
CampusEnergy2021
BRIDGE TO THE FUTURE
Feb. 16-18 | CONNECTING VIRTUALLY
WORKSHOPS | Thermal Distribution: March 2 | Microgrid: March 16

THREE THERMAL ENERGY STORAGE TANK CASE STUDIES AT UNIVERSITIES

How project challenges were overcome so that owners could realize significant benefits

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DN TANKS

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Q&A Will Not Be Answered Live

Please submit questions in the Q&A box.
The presenters will respond to questions off-line.

Every TES Tank Project Comes with Challenges

Edinburg, TX - UT

Cypress, CA – College

Orlando, FL - UCF

College Campuses

Lackland AFB, TX

San Antonio, TX - Airport

Raleigh, NC

Government and Municipalities

Danville, PA - Geisinger

Ashburn, VA – DFP

Front Royal, VA - Dominion

Private Industry, Power Plants, and Data Centers

But, in the end, the owner gets a significant benefit

The first hurdle to overcome with any Thermal Energy Storage project is meeting the ROI requirements

TES Tanks Must Provide a Financial Benefit

Return on Investment

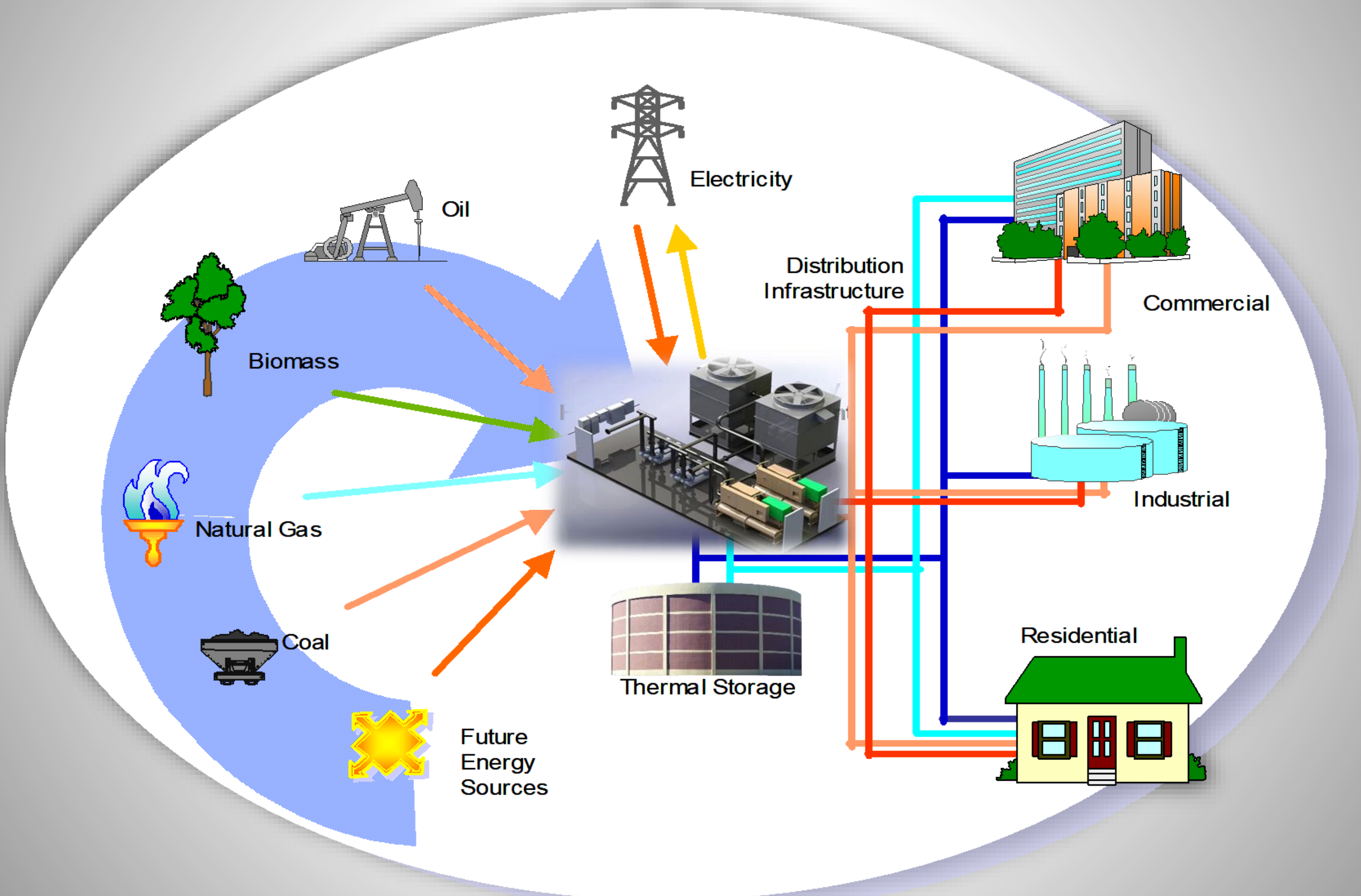
- **Energy Cost Savings and Incentives**
  - kW Savings – electric demand reduction
  - kWh Savings – time of use consumption rates
  - kWh Reduction – operating during cooler ambient conditions
  - Incentives from the state or utility company – if available
- **Cost Avoidance** – when expanding the campus, add a TES tank instead of more chiller equipment

