Agenda

- UNL Utility Infrastructure
- NUcorp
- Unique Nature of Master Plan
- Master Plan Details
- Results
UNIVERSITY OF NEBRASKA-LINCOLN
University of Nebraska-Lincoln

Campus Populations

- 26,079 students
  - 20,954 undergraduate
  - 4,606 graduate
  - 519 professional
- 1,891 faculty
- 4,060 staff

East Campus
- 2.8 million GSF
- 53 major buildings
- 343 acres

City Campus
- 11.9 million GSF
- 90 major buildings
- 280 acres
Utility Plants

- 5 Facilities
- 33,000 Tons Cooling
- 68,000 Ton-hrs TES
- 460 KPPH Steam
- ~11 Miles Thermal Distribution
- 4,875 Tons WSHP
City Campus Utility Plant (CCUP)

Steam
- 3 dual-fired boilers
- 600 & 250 psi
- 240,000 lb/hr cap.
- 298 million lb/yr
- 6 miles of tunnels and direct buried pipe
- 35 psi, superheated
- Converted to hot water for use in buildings

Chilled Water
- 23 Ton capacity
- 24 million Ton-Hr per year
- 26,200 gpm peak
- 7.4 miles of direct buried pipe
- 8° avg ΔT

Electricity
- No generation
- WAPA + LES
- 20.5 MW peak
- 108,418 MWh/yr

City Campus
- built in 1929
- 4 dual-fired boilers
- 6 electric chillers
- 1 steam chiller
East Campus Utility Plant (ECUP)

Steam
- 3 dual-fired boilers
- 65 psi, saturated
- 220,000 lb/hr cap.
- 142 million lb/yr
- 4.7 miles of tunnels and direct buried pipe
- Converted to hot water for use in buildings

Chilled Water
- 7.5 Ton capacity
- variable secondary
- 10.5 million TonHr per year
- 12,500 gpm peak
- 4.7 miles of direct buried pipe
- 7° avg ΔT

Electricity
- No generation
- Lincoln Elec System
- 9.1 MW peak
- 39,584 MWh/yr

East Campus
- built in 1915
- 3 dual-fired boilers
- 3 electric chillers
East Campus Thermal Energy Storage (ETES)

- Online in 2013
- 2.8 million gallons
- 16,300 Ton-hr capacity
- 2500 Ton variable-speed chiller
- Free-cooling capacity in winter
- 2 MW demand reduction (15%)
City Campus Thermal Energy Storage (CTES)

- Online in May 2018
- 8.2 million gallons
- 52,000 Ton-Hr capacity
- 5-6 MW demand reduction (20%) in first year of operation
Long-Term Energy Trends

EUI vs Enrollment

- Energy Use Index
- Student Enrollment

EUI vs Research $

- Energy Use Index
- Research Expenditures
NUCORP
NUCorp

- **Mission**

  “Develop, maintain, monitor, control and coordinate energy requirements, utility infrastructure facilities and all related energy, utility and infrastructure.”

- **Partnership**

  - Raise Capital by Issuing Bonds
  - Accounting Management
  - Financial Projections
  - Rate Development
  - Energy Procurement
UTILITY MASTER PLAN

Prioritize Safety,
Increase Reliability, Maximize Efficiency
Utility Master Plan

- Optimization of existing assets
  - Chiller/Boiler Retrofits
  - TES Dispatch Optimization

- Condition Assessment of Distribution System

- Traditional Utility Master Planning
  - Load Projections (data availability through in-house BAS)
  - Distribution Modeling (mature GIS system)
  - Viability of CHP, Renewables etc.
Campus Development: Load Growth Summary

