ZNE Technical Assistance Program

Richmond Public Works

DNV GL
09/26/2017
Agenda

• Program Overview
• Richmond Public Services Overview
• Deep Dive on Richmond
• Lessons Learned
• Questions
ZNE Technical Assistance Program
ZNE Technical Assistance Program

Hayward Path to ZNE

Electricity
- Municipal Energy Use: 21.8 GWh
- Biogas Cogen: 9.4 GWh
- Wastewater Solar: 2.4 GWh
- Distributed Solar: 0.6 GWh
- Remaining 2016: 14.0 GWh

Portfolio Analysis – City of Hayward
ZNE Technical Assistance Program

Hayward Path to ZNE

Past  Future

Electricity
- Municipal Energy Use: 21.8 GWh
- Biogas Cogen: 9.4 GWh
- Wastewater Solar: 2.4 GWh
- Distributed Solar: 0.6 GWh
- Remaining 2016: 14.0 GWh
- LED Retrofit: 0.4 GWh
- Other EE: 0.6 GWh
- Solar Potential: 13.0 GWh

Gas
- Municipal Energy Use: 4.6 GWh

Portfolio Analysis – City of Hayward
## Payback Analysis

<table>
<thead>
<tr>
<th></th>
<th>Annual Energy Use (kWh)</th>
<th>Savings (kWh)</th>
<th>Savings %</th>
<th>Savings $/yr</th>
<th>Capital Cost</th>
<th>Payback (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior Lighting</td>
<td>3,981</td>
<td>5,971</td>
<td>60%</td>
<td>$1,411</td>
<td>$17,500</td>
<td>12.4</td>
</tr>
<tr>
<td>Exterior Lighting</td>
<td>8,304</td>
<td>8,304</td>
<td>50%</td>
<td>$1,963</td>
<td>$2,160</td>
<td>1.1</td>
</tr>
<tr>
<td>Heating</td>
<td>28,885</td>
<td>6,138</td>
<td>18%</td>
<td>$1,451</td>
<td>$6,000</td>
<td>4.1</td>
</tr>
<tr>
<td>DHW</td>
<td>174</td>
<td>98</td>
<td>36%</td>
<td>$23</td>
<td>$400</td>
<td>17.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>54,615</strong></td>
<td><strong>20,511</strong></td>
<td><strong>27%</strong></td>
<td><strong>$4,848</strong></td>
<td><strong>$26,060</strong></td>
<td><strong>5.4</strong></td>
</tr>
</tbody>
</table>

## ZNE Technical Assistance Program

**Levelized Cost of Energy**

- $0.24 **Purchased Electric**
- $0.11 **Solar**
- $0.20 **Interior Lighting**
- $0.26 **Exterior Lighting**
- $0.08 **Heating**
- $0.31 **DHW**

Deep Energy Retrofits – Berkeley Live Oak Recreation Center
# ZNE Technical Assistance Program

**Predicted Site Energy Use**

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>481,680 kWh</td>
<td></td>
</tr>
</tbody>
</table>

**Recommended 10% Safety Factor**

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>354,377 kWh</td>
<td>171,828 kWh</td>
</tr>
</tbody>
</table>

**Solar Energy Generation**

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>354,377 kWh</td>
<td>171,828 kWh</td>
</tr>
<tr>
<td>529,848 kWh</td>
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</tr>
</tbody>
</table>

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**New Construction – Dublin Police Station**

[Image of Dublin Police Station with solar panels and parking lot]

[Logo: Bay Area Regional Energy Network]
Richmond Project Overview

• Opportunity to consolidate PW and parks facilities

• Existing Green Building Ordinance of LEED Silver

• City Manager requested a cost benefit life cycle analysis to explore ZNE
Project Benefit #1

- Activate a former steel processing and distribution center
  • Opened in 1949
  • Closed in 1989

- Zoned for live/work space OR municipal corporation yard
Project Benefit #2

Return Park’s Corporation yard to the City’s heritage Nicholl Park
Project Benefit #3

Provide opportunities to redevelop Public Works yard into housing adjacent to Richmond Greenway
CalEnviroScreen Context
## Preliminary Design

<table>
<thead>
<tr>
<th>Energy Use</th>
<th>Electricity</th>
<th>Natural Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parks + Corp Yard</td>
<td>54%</td>
<td>46%</td>
</tr>
<tr>
<td>New Lighting Load</td>
<td>79,080</td>
<td></td>
</tr>
<tr>
<td>250 kW PV System</td>
<td>329,061</td>
<td></td>
</tr>
<tr>
<td>500 kW PV System</td>
<td>658,122</td>
<td></td>
</tr>
</tbody>
</table>

Total Energy Use: 610,430

### Energy Sources

- **Non-Renewable Natural Gas**
- **Renewable Electricity**
Energy Simulation

- 0.00 - 6.71 mph
- 6.71 - 13.42 mph
- 13.42 - 20.13 mph
- 20.13 - 26.84 mph
- 26.84 - 33.55 mph
- > 33.55 mph
Energy Efficiency Measures

