Houses of Religious Worship

Best Practices for Utility Cost Reduction

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Presentation Outline

• Utility Pricing & Production Data
• HVAC 101 and Human Comfort
• Ventilation Requirements
• Older HVAC
• Modern HVAC
• Lighting
• Renewable Energy
• Top Conservation Recommendations
• Q & A
Utility Pricing and Production Data
## Monetary Fuel Prices

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Unit Price</th>
<th>Heating Value [Btu/unit]</th>
<th>Fuel Unit</th>
<th>Efficiency</th>
<th>Monetary Value ($/MMbtu)</th>
<th>Index Price Ranking</th>
<th>Index Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>$0.250</td>
<td>3,412</td>
<td>KWH</td>
<td>100%</td>
<td>$73.27</td>
<td>100%</td>
<td>4.1</td>
</tr>
<tr>
<td>Propane</td>
<td>$3.80</td>
<td>91,500</td>
<td>Gallon</td>
<td>80%</td>
<td>$51.91</td>
<td>71%</td>
<td>2.9</td>
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<tr>
<td>Propane</td>
<td>$3.80</td>
<td>91,500</td>
<td>Gallon</td>
<td>95%</td>
<td>$43.72</td>
<td>60%</td>
<td>2.4</td>
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<tr>
<td>#2 Oil</td>
<td>$4.69</td>
<td>140,000</td>
<td>Gallon</td>
<td>84%</td>
<td>$39.88</td>
<td>54%</td>
<td>2.2</td>
</tr>
<tr>
<td>Heat Pump</td>
<td>$0.25</td>
<td>3,412</td>
<td>KWH</td>
<td>300%</td>
<td>$24.42</td>
<td>33%</td>
<td>1.4</td>
</tr>
<tr>
<td>Wood Pellet</td>
<td>$5.98</td>
<td>328,000</td>
<td>40 lb Bag</td>
<td>70%</td>
<td>$26.05</td>
<td>36%</td>
<td>1.5</td>
</tr>
<tr>
<td>Cord Wood</td>
<td>$325.00</td>
<td>24,000,000</td>
<td>cord</td>
<td>60%</td>
<td>$22.57</td>
<td>31%</td>
<td>1.3</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>$1.70</td>
<td>100,000</td>
<td>Therm</td>
<td>80%</td>
<td>$21.25</td>
<td>29%</td>
<td>1.2</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>$1.70</td>
<td>100,000</td>
<td>Therm</td>
<td>95%</td>
<td>$17.89</td>
<td>24%</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Max: $73.27

*Note: A COP of 3.0 = 300% Efficiency
Natural Gas
[Source: U.S. Energy Administration (EIA)]

Figure 21. Average price of natural gas delivered to U.S. commercial consumers, 2020
(dollars per thousand cubic feet)

(Note: Prices are in nominal dollars.
Massachusetts Historical Natural Gas Prices

- **Synagogues are Commercial Rate Class**

House of Worship Utility Cost Reduction
### Residential Electric Rates

Approximately **80%** of Synagogues are "Residential" Rate Class

(Average Rates: **Jan 2022 - June 2022**, Source: EIA)

