Thermal Energy in Raleigh, NC
Modernizing Infrastructure Using an Inventive District Cooling Solution
Financed via Performance Contract

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Outline

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• The Solution
  – District Cooling (DC) & Thermal Energy Storage (TES)
  – New and Old Chiller Plant Investments
  – High Chilled Water (CHW) Delta T
  – Installed Capacities and Loads
• Unique Results & Benefits
  – Managing Energy & Energy Costs
  – Expandability
  – Reliability & Redundancy
• Summary & Conclusions
Introduction and Background

State of NC gov’t building complex – Raleigh, NC

- Aging energy infrastructure
- Rising energy costs
- Limited budget for modernization

Decision to pursue Performance Contract:

- Financed by energy & maint. cost savings
- Late 2004 – Request for Qualifications
- 1st half 2005 – Detailed Audit phase
- Jan - Nov 2006 – Project Execution phase
Performance Contracting

• Guaranteed Energy Solution
• Paid for from guaranteed cost savings:
  ▪ Energy – reduced consumption and demand
  ▪ Operational – maintenance, service contracts
  ▪ Capital Avoidance – offset future planned projects, reallocate monies
• No capital expenditures incurred
• Energy education and awareness
• Meet energy efficiency initiatives & requirements
Performance Contracting Benefits

- Replaces Assets that are beyond useful life
- Provide Additional Capacity
- Leverages Limited Budgets and Resources
- Reduces Maintenance Cost
- Increases Comfort
- Generates Cash Flow
- Accommodates Future Expansion
- Ensures Quality and Operability
The Solution

Innovative approach (including items beyond RFP):

• **Major expansion of DC network:**
  - Modernization of old DC plant
  - Rehabilitation of old TES tank
  - Large new “packaged” DC plant
  - Large new TES tank
  - Control for high CHW Delta T
  - Did not replace chillers within buildings

• Lighting improvements
• HVAC and control improvements in buildings
• Water conservation
Benefits of the Solution

- Reduce energy use by over 20 million kWh/yr
- Reduce water use by over 10 million gals/yr
- Over $2 million per year in energy savings
- ~$18.9 million in new financed infrastructure
- Over $7 million in future capital avoidance
- Improved building comfort
- Expanded cooling capacity and redundancy
The Backbone of the Solution – District Cooling (DC)

- Did not pursue in-building chiller replacements
- Expanded the DC network
- Investment focused on efficient new CHW plant
- Primary CHW source – the new CHW plant
- Secondary source – the old (rehab’ed) CHW plant
- Peaking & back-up – best of the in-bldg chillers
- Direct-buried un-insulated HDPE piping
The Key Enhancement of the Solution – Thermal Energy Storage (TES)

**Existing TES Tank – 0.7 millions gals**
- In-ground rectangular concrete tank
- Rehab’d after 18 years of non-use
- Repaired leaks; replaced broken diffusers; new integration
- ~7,100 Ton-hours at 39/55 ºF CHWS/R temps
- Up to ~1,300 Ton discharge rate

**New TES Tank – 2.7 million gals (architectural façade)**
- Partly-buried cylindrical concrete tank, AWWA D110 Type III
- 26,270 Ton-hours at 39/55 ºF CHWS/R temps
- Up to ~4,500 Ton discharge rate

*TES minimizes chiller use in high-cost on-peak times and provides capacity at low cap. $ vs. chiller plants.*
Prioritizing Investments in Efficiency
– New versus Old Chiller Plants

Existing CHW Plant – limited investment

• Retired 1 of 3 old inefficient chillers, in place
• Rehab’d 2 of 3 old chillers, for lower CHWS temp
• Orig design CHW Delta T was 12 °F (actual typ’ly 6 to 9 °F)
• Re-spec’d for CHW Delta T of 16 °F (39/55 °F CHWS/R)

New CHW Plant – “packaged” (vs. “stick-built”) plant

• Footprint – small plot; easy to site; less visual impact
• Schedule – shorter overall; much shorter on-site time
• Efficiency – high, w/ series chillers; high Delta T; low CHWS
• Price – lower capital $/Ton
• Performance – guarantee of total plant Tons and kW/Ton
Optimization of the Solution – High Chilled Water (CHW) Delta T

- Raised CHW Delta T (from 6 to 9 °F) to 15 °F
- Enhanced capacity and reduced size & cost of DC piping, DC pumps, and TES tanks.
- Lowered CHWS at new and old chiller plants
- Raised CHWR using Pressure-Indep. FCVs
- Peaking / back-up chillers in the bldgs, used only rarely, will only serve their own bldgs
# DC Capacity and Design Day Loads