Resiliency

- **Mission Critical Back-up**
  - Reservoir of chilled water ensures no downtime
  - Dual purpose fire water storage tank
  - Useful life of 50+ years

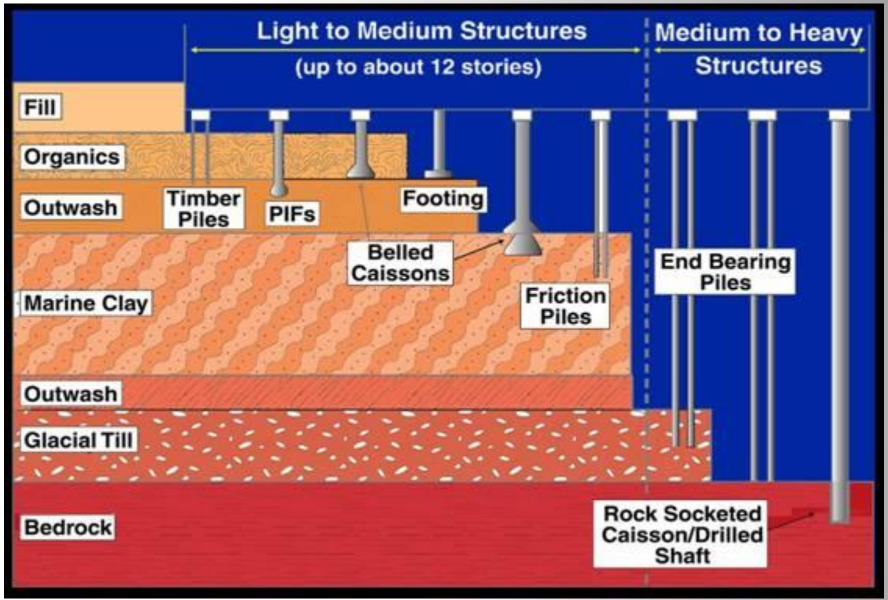
Once the ROI hurdle is met, then it's all down hill. Right?

There is the matter of connecting and operating the TES tank within the District Cooling system



And there are other challenges to consider…

- Location for the tank
- Soil conditions & tank foundation
- Site constraints
- Schedule
- Appearance



Three TES Tank Case Studies

Bucknell
UNIVERSITY

- Private university campus in PA
- In 2013, implemented a 50-acre expansion including new buildings
- Needed additional cooling capacity
- Chose to add a 900,000-gallon (6,500 ton-hour) TES tank instead of a new chiller and equipment

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Initial Cost and Operating Cost Comparison

Chilled Water Option	Estimated Construction Cost	Annual Energy Cost	Life Cycle Operating Cost
Water-cooled screw chiller	$1,910,000	$50,000	$1,343,519
Water-cooled centrifugal chiller	$1,830,000	$44,000	$1,182,296
Air cooled screw chiller	$1,730,000	$60,000	$1,612,222
Thermal energy storage tank	$1,880,000	-$23,000	-$618,019