<table>
<thead>
<tr>
<th>State</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hawaii</td>
<td>$0.407</td>
</tr>
<tr>
<td>California</td>
<td>$0.262</td>
</tr>
<tr>
<td>Connecticut</td>
<td>$0.253</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>$0.249</td>
</tr>
<tr>
<td>Maine</td>
<td>$0.229</td>
</tr>
<tr>
<td>Alaska</td>
<td>$0.229</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>$0.228</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>$0.226</td>
</tr>
<tr>
<td>New York</td>
<td>$0.213</td>
</tr>
<tr>
<td>Vermont</td>
<td>$0.199</td>
</tr>
<tr>
<td>Michigan</td>
<td>$0.175</td>
</tr>
<tr>
<td>New Jersey</td>
<td>$0.167</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>$0.154</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>$0.150</td>
</tr>
<tr>
<td>Illinois</td>
<td>$0.148</td>
</tr>
<tr>
<td>Indiana</td>
<td>$0.143</td>
</tr>
<tr>
<td>Maryland</td>
<td>$0.141</td>
</tr>
<tr>
<td>Alabama</td>
<td>$0.138</td>
</tr>
<tr>
<td>Colorado</td>
<td>$0.138</td>
</tr>
<tr>
<td>District of Columbia</td>
<td>$0.138</td>
</tr>
<tr>
<td>Minnesota</td>
<td>$0.138</td>
</tr>
<tr>
<td>South Carolina</td>
<td>$0.136</td>
</tr>
<tr>
<td>Florida</td>
<td>$0.136</td>
</tr>
<tr>
<td>Kansas</td>
<td>$0.135</td>
</tr>
<tr>
<td>New Mexico</td>
<td>$0.134</td>
</tr>
<tr>
<td>Nevada</td>
<td>$0.134</td>
</tr>
<tr>
<td>Georgia</td>
<td>$0.133</td>
</tr>
<tr>
<td>Ohio</td>
<td>$0.132</td>
</tr>
<tr>
<td>Delaware</td>
<td>$0.131</td>
</tr>
<tr>
<td>West Virginia</td>
<td>$0.130</td>
</tr>
<tr>
<td>Arizona</td>
<td>$0.129</td>
</tr>
<tr>
<td>Texas</td>
<td>$0.128</td>
</tr>
<tr>
<td>Virginia</td>
<td>$0.127</td>
</tr>
<tr>
<td>Iowa</td>
<td>$0.125</td>
</tr>
<tr>
<td>Mississippi</td>
<td>$0.125</td>
</tr>
<tr>
<td>Kentucky</td>
<td>$0.123</td>
</tr>
<tr>
<td>South Dakota</td>
<td>$0.119</td>
</tr>
<tr>
<td>North Carolina</td>
<td>$0.118</td>
</tr>
<tr>
<td>Tennessee</td>
<td>$0.117</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>$0.116</td>
</tr>
<tr>
<td>Louisiana</td>
<td>$0.116</td>
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<tr>
<td>Missouri</td>
<td>$0.114</td>
</tr>
<tr>
<td>Arkansas</td>
<td>$0.113</td>
</tr>
<tr>
<td>Oregon</td>
<td>$0.112</td>
</tr>
<tr>
<td>Montana</td>
<td>$0.109</td>
</tr>
<tr>
<td>Wyoming</td>
<td>$0.109</td>
</tr>
<tr>
<td>North Dakota</td>
<td>$0.108</td>
</tr>
<tr>
<td>Utah</td>
<td>$0.107</td>
</tr>
<tr>
<td>Nebraska</td>
<td>$0.106</td>
</tr>
<tr>
<td>Idaho</td>
<td>$0.102</td>
</tr>
<tr>
<td>Washington</td>
<td>$0.102</td>
</tr>
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</table>
GHG Power Production in our Region:

<table>
<thead>
<tr>
<th>State</th>
<th>Power Use (TWH)</th>
<th>Population (Millions)</th>
<th>Annual MWH/capita</th>
<th>$ per KWH</th>
<th>Nat Gas</th>
<th>Oil</th>
<th>Biomass</th>
<th>Coal</th>
<th>GHG Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecticut</td>
<td>41.2</td>
<td>3.61</td>
<td>11.4</td>
<td>22.4</td>
<td>57.0%</td>
<td>0.0%</td>
<td>3.3%</td>
<td>0.0%</td>
<td>60%</td>
</tr>
<tr>
<td>Maine</td>
<td>10.4</td>
<td>1.37</td>
<td>7.6</td>
<td>18.0</td>
<td>16.9%</td>
<td>0.4%</td>
<td>23.4%</td>
<td>0.0%</td>
<td>41%</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>18.3</td>
<td>6.98</td>
<td>2.6</td>
<td>23.5</td>
<td>76.1%</td>
<td>0.2%</td>
<td>8.3%</td>
<td>0.0%</td>
<td>85%</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>16.7</td>
<td>1.39</td>
<td>12.0</td>
<td>20.7</td>
<td>21.8%</td>
<td>0.2%</td>
<td>6.5%</td>
<td>0.0%</td>
<td>29%</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>8.0</td>
<td>1.10</td>
<td>7.3</td>
<td>23.4</td>
<td>91.8%</td>
<td>1.0%</td>
<td>2.6%</td>
<td>0.0%</td>
<td>95%</td>
</tr>
<tr>
<td>Vermont</td>
<td>2.4</td>
<td>0.65</td>
<td>3.7</td>
<td>19.5</td>
<td>0.0%</td>
<td>0.0%</td>
<td>17.8%</td>
<td>0.0%</td>
<td>18%</td>
</tr>
<tr>
<td>New England</td>
<td>97.0</td>
<td>15.1</td>
<td>6.4</td>
<td>21.9</td>
<td>51.7%</td>
<td>0.2%</td>
<td>7.3%</td>
<td>0.0%</td>
<td>59%</td>
</tr>
<tr>
<td>New York</td>
<td>132.0</td>
<td>19.84</td>
<td>6.7</td>
<td>20.5</td>
<td>40.1%</td>
<td>0.2%</td>
<td>2.0%</td>
<td>0.1%</td>
<td>42%</td>
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<tr>
<td>New Jersey</td>
<td>61.5</td>
<td>9.27</td>
<td>6.6</td>
<td>16.3</td>
<td>49.9%</td>
<td>0.1%</td>
<td>2.4%</td>
<td>1.4%</td>
<td>54%</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>231.0</td>
<td>12.80</td>
<td>18.0</td>
<td>14.1</td>
<td>52.1%</td>
<td>0.0%</td>
<td>2.6%</td>
<td>8.9%</td>
<td>64%</td>
</tr>
</tbody>
</table>