<table>
<thead>
<tr>
<th></th>
<th>2019</th>
<th>YEAR 5</th>
<th>YEAR 20</th>
<th>AVG GROWTH/YR</th>
</tr>
</thead>
<tbody>
<tr>
<td>AREA (MGSF)</td>
<td>15.6</td>
<td>16 (3%)</td>
<td>16.8 (8%)</td>
<td>0.5%</td>
</tr>
<tr>
<td>CHW (ktons)</td>
<td>16.3</td>
<td>17.5 (7%)</td>
<td>20 (22%)</td>
<td>1.1%</td>
</tr>
<tr>
<td>STM (MMBtu)</td>
<td>241</td>
<td>259 (7%)</td>
<td>298 (23%)</td>
<td>1.2%</td>
</tr>
<tr>
<td>ELE (MW)</td>
<td>32</td>
<td>35 (8.0%)</td>
<td>40 (25%)</td>
<td>1.2%</td>
</tr>
</tbody>
</table>

- Modest Campus Development
- Focus on Existing Assets
- Target Improved Efficiency, Reliability
Capacity Management

- Increase Reliability
- Improve Efficiency
- Manage Retirement

- Capacity Renewal
- Overhaul/Replace Existing Chillers
- Optimize Equipment Dispatch
Steam Tunnel Evaluation: City Campus
Electrical Feeder & Ductbank Analysis

- Load Growth/Capacity
- Reliability/Resiliency
  - Paper Insulated Lead Cable (PILC)
  - Clay Tile Ductbank
  - Transite Ductbank
- Phased Replacement
Distribution Modeling

- Visualize District Energy Systems
- Identify & Troubleshoot Existing Issues
- Evaluate Impact of Future Changes
Chilled Water Systems: Chiller #3 Analysis

▶ CH-3 Advantages
  • Can Shed 3.5-5MW at Peak
  • High Tons/Sqft in Plant

▶ Recommendation (Near-Term)
  • Enhanced Startup

▶ Recommendation (Long-Term)
  • Rerate to 250# Steam

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
<th>First Cost</th>
<th>Potential Annual Savings</th>
<th>Simple Payback</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Enhanced Startup</td>
<td>$25,000</td>
<td>$40,000</td>
<td>0.63</td>
</tr>
<tr>
<td>2</td>
<td>Push-Button Startup</td>
<td>$512,467</td>
<td>$80,000</td>
<td>6.41</td>
</tr>
<tr>
<td>3A</td>
<td>Partial Rerate - 250#</td>
<td>$1,191,154</td>
<td>$216,000</td>
<td>5.51</td>
</tr>
<tr>
<td>3B</td>
<td>Full Rerate - 250#</td>
<td>$2,955,629</td>
<td>$205,000</td>
<td>14.42</td>
</tr>
<tr>
<td>3C</td>
<td>New Turbine - 250#</td>
<td>$1,849,100</td>
<td>$205,000</td>
<td>9.02</td>
</tr>
<tr>
<td>4</td>
<td>Extraction Turbine</td>
<td>$4,800,000</td>
<td>$230,000</td>
<td>20.87</td>
</tr>
<tr>
<td>5</td>
<td>Tube Replacement</td>
<td>$881,945</td>
<td>$14,000</td>
<td>63</td>
</tr>
</tbody>
</table>

Mutually Exclusive
Additional Technologies Review

- Cogeneration Analysis
- Solar Analysis
- Wind Analysis
- Battery Storage Analysis
- HHW/Geoexchange Conversion Analysis
Results

► $127M in recommended projects

► Near-Term Project Highlights

• Steam Tunnel Phasing

• Burner Retrofits

• Boiler Replacements

• Chiller Renewals
Use Master Planning Effectively!

► Document Existing Assets – “Go-To” Reference
► Identify & Plan for Load Growth – Proactive not Reactive
► Maximize Usefulness of Existing Assets – Efficiency!
► Explore New Technologies/Strategies – High Level Look
THANK YOU!

- Lalit Agarwal
  Director, Utility & Energy Management
  University of Nebraska-Lincoln

- Justin Grissom, PE
  Burns & McDonnell \ OnSite Energy & Power
  jgrissom@burnsmcd.com

- Zachary Poss, PE
  Burns & McDonnell \ OnSite Energy & Power
  zposs@burnsmcd.com