**RECOMMENDATION:**
HEAT PUMP HOT WATER
Heating System Options

**ENVELOPE**

**HOT WATER**

**SPACE HEATING**

**RECOMMENDATION:**

RADIANT HEATING

**ALTERNATIVE:**

GAS FURNACE

**ALTERNATIVE:**

DUAL PACKS HEAT PUMP
Energy Efficiency Measures

HOT WATER
SPACE HEATING

RECOMMENDATION: INSULATION

Projected Energy Usage Between Existing Envelope and Improve Envelope

- Case 1 Gas Furnace
- Case 2 Radiant Electric
- Case 3 Dual Packs
Energy Efficiency Measures

**Recommendation:** Insulation

### Projected Energy Usage Between Existing Envelope and Improve Envelope

<table>
<thead>
<tr>
<th>Case</th>
<th>Energy Usage (Mil-BTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1 Gas Furnace</td>
<td>5,000</td>
</tr>
<tr>
<td>Case 2 Radiant Electric</td>
<td>3,500</td>
</tr>
<tr>
<td>Case 3 Dual Packs</td>
<td>2,000</td>
</tr>
</tbody>
</table>
Energy Efficiency Measures

**RECOMMENDATION:** INSULATION

### Projected Energy Usage Between Existing Envelope and Improve Envelope

<table>
<thead>
<tr>
<th>Energy Usage (Mil-BTU)</th>
<th>Case 1 Gas Furnace</th>
<th>Case 2 Radiant Electric</th>
<th>Case 3 Dual Packs</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,500</td>
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<tr>
<td>2,000</td>
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<td></td>
</tr>
<tr>
<td>1,500</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Energy Efficiency Measures

**Recommendation:**
Insulation

Projected Energy Usage Between Existing Envelope and Improve Envelope

- **Case 1 Gas Furnace:**
  - Existing Envelope: 4,500 Mil-BTU
  - Moderate Insulation: 3,500 Mil-BTU
  - Energy Savings: 29%

- **Case 2 Radiant Electric:**
  - Existing Envelope: 4,000 Mil-BTU
  - Moderate Insulation: 2,600 Mil-BTU
  - Energy Savings: 36%

- **Case 3 Dual Packs:**
  - Existing Envelope: 3,000 Mil-BTU
  - Moderate Insulation: 2,200 Mil-BTU
  - Energy Savings: 24%
Energy Savings Summary

Annual Energy Savings (Million BTU)

- Proposed System: 4,500 Million BTU
- Envelope: 3,200 Million BTU
- Radiant Heating: 1,800 Million BTU
- All Electric: 2,279 Million BTU or equivalent 668,000 kWh/yr reduction
Energy Efficiency Measures

**RECOMMENDATION:** RADIANT HEATING

**ALTERNATIVE:** GAS FURNACE

**ALTERNATIVE:** DUAL PACKS HEAT PUMP

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**Space Heating Energy Usage and Cost**

- **Case 1 Gas Furnace**
  - Projected Annual Energy Usage: 3,206 MBTU
  - Cost: $57,983

- **Case 2 Radiant Electric**
  - Projected Annual Energy Usage: 2,478 MBTU
  - Cost: $92,617

- **Case 3 Dual Packs**
  - Projected Annual Energy Usage: 1,133 MBTU
  - Cost: $21,979

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The chart shows projected annual energy usage and cost for different space heating options.
Renewables

ZNE Solar PV System Size by Heating System

720 kW

Heating

Light / Plug

Gas Furnace Radiant Electric Dual Packs
Renewables

ZNE Solar PV System Size by Heating System

720 kW

560 kW

Gas Furnace  Radiant Electric  Dual Packs

Heating

Light / Plug

Heating

Light / Plug
Renewables

ZNE Solar PV System Size by Heating System

720 kW
- Heating
- Light / Plug

Gas Furnace

560 kW
- Heating
- Light / Plug

Radiant Electric

260 kW
- Heating
- Light / Plug

Dual Packs

[Image of solar panels]
Heating Cost Comparison

- **Gas Furnace**: $1,944,400
- **Radiant Electric**: $1,392,570
- **Dual Packs**:
  - **Utility (No Solar)**: $3,324,000
  - **Utility (With Solar)**: $3,324,000

*Initial Cost Diagram*
Heating Cost Comparison

Annual Utility Operations & Savings

Retail vs Wholesale
Life Cycle Cost Analysis

Heating System – Cumulative Costs

- Gas Furnace
- Radiant
- Heat Pump
Lessons Learned

- Incorporate ZNE requirement early in procurement and design process
- Consulting a professional engineer amplifies our policy recommendation with technical cost benefit analysis
Lessons Learned

- Include life-cycle costs; natural gas “Reznor” heaters are much cheaper to install in warehouses

- Point to the past; developers prefer natural gas heating, although original heating systems may be electric
Questions? Thank you!

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