Power System Transformation:
A Distribution Perspective

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President and CEO, Holy Cross Energy
About Holy Cross Energy

- $120 million revenue
- 160 employees
- 240 MW peak demand
- 60,000 meters
- 3,000 miles of distribution
- 120 miles of transmission
Our Power Supply Mix

- Coal: 46%
- Gas: 9%
- Wind: 30%
- Biomass: 8%
- Hydro: 3%
- Solar: 2%
- Coal Methane: 2%

>40% reduction in GHG emissions since 2012
More than half of the Holy Cross Energy electricity demand comes from customers that have committed to using 100% renewable energy by 2030:

Cities and Towns:
- Aspen
- Basalt
- Carbondale
- Eagle
- Minturn
- Snowmass Village
- Vail

County Governments:
- Eagle
- Pitkin

Large Employers:
- Aspen Skiing Company
- Vail Resorts
Our Industry is Changing … Fast!

Several trends affecting the electric utility industry:

• Flat load growth
• Low natural gas prices
• Lower-cost renewables
• Expanding electricity markets
• Cheaper, better distributed resources
• Connected everything
• More consumer choices
Flat Load Growth

**Figure 3.31. EIA Annual Electricity Sales 2000–2016 (terawatt-hours) and AEO Reference Case Electricity Sales Projections 2017–2030**

Total U.S. Electricity Sales (TWh)

- **HCE -2% in 2017**
Low Natural Gas Prices

Figure 3.18. Wholesale Day-Ahead Electricity Prices vs. Henry Hub Natural Gas Price (Monthly Average)\textsuperscript{108}
## Lower-Cost Renewables

### RFP Responses by Technology

<table>
<thead>
<tr>
<th>Generation Technology</th>
<th># of Bids</th>
<th>Bid MW</th>
<th># of Projects</th>
<th>Project MW</th>
<th>Median Bid Price or Equivalent</th>
<th>Pricing Units</th>
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<tbody>
<tr>
<td>Combustion Turbine/IC Engines</td>
<td>29</td>
<td>6,365</td>
<td>19</td>
<td>4,436</td>
<td>$5.08</td>
<td>$/kW-mo</td>
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<tr>
<td>Combustion Turbine with Battery Storage</td>
<td>7</td>
<td>804</td>
<td>3</td>
<td>476</td>
<td>6.21</td>
<td>$/kW-mo</td>
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<tr>
<td>Gas-Fired Combined Cycles</td>
<td>3</td>
<td>873</td>
<td>3</td>
<td>873</td>
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<td>$/kW-mo</td>
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<tr>
<td>Stand-alone Battery Storage</td>
<td>28</td>
<td>2,144</td>
<td>24</td>
<td>1,945</td>
<td>10.53</td>
<td>$/kW-mo</td>
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<tr>
<td>Compressed Air Energy Storage</td>
<td>1</td>
<td>317</td>
<td>1</td>
<td>317</td>
<td></td>
<td>$/kW-mo</td>
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<tr>
<td>Wind</td>
<td>96</td>
<td>41,915</td>
<td>42</td>
<td>16,949</td>
<td>$19.30</td>
<td>$/MWh</td>
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<tr>
<td>Wind and Solar</td>
<td>5</td>
<td>2,601</td>
<td>4</td>
<td>2,151</td>
<td>19.96</td>
<td>$/MWh</td>
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<tr>
<td>Wind with Battery Storage</td>
<td>11</td>
<td>5,700</td>
<td>5</td>
<td>2,700</td>
<td>20.63</td>
<td>$/MWh</td>
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<tr>
<td>Solar (PV)</td>
<td>148</td>
<td>28,382</td>
<td>78</td>
<td>14,085</td>
<td>30.96</td>
<td>$/MWh</td>
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<tr>
<td>Wind and Solar and Battery Storage</td>
<td>7</td>
<td>4,048</td>
<td>7</td>
<td>4,048</td>
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<td>Solar (PV) with Battery Storage</td>
<td>79</td>
<td>14,980</td>
<td>57</td>
<td>10,098</td>
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<td>IC Engine with Solar</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td></td>
<td>$/MWh</td>
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<tr>
<td>Waste Heat</td>
<td>2</td>
<td>21</td>
<td>1</td>
<td>11</td>
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<td>$/MWh</td>
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<tr>
<td>Biomass</td>
<td>1</td>
<td>9</td>
<td>1</td>
<td>9</td>
<td></td>
<td>$/MWh</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>418</strong></td>
<td><strong>108,163</strong></td>
<td><strong>246</strong></td>
<td><strong>58,101</strong></td>
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Source: PSCo 2017 All-Source RFP
Expanding Electricity Markets

**SPP & Mountain West Footprint**

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<tr>
<th></th>
<th>SPP</th>
<th>MWTG</th>
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<tbody>
<tr>
<td>Square miles</td>
<td>546,000</td>
<td>165,000</td>
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<tr>
<td>Miles of transmission</td>
<td>65,755</td>
<td>16,000</td>
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<tr>
<td>Population</td>
<td>17.5 mil</td>
<td>6.4 mil</td>
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<tr>
<td>Generating capacity</td>
<td>83,945 MW</td>
<td>21,000 MW</td>
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</table>

Negative prices!
Cheaper, Better, Distributed Resources

Solar PV: Utility-Scale

- Median Utility-Scale PV Installed Cost
- Total Capacity
- $/Watt DC
- 2008 to 2015

Solar PV: Distributed

- Average Distributed PV Installed Cost
- Total Capacity
- $/Watt
- 2008 to 2015

Electric Vehicles

- Modeled Battery Costs
- Cumulative EV Sales
- $/kWh
- 2009 to 2015

LEDs

- LED A-Type Cost
- Total LED A-Type Bulb Installations
- $/kilolumen
- 2008 to 2015
- Millions
Connected Everything

Solar PV
Solar PV energy may be self-consumed, delivered to the grid, or stored in a battery.

Smart AC
AC unit can be configured to pre-cool the home with solar output, then allow the home temperature to "drift" up to a set maximum temperature before drawing from the grid.

Smart domestic water heater
Water heater can be set to pre-heat water with solar output and store hot water for later use

Battery
Solar energy may be stored in an electrical battery for later use

Electric vehicle
Excess solar output can be delivered to an electric vehicle and used for transportation or stored for home use
More Consumer Choices

source

CCA
buying and building electricity supply

delivery

UTILITY
delivering energy, maintaining lines, billing customers

customer

YOU
benefitting from affordable rates, local control, cleaner energy

Your choice of free:

TXU Energy Free Nights

TXU Energy Free Weekends
Our Electric Grid Used to be THIS...
Now, Our Grid is More Like THIS…
And very soon, it will be THIS!!!
So What’s a Utility to Do?

Respect the Past
• Maintain Poles and Wires
• Ensure Reliable Service
• Procure Necessary Resources
• Answer Customer Needs

Embrace the Future
• Flexible Clean Power Supply
• Grid Visibility and Control
• Sustainable Rate Design
• Know Our Customers Better
• Deliver New Products/Services

“Give our members what they want …

before someone else does!”
Holy Cross Energy provides safe, reliable, affordable and sustainable energy and services that improve the quality of life for our members and their communities.

Find out more at www.holycross.com