<table>
<thead>
<tr>
<th>Description</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Packaged DC Plant</td>
<td>2,900 T (off-peak; on-pk as needed)</td>
</tr>
<tr>
<td>Old (Rehab’d) DC Plant</td>
<td>1,400 T (off-peak; on-pk as needed)</td>
</tr>
<tr>
<td>Peaking Chillers in Bldgs</td>
<td>2,800 T (rarely, and only off-peak)</td>
</tr>
<tr>
<td>Admin Bldg</td>
<td>485 T</td>
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<tr>
<td>Albemarle</td>
<td>450 T</td>
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<tr>
<td>Mus of History</td>
<td>515 T</td>
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<tr>
<td>Mus of Nat Sci</td>
<td>600 T</td>
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<tr>
<td>New Revenue</td>
<td>750 T</td>
</tr>
<tr>
<td>New TES Capacity</td>
<td>3,700 T (26,270 T-hrs)</td>
</tr>
<tr>
<td>Old TES Capacity</td>
<td>800 T ( 7,100 T-hrs)</td>
</tr>
<tr>
<td>Total Chillers Only</td>
<td>7,100 T</td>
</tr>
<tr>
<td>Total Chillers + TES</td>
<td>11,600 T</td>
</tr>
<tr>
<td>Design Day Peak Load</td>
<td>5,472 T (6,460 T w/ Leg &amp; LOB)</td>
</tr>
<tr>
<td>Design Day 24-hr Average</td>
<td>3,756 T (4,388 T w/ Leg &amp; LOB)</td>
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Unique Results and Benefits

• Managing Energy and Energy Costs
• Expandability for Future Load Growth
• Reliability and Redundancy
Managing Energy and Energy Costs

- Each bldg & CHW plant is individually metered
- Each has different loads, load profiles, & tariffs
- In-bldg chillers used only off-peak, if ever
- Allows most bldgs to use “Small TOU” tariff
- CHW plants use attractive “TES” tariff
- Series chillers and variable speed pumping
- Custom Energy Mgmt System
- Extensive monitoring of system and each bldg

Keys to maximizing savings (and to project viability): managing loads (with DC & TES) and tariff choices
Expandability for Future Growth

• Project accommodates future expansion:
  – Load growth within buildings on the DC network
  – Addition of more existing buildings to DC network
  – Addition of future new buildings to DC network

• Several key steps were taken to achieve this:
  – DC headers oversized for addition of 2 more existing bldgs (committed in May 2006) + 3 future bldgs
  – Modest oversizing of new TES (fully useable now)
  – New CHW Plant designed for modular expandability

Project economics allowed these incremental investments now, rather than larger ones later.
Reliability and Redundancy

- At least “N+1” redundancy in critical mechanical items (chillers, pumps, cooling towers)
- Peak loads in all DC-connected buildings can be met in the hottest weather, even with the loss of the largest item, or the loss of TES.
- Not economically viable for individual buildings
- But DC (integrated system) approach allows it

*The State enjoys this important & valuable benefit, solely as a result of pursuing the DC solution.*
Preliminary Architect’s Sketch
Summary

1. Project combined: new and existing assets; DC, TES, plus lighting, HVAC, and water usage measures; all 100% self-financed by operating savings.

2. Large capital investment ($18.9 million)
   - E.g. DC piping, New Energy Conservation Center (with its packaged chiller plant & TES), P-Indep FCVs
   - Fully justified by large operating savings vs. initial request to replace chillers within independent bldgs.

3. ESCO gets: attractive ROI and large NPV.

4. State gets (far beyond its original expectations): new infrastructure; no capital req’d; large savings in energy & energy cost; redundancy & reliability; ease of expandability; and a model for other State projects.
Conclusions

- The ESCO-led team of focused experts yielded an integrated solution whose benefits total more than the sum of the benefits of the parts.
- Performance Contracting is a viable and beneficial vehicle to implement major DC & TES.
- Max savings (even the project viability) were achieved only by combining all key elements: DC, TES, Delta T enhancement, and tariff mgmt.

Project demonstrates power of District Energy, especially when leveraged with complementary technologies that may be impractical or uneconomical to apply within individual buildings.
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  Engineering Consultant – Affiliated Engineers, Inc.
  Packaged DC Plant – TAS, Ltd.
  TES Tank Supplier – Natgun Corporation
  P-Indep FCV Supplier – Cool Systems / Flow Control Ind.
  Control System Supplier – Siemens Building Technologies
  Electric Utility – Progress Energy
Questions?

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