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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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'd) 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 ºF (actual typ'ly 6 to 9 ºF)
- Re-spec'd for CHW Delta T of 16 ºF (39/55 ºF 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 ºF) to 15 ºF
- 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

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

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

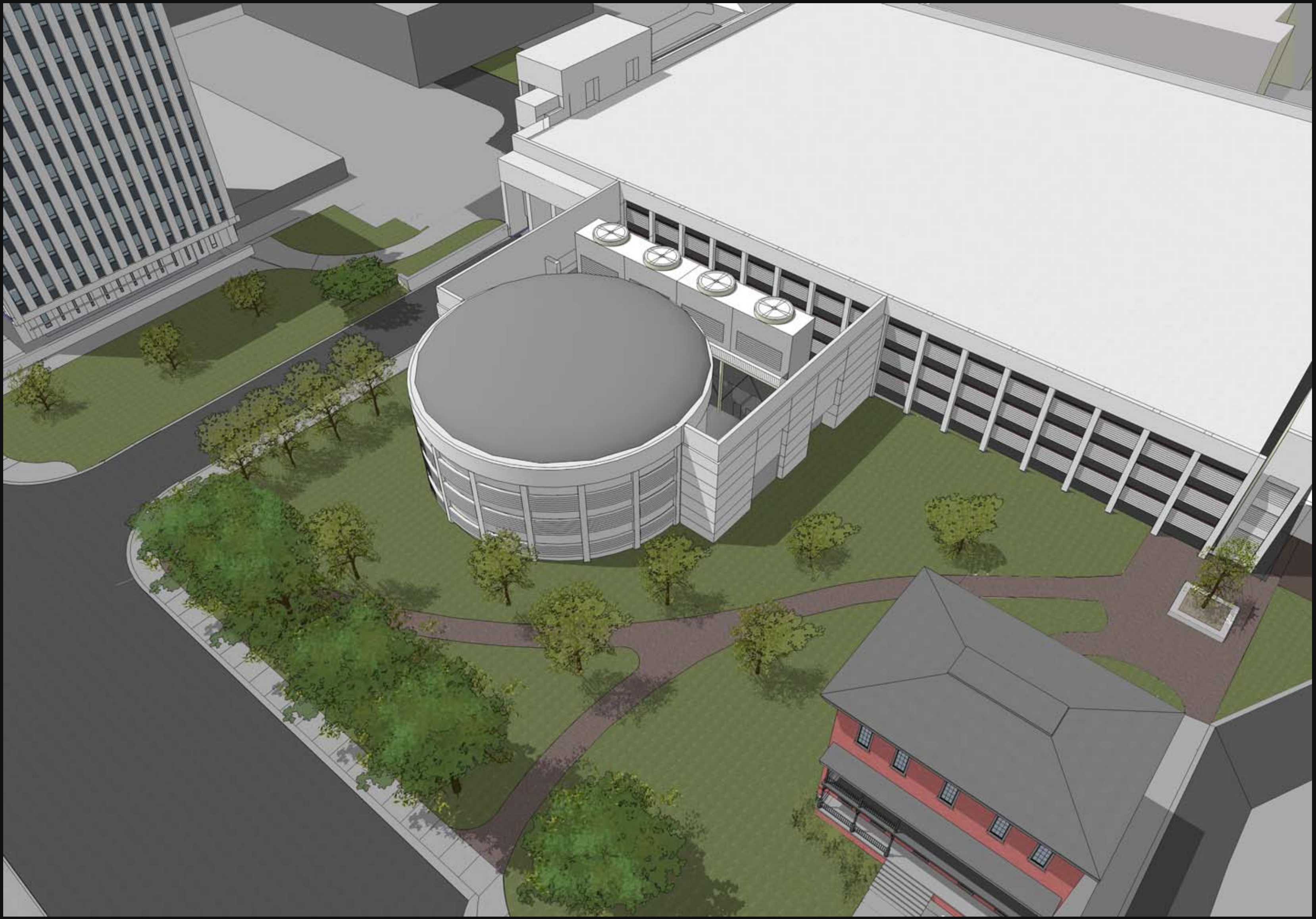
Project economics allowed these incremental investments now, rather than larger ones later.

