Analysis Purpose & Goals

Goal of study: Evaluate & compare various HVAC systems qualitatively and quantitatively

- OPTION 1*: VAVs
- OPTION 2*: Active Chilled Beams (ACB)
- OPTION 3a: Air Source VRF
- OPTION 3b: Ground Source VRF
- OPTION 4*: Fan Coil Units (FCUs)

*Options were considered for Natural Gas (NG) & Propane (LPG)
<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
<th>Heating</th>
<th>Cooling</th>
<th>Comfort</th>
<th>IAQ</th>
<th>Maintenance</th>
<th>Durability</th>
<th>Acoustics</th>
<th>GRI (On site)</th>
<th>Capital Cost</th>
<th>Energy Use</th>
<th>Energy Cost</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1a</td>
<td>VAV terminal units with reheat, ventilation through ERUs</td>
<td>Single zone AHUs with DX cooling for gyms, café, and kitchen</td>
<td>NG</td>
<td>Air Cooled Chiller</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Option 1b</td>
<td>VAV terminal units with reheat, ventilation through ERUs</td>
<td>Single zone AHUs with DX cooling for gyms, café, and kitchen</td>
<td>LPG</td>
<td>Air Cooled Chiller</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>5</td>
<td>8</td>
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<tr>
<td>Option 2a</td>
<td>4 pipe chilled beam system</td>
<td>Single zone AHUs with DX cooling for gyms, café, and kitchen</td>
<td>NG</td>
<td>Air Cooled Chiller</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>14</td>
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<tr>
<td>Option 2b</td>
<td>4 pipe chilled beam system</td>
<td>Single zone AHUs with DX cooling for gyms, café, and kitchen</td>
<td>LPG</td>
<td>Air Cooled Chiller</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
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<td>Option 3a</td>
<td>Air Source VRF system with DOAS ventilation system</td>
<td>Single zone AHUs with DX cooling for gyms, café, and kitchen</td>
<td>Electric</td>
<td>Electric</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>4</td>
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<tr>
<td>Option 3b</td>
<td>Ground source VRF system with DOAS ventilation system</td>
<td>Single zone AHUs with DX cooling for gyms, café, and kitchen</td>
<td>Electric</td>
<td>Electric</td>
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<td>4</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Option 4a</td>
<td>Fan coil units with DOAS ventilation system</td>
<td>Single zone AHUs with DX cooling for gyms, café, and kitchen</td>
<td>NG</td>
<td>Air Cooled Chiller</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>2</td>
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<tr>
<td>Option 4b</td>
<td>Fan coil units with DOAS ventilation system</td>
<td>Single zone AHUs with DX cooling for gyms, café, and kitchen</td>
<td>LPG</td>
<td>Air Cooled Chiller</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
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</tbody>
</table>

Lower total indicates a better system.
Energy Usage Comparison

ENERGY USE BREAKDOWN: BASELINE VAV

- Heating: 54%
- Fans: 12%
- DHW: 3%
- Pumps: 1%
- Ext Light: 1%
- Misc: 14%
- Int Lights: 10%
- Cooling: 5%

ENERGY USE INTENSITY

- Option 1: VAV
- Option 2: ACB
- Option 3a: Air Source VRFs
- Option 3b: Ground Source VRFs
- Option 4: FCUs
Cost Analysis

Operating Cost

Utility Rates source:
Energy Information Agency
- Electricity: 16 cents/KWH
- NG: 1.05 $/Therm
- LPG: 3 $/Therm
Gas Use Profiles

The gas use profiles shown in these charts are for Options 2a (NG) and 2b (LPG).