	N/A	57
Source (kBtu/ft^2)	98	101	67	N/A	92
Energy Cost					
$/year	$ 8,488.48	$ 9,002.62	$ 5,794.41	N/A	$ 7,972.92
$/ft^2/year	$ 1.19	$ 1.26	$ 0.81	N/A	$ 1.12

B. Energy Consumption

i. AM Shalom – Traditional Structure

We have analyzed 22 months of electrical data and 24 months of natural gas to data for this study, while accounting for weather and floor area.

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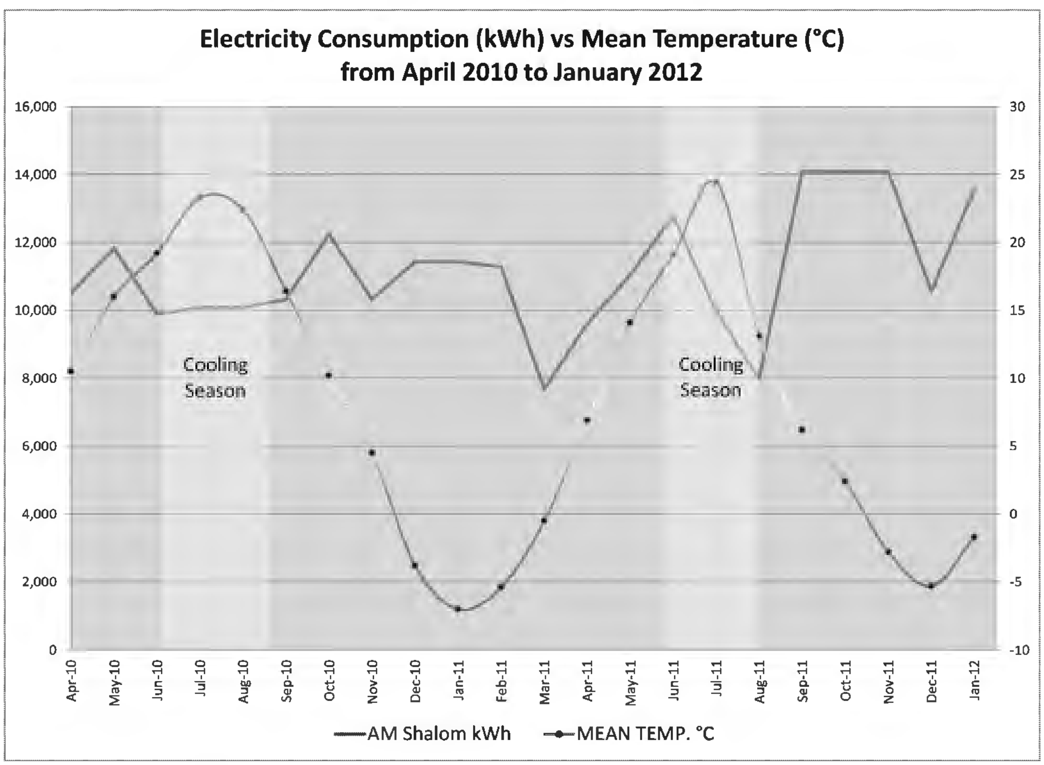
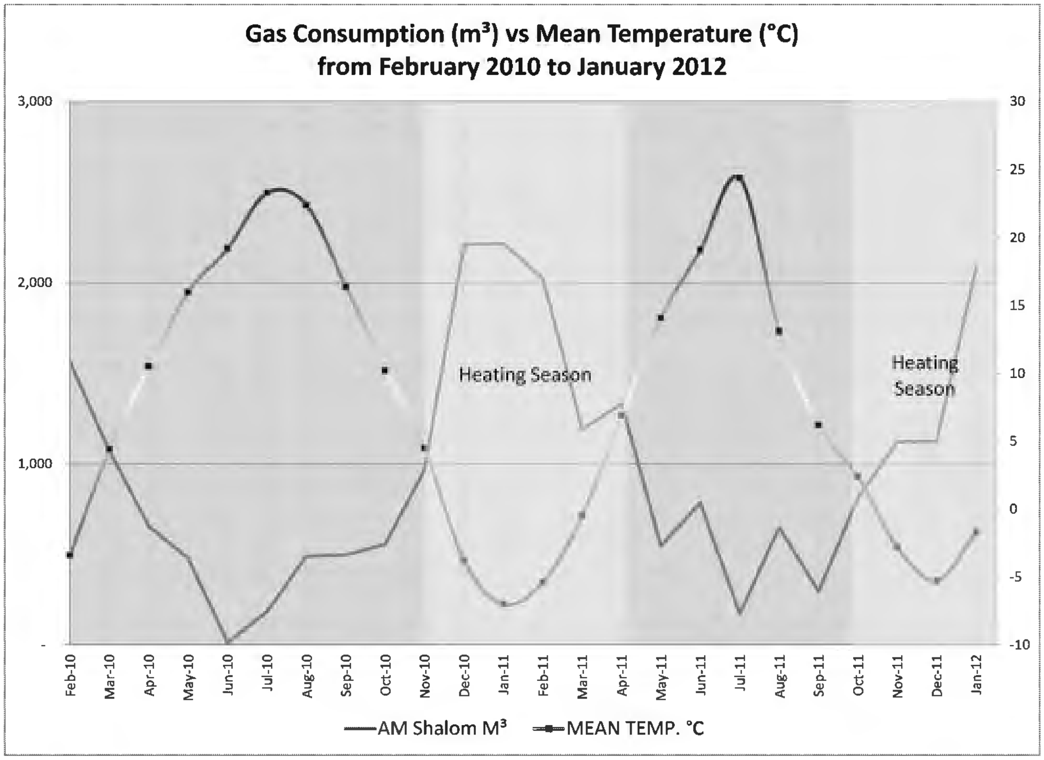
[illegible]	[illegible]	[illegible]	[illegible]
Apr-10	10,500	$1,469	$0.1399
May-10	11,820	$1,923	$0.1627
Jun-10	9,900	$1,609	$0.1625
Jul-10	10,080	$1,548	$0.1536
Aug-10	10,080	$1,548	$0.1536
Sep-10	10,320	$1,463	$0.1418
Oct-10	12,240	$1,624	$0.1327
Nov-10	10,320	$1,441	$0.1397
Dec-10	11,430	$1,536	$0.1343
Total	96,690	$14,162	$0.1465
Jan-11	11,430	$1,536	$0.1343
Feb-11	11,280	$1,335	$0.1184
Mar-11	7,680	$983	$0.1280
Apr-11	9,600	$1,229	$0.1281
May-11	11,040	$1,512	$0.1370
Jun-11	12,780	$1,939	$0.1517
Jul-11	9,960	$1,760	$0.1767
Aug-11	7,980	$1,307	$0.1638
Sep-11	14,080	$1,823	$0.1295
Oct-11	14,080	$1,823	$0.1295
Nov-11	14,080	$1,823	$0.1295
Dec-11	10,560	$1,410	$0.1335
Total	134,550	$18,480	$0.1373
Jan-12	13,560	$1,815	$0.1338
Total	13,560	$1,815	$0.1338