Note: 1 TWH = 1,000,000 MWH
Non-GHG Power Production in our Region:

<table>
<thead>
<tr>
<th>State</th>
<th>Hydro</th>
<th>Solar</th>
<th>Wind</th>
<th>Nuclear</th>
<th>Non-GHG Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecticut</td>
<td>1%</td>
<td>0.6%</td>
<td>0.0%</td>
<td>38.2%</td>
<td>40%</td>
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<tr>
<td>Maine</td>
<td>34.4%</td>
<td>0.3%</td>
<td>24.0%</td>
<td>0.5%</td>
<td>59%</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>5.4%</td>
<td>8.5%</td>
<td>1.5%</td>
<td>0.0%</td>
<td>15%</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>8.9%</td>
<td>0.0%</td>
<td>3.1%</td>
<td>59.0%</td>
<td>71%</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>0.0%</td>
<td>2.6%</td>
<td>2.9%</td>
<td>0.0%</td>
<td>6%</td>
</tr>
<tr>
<td>Vermont</td>
<td>57.8%</td>
<td>8.0%</td>
<td>16.2%</td>
<td>0.0%</td>
<td>82%</td>
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<tr>
<td>New England</td>
<td>8.1%</td>
<td>2.3%</td>
<td>4.0%</td>
<td>26.4%</td>
<td>41%</td>
</tr>
<tr>
<td>New York</td>
<td>23.8%</td>
<td>0.8%</td>
<td>3.8%</td>
<td>29.1%</td>
<td>58%</td>
</tr>
<tr>
<td>New Jersey</td>
<td>0.0%</td>
<td>2.6%</td>
<td>0.0%</td>
<td>43.5%</td>
<td>46%</td>
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<tr>
<td>Pennsylvania</td>
<td>1.5%</td>
<td>0.1%</td>
<td>1.7%</td>
<td>33.1%</td>
<td>36%</td>
</tr>
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<td>Category</td>
<td>MMBTU</td>
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<tr>
<td>-----------------------</td>
<td>------------------</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Buildings</td>
<td>459,738,440</td>
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<td>Transportation</td>
<td>421,693,000</td>
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<td>Power Generation Fuel</td>
<td>127,992,120</td>
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<tr>
<td>Biomass Fuel</td>
<td>58,600,000</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,068,023,560</strong></td>
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</tr>
</tbody>
</table>

**Massachusetts Fuel Consumption MMBTU (2020)**

- Buildings: 43%
- Transportation: 39%
- Power Generation Fuel: 12%
- Biomass Fuel: 6%
Comments

Our dominant source of energy for continuous electricity generation is natural gas, oil, and biomass, only 8% is truly renewable. The renewable sources do not operate 24/7. We are therefore dependent on renewables to supplement our energy needs and will continue to depend on fossil energy until fusion and/or hydrogen become the dominant fuel source.
Electrification

- Conversion from fossil fuel to resistive electric will result in greater release of GHG due to the dominant use of gas/oil/wood for electricity generation, the poor overall efficiencies of power plants, and the power line transmission losses.
HVAC 101
Comfort & Air Balance
The purpose of HVAC systems is to add/remove heat, moisture, and air pollutants from a controlled space and provide conditions to promote human comfort/health.
Human Comfort

• Dry bulb temperature
• Relative humidity
• Air velocity
• Fresh Air
• Noise
• Pollutants
Types of HVAC Systems

The purpose of HVAC systems is to add/remove heat, moisture and air pollutants from a controlled space and provide conditions to promote human comfort.