Information on this slide is courtesy of Jim Knight, Director of Energy and Utilities at Bucknell University

Site Constraints

Tank site, steeply sloped, and sandwiched between;

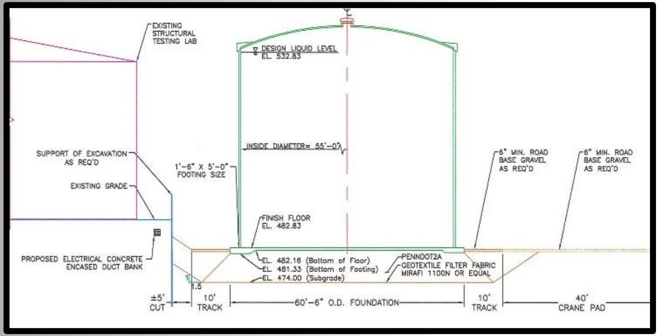
a public road and underground utilities

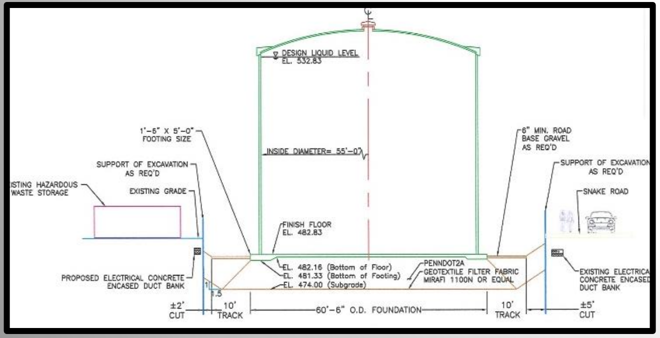
150-year old “heritage” oak tree

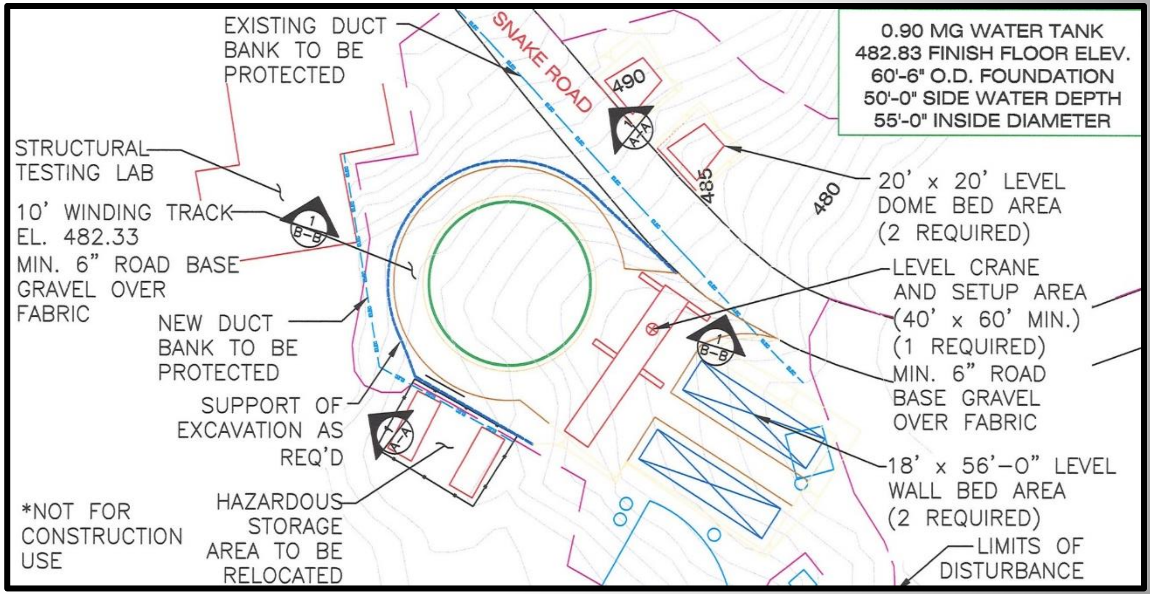
hazmat storage area

engineering lab building

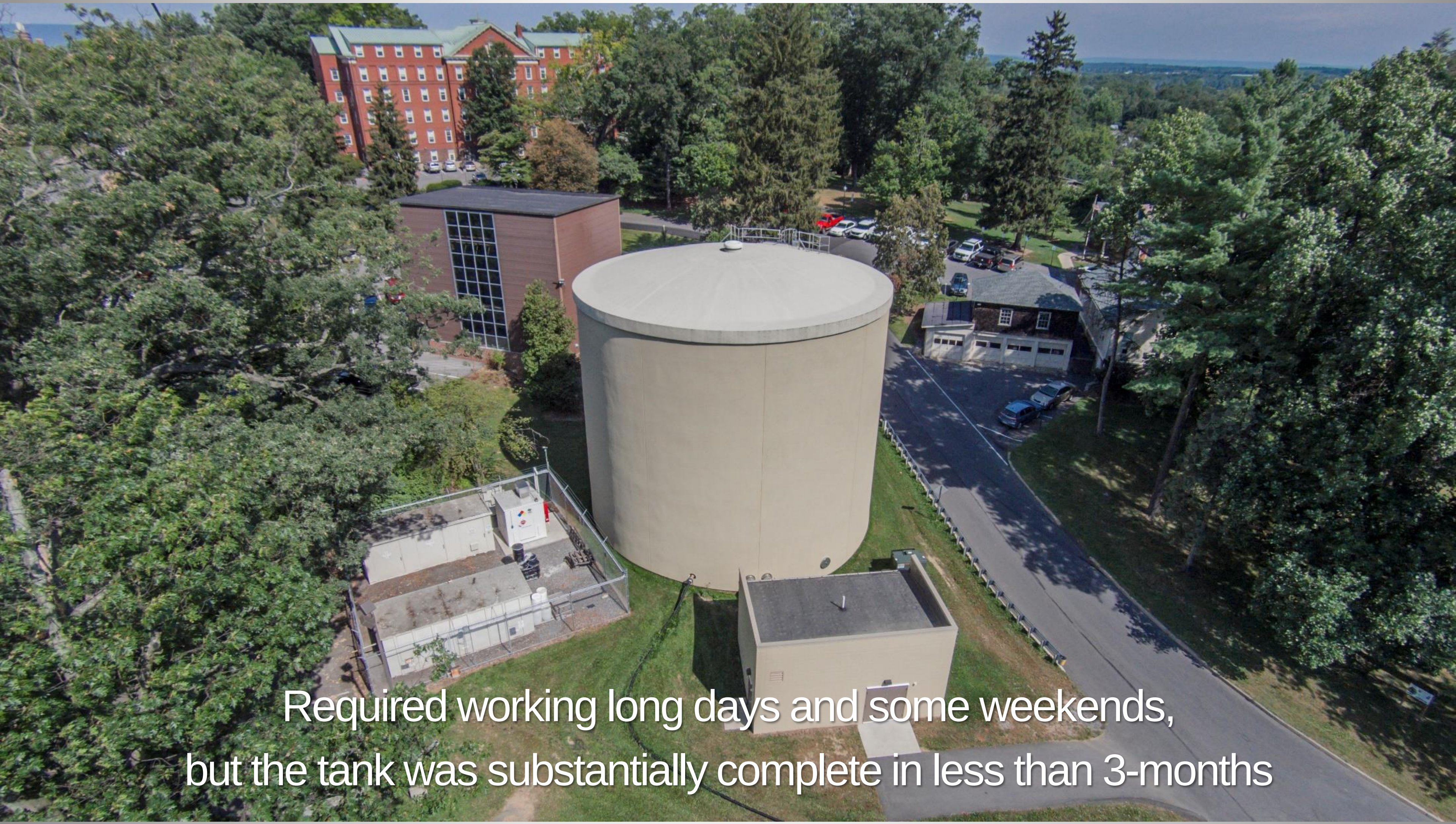
A "Tight Site" Requires Careful Planning and a Detailed Tank Construction Layout