Reliability and Redundancy

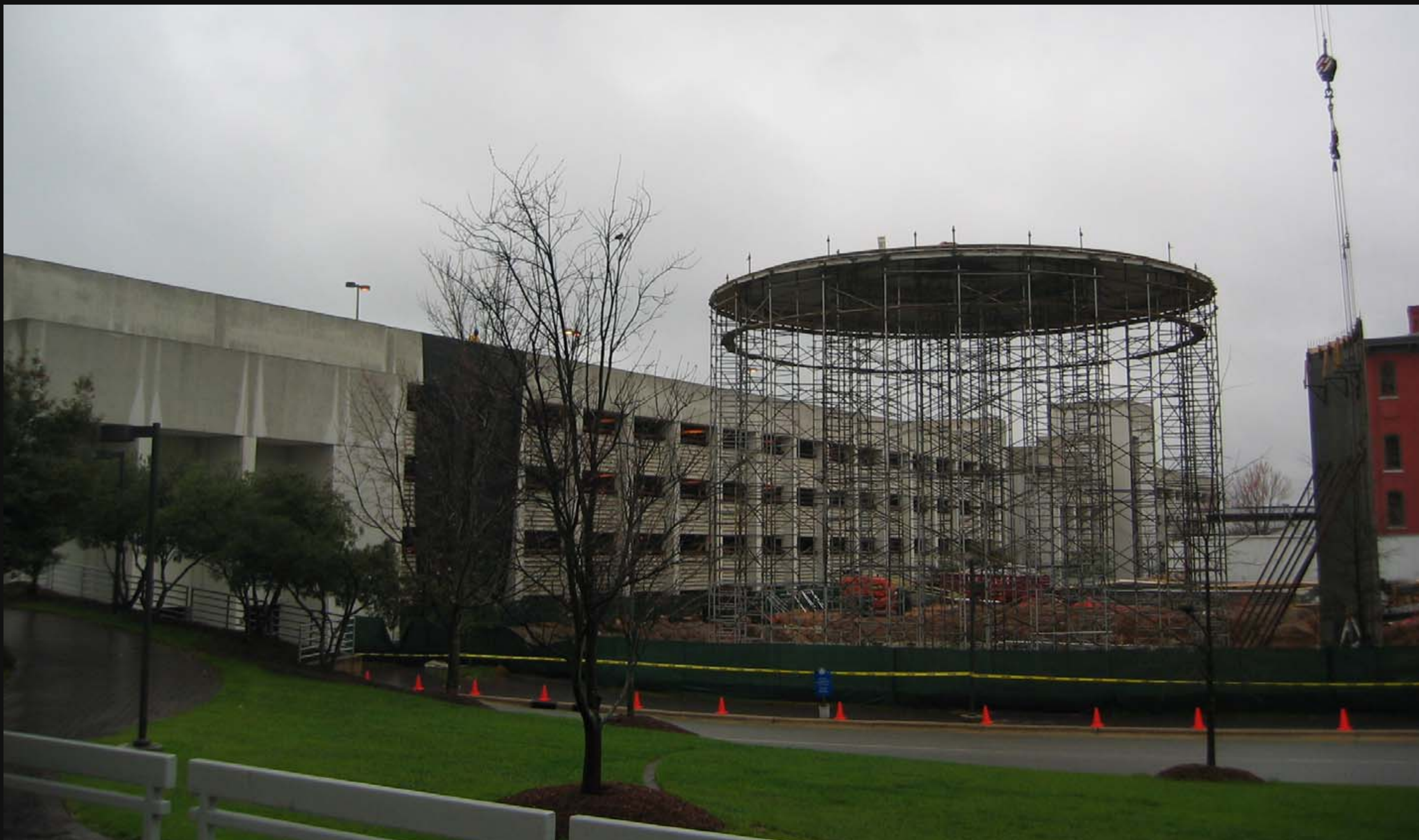
- At least “N+1” redundancy in critical mechanical items (chillers, pumps, cooling towers)
- Peak loads in all DC-connected buildings can be met in the hottest weather, even with the loss of the largest item, or the loss of TES.
- <u>Not</u> economically viable for <u>individual</u> buildings
- But DC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



TES Tank Construction – March 2006



TES Tank Construction – May 2006

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 <u>all</u> 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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DC / TES Consultant	– The Cool Solutions Company
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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