Types of heating systems:

- Direct Fired
- Furnaces, duct distribution
- Hydronic Baseboard
- Hydronic Fan-coil
- Hydronic Unit Heater
- Heat Pump
- Steam Radiator
- Unit Ventilator
- Variable Air Volume
Ventilation of an Assembly Space

**Circulation:**
Rooms of Assembly require constant air circulation

**Outside Air:**
Activation of louvers, MUAU, or exhaust fan

**Infiltration:** Normally occurring air flow through walls/windows
Air Balance Testing Equipment
Measures air velocity in ducts and building openings
Typical Cog V-belt with Adjustable Motor Sheave
Variable Frequency Drive (VFD) for control of blower/pump speeds

House of Worship Utility Cost Reduction
Mechanical Systems

Hydronic System

Rooftop Exhaust

House of Worship Utility Cost Reduction
Typical Duct Distribution System
Hot Air v. Radiant/Baseboard
Hydronic Radiant System
Radiant Heat
Under Floor Heating
Hydronic Baseboard Heat
Assorted Unit Ventilators
Hydronic Boilers
What is the Building Heating Load
Are the Systems Sized Properly?

- $U = 1/R$
- $U$ has units of: $[\text{BTU/}(\text{hr}\cdot\text{SF}\cdot\text{°F})]$

$$Q = U \times \text{Area} \times (T_{\text{in}} - T_{\text{out}}) \ (\text{Btu/hr})$$

$$Q_{\text{envel}} = \sum (U\times A)_{\text{overall}} \times (\Delta T) \ (\text{Btu/hr})$$

House of Worship Utility Cost Reduction
Traditional Boiler Room
Typical Oil-Fired Hot Air Furnace

House of Worship Utility Cost Reduction
Hydronic Coils
Air-Cooled Chiller
What is your Equipment Efficiency?

- Efficiency = Useful energy/Total energy

- Boilers:
  - AFUE
  - Combustion Efficiency

- Chillers:
  - COP
  - EER, SEER
  - EER = COP x 3.412
HVAC Maintenance, Commissioning
ASHRAE 180-2018

- HVAC Mechanical systems should be recommissioned at least once each year.
- Hydronic fan-coil systems that circulate boiler water must be protected with anti-freeze to prevent freezing in cold weather climates.
Ventilation Requirements
Fresh Air Requirements

- ANSI/ASHRAE Standard 62.1-2004 (Indoor Air Quality)

Previous: **6 CFM /person**

Present: **20 CFM/Person** (New CDC Requirement)
Infiltration ~ Air Changes

- ACH ~ Air Changes per Hour
- ACH = f (Envelope, Wind Velocity, Temp Gradient, Building Height)

- Tight: 0.25 ACH
- Average: 0.50 ACH
- High leakage: ≥1.0 ACH
CDC:
“Ensure that ventilation systems operate properly and increase circulation of outdoor air as much as possible by opening windows and doors, using fans, etc.”
"One potential target benchmark for good ventilation is CO₂ readings below 800 ppm."

- 800 ppm = 20 cfm/person of fresh air (@ MET 1)
- ASHRAE standard of only 7 cfm/person is not adequate.
  - Maximize existing O.A. capacity
  3x 7 cfm/person O.A ventilation; 33% occupancy
Basis of Proposed Ventilation Rates

a) At 33% occupancy, outdoor air flowrates can be increased to provide more fresh air per person. If systems were designed for 7 cfm per person, the systems should be able to provide approximately three-times the outdoor air at 33% occupancy.

b) Determine maximum COVID Occupancy

c) Determine maximum cooling capacity

d) Determine maximum heating capacity

e) If system meets energy capacity requirements, set outside air flowrates based on the following criteria:
**Recommended Ventilation Rates**

**Air circulation:**
0.75 cfm per sf (1 ton/500 sf) + 25 cfm/person

Air circulation to be enabled 2 hours before event and 2 hours after event.