Gas			
Month	Cubic Meters (m^3)	Total $	$/m3
Nov-09	882	$391	$0.4434
Dec-09	1,335	$559	$0.4186
Total	2,217	$950	$0.4285
Jan-10	2,357	$958	$0.4063
Feb-10	1,563	$660	$0.4221
Mar-10	1,072	$470	$0.4383
Apr-10	656	$316	$0.4811
May-10	478	$249	$0.5202
Jun-10	12	$65	$5.3992
Jul-10	182	$132	$0.7237
Aug-10	489	$253	$0.5170
Sep-10	496	$256	$0.5153
Oct-10	556	$279	$0.5020
Nov-10	967	$435	$0.4497
Dec-10	2,213	$899	$0.4063
Total	11,041	$4,970	$0.4501
Jan-11	2,218	$902	$0.4067
Feb-11	2,026	$832	$0.4109
Mar-11	1,191	$523	$0.4389
Apr-11	1,331	$568	$0.4264
May-11	546	$280	$0.5132
Jun-11	785	$370	$0.4719
Jul-11	170	$75	$0.4419
Aug-11	649	$319	$0.4908
Sep-11	296	$182	$0.6135
Oct-11	814	$380	$0.4667
Nov-11	1,122	$496	$0.4419
Dec-11	1,125	$498	$0.4422
Total	12,273	$5,424	$0.4420
Jan-12	2,090	$860	$0.4113
Feb-12	1,497	$644	$0.4300
Total	3,587	$1,503	$0.4191

The following charts display electricity and natural gas consumption for roughly two years. Electricity consumption appears to peak in the later part of the year. This can be attributed to the private daycare located on site. Natural gas consumption has increased compared to the previous year leading to higher annual costs, despite a slight decrease in the effective rate. Gas usage peaks during the winter months due to gas-fired heating equipment.



The following graph displays electricity consumption relative to average outdoor temperature. An area where consumption is consistent is due to larger billing periods (up to 93 days). Consumption appears to increase during the spring and summer months of 2011, indicating electric air conditioning units.



The following graph displays natural gas consumption relative to average outdoor temperature. Consumption appears to increase during the winter months, indicating heating is provided by gas-fired equipment. Low levels of consumption during the summer months indicate a gas-fired water heater.

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