**Exhaust or Outside Air:**
20 cfm/person and as maintained by a carbon dioxide controller.
Carbon Dioxide Monitor/Controller

CO₂ Monitor

CO₂ Controller

House of Worship Utility Cost Reduction
Older HVAC v Modern HVAC
COVID HVAC Preparation
COVID Preparation for Older Building HVAC
[No central HVAC duct distribution]

- Open Doors and Windows
- Utilize carbon dioxide monitors
- Window fans
- Ceiling fans
- Use of HEPA filters
Older Building
Steam Radiator Systems

House of Worship Utility Cost Reduction
Typical Window Fan
400 cfm, 20 persons/fan
Exhaust air out of space
Free-standing HEPA Filters

HEPA Filter Operation - 99.97% Effective

Dust particles

10,000

HEPA filter material

House of Worship Utility Cost Reduction
Carbon Dioxide Monitor/Controller

CO₂ Monitor

CO₂ Controller

House of Worship Utility Cost Reduction
COVID Preparation for Modern Building HVAC

- Carbon dioxide controller
- Carbon dioxide monitor
- Exhaust fans
- Outside air louvers
- Ceiling fans
- Energy Recovery
- MERV-13 Filters
Modern HVAC Components
Typical Heating/Cooling RTU
Duct System Components

• Duct system Designs:
• Single blower: supply, return, filter
• Dual Duct: supply blower: outside air intake
• Return blower: exhaust air discharge

• Variable Air Volume

• Components
• Dampers
• Grilles
• Heat exchange surface
• Ductwork
• Control system
Lighting
Light Emitting Diode
The Nobel Prize in Physics for 2014
LED Lighting
The Nobel Prize in Physics for 2014

• **Isamu Akasaki**
  Meijo University, Nagoya, Japan and Nagoya University, Japan

• **Hiroshi Amano**
  Nagoya University, Japan

• **Shuji Nakamura**
  University of California, Santa Barbara, CA, USA

• “For the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources"
House of Worship Utility Cost Reduction
House of Worship Utility Cost Reduction
Compact Fluorescent Lamps
[Now Obsolete]
Lighting Occupancy Sensors

- Passive infrared (PIR) sensors react to the infrared heat energy emitted by people.
  - **Ultrasonic** occupant sensors activate a quartz crystal that emits ultrasonic waves and then senses the frequency of the reflected waves. Motion causes the reflected wave's frequency to shift (Doppler effect).
- Audible noise detectors
- Direct influence: foot pad, lever, or light beam.
Typical Exit Sign Upgrades

- LED lamp retrofits
- Electroluminescent panels
- New LED emergency/exit signs
Color Rendering Index

- Left to Right: Warm – Neutral – Cool
- Incandescent/Halogen: CRI ~ 100
- Fluorescent: CRI ~ 50-90

House of Worship Utility Cost Reduction
<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Output (Lumens)</td>
<td>800</td>
</tr>
<tr>
<td>Watts</td>
<td>12.5</td>
</tr>
<tr>
<td>Lumens per Watt (Efficacy)</td>
<td>64</td>
</tr>
<tr>
<td><strong>Color Accuracy</strong></td>
<td></td>
</tr>
<tr>
<td>Color Rendering Index (CRI)</td>
<td>80</td>
</tr>
<tr>
<td><strong>Light Color</strong></td>
<td></td>
</tr>
<tr>
<td>Correlated Color Temperature (CCT)</td>
<td>2700K (Warm White)</td>
</tr>
</tbody>
</table>

![Lighting Facts Diagram](image)

All results are according to IESNA LM-79-2008: Approved Method for the Electrical and Photometric Testing of Solid-State Lighting. The U.S. Department of Energy (DOE) verifies product test data and results.


Registration Number: ZC23-5RLZ31
Model Number: 12E26A60
Type: Replacement lamp - Omnidirectional (A Lamp)
## Power and Performance Comparison

<table>
<thead>
<tr>
<th>Lumens</th>
<th>Incandescent</th>
<th>Halogen</th>
<th>CFL</th>
<th>LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>450 lumens</td>
<td>40W</td>
<td>29W</td>
<td>9W</td>
<td>7W</td>
</tr>
<tr>
<td>800 lumens</td>
<td>60W</td>
<td>43W</td>
<td>14W</td>
<td>10W</td>
</tr>
<tr>
<td>1,100 lumens</td>
<td>75W</td>
<td>53W</td>
<td>19W</td>
<td>17W</td>
</tr>
<tr>
<td>1,600 lumens</td>
<td>100W</td>
<td>72W</td>
<td>23W</td>
<td>20W</td>
</tr>
</tbody>
</table>

House of Worship Utility Cost Reduction
Lighting Audit Form

More information about identifying bulb types is available in the accompanying guidelines documents.

<table>
<thead>
<tr>
<th>Lighting</th>
<th>Floor Name or Number</th>
<th>Location Description (near window, internal office, hallway, etc.)</th>
<th>Lamp Type</th>
<th>Ballast Type</th>
<th>Wattage</th>
<th>Total Number of Lamps</th>
<th>Number of hours lights are left on each day</th>
<th>Total kWh per Day</th>
<th>How are lights controlled?</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

House of Worship Utility Cost Reduction
Renewable Energy

https://www.dsireusa.org/
Primary Ownership v. 3rd Party

THE PROS & CONS

PRIMARY OWNERSHIP

- Take Full Advantage of Electricity Savings
- Property Value Increases
- SREC Income
- Substantial Upfront Investment
- Responsible for Maintenance
- May Need to Increase Property Insurance

THIRD-PARTY OWNERSHIP

- Little to No Upfront Cost
- Reduced Electricity Rate
- Not Responsible for Maintenance
- No SREC Income
- Contractually Bound
- No Added Property Value
- Difficulty Selling Your Property

House of Worship Utility Cost Reduction
Roof v. Ground Mount Solar
[Advantages and Disadvantages]
Top Conservation Recommendations
#1

Tune Up Burner/Service Boiler
#2

Weatherize Your Building
#3
Install Energy Management Controls

- Set-back Temperatures
- Multiple Building Sensors
- Electronic Temperature Control
- Outdoor Sensor
- Install Zone Valves

House of Worship Utility Cost Reduction
#4
Convert Away From Electric Heat

Equivalent Price of Oil v. Cost/KWH

Cost per KWH

Equivalent Oil Price Per Gallon
Total Appliance Load: 60 kW
Convert to gas: $23,000 savings/yr
2 year R.O.I.
#5
Monitor Boilers
~ Install water meter on make-up
~ Install oil meter or hour meter on burner(s)

- What is your combustion efficiency?
- What is your steam leakage rate?
- What is your steam/fuel ratio?
#6
Reduce Water Use

- Plug leaks!
- Install pressure regulators to reduce building pressure
- Install aerators
- Install low flow toilets
Water Leak @ 1 gpm

<table>
<thead>
<tr>
<th>City</th>
<th>Water ($/ccf)</th>
<th>Sewer ($/ccf)</th>
<th>Total ($/ccf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lawrence</td>
<td>$ 3.10</td>
<td>$ 3.35</td>
<td>$ 6.45</td>
</tr>
<tr>
<td>Springfield</td>
<td>$ 2.14</td>
<td>$ 7.47</td>
<td>$ 9.61</td>
</tr>
<tr>
<td>Worcester</td>
<td>$ 3.67</td>
<td>$ 8.48</td>
<td>$12.15</td>
</tr>
<tr>
<td>Boston</td>
<td>$ 7.40</td>
<td>$10.06</td>
<td>$17.46</td>
</tr>
<tr>
<td>Newton</td>
<td>$12.26</td>
<td>$16.49</td>
<td>$28.75</td>
</tr>
</tbody>
</table>

(Cold Water)

Energy Only

House of Worship Utility Cost Reduction
Conserve drinking water for irrigation. Consider well water.
#7
Shut off commercial refrigeration equipment when not in use; use residential units.
#8 Supplement Heating/Cooling with Ductless Heat Pumps (Wall, Floor, Ceiling mounted)
Heat Pump COP

COP v. Ambient Temperature (Heating)

COP

Temperature (°F)

-20 -15 -10 -5 0 5 10 15 20 25 30 35 40 45 50

House of Worship Utility Cost Reduction
Apply for Utility Rebates

- VFDs;
- Heat Pump Rebates
- Weatherization
- LED Lighting & Controls
- Custom Measures

#9

BTU = $
• [www.masssave.com/rebates](http://www.masssave.com/rebates)


• Pays for **70%** of project costs.

• Pays for **$2,500** per ton for heat pumps.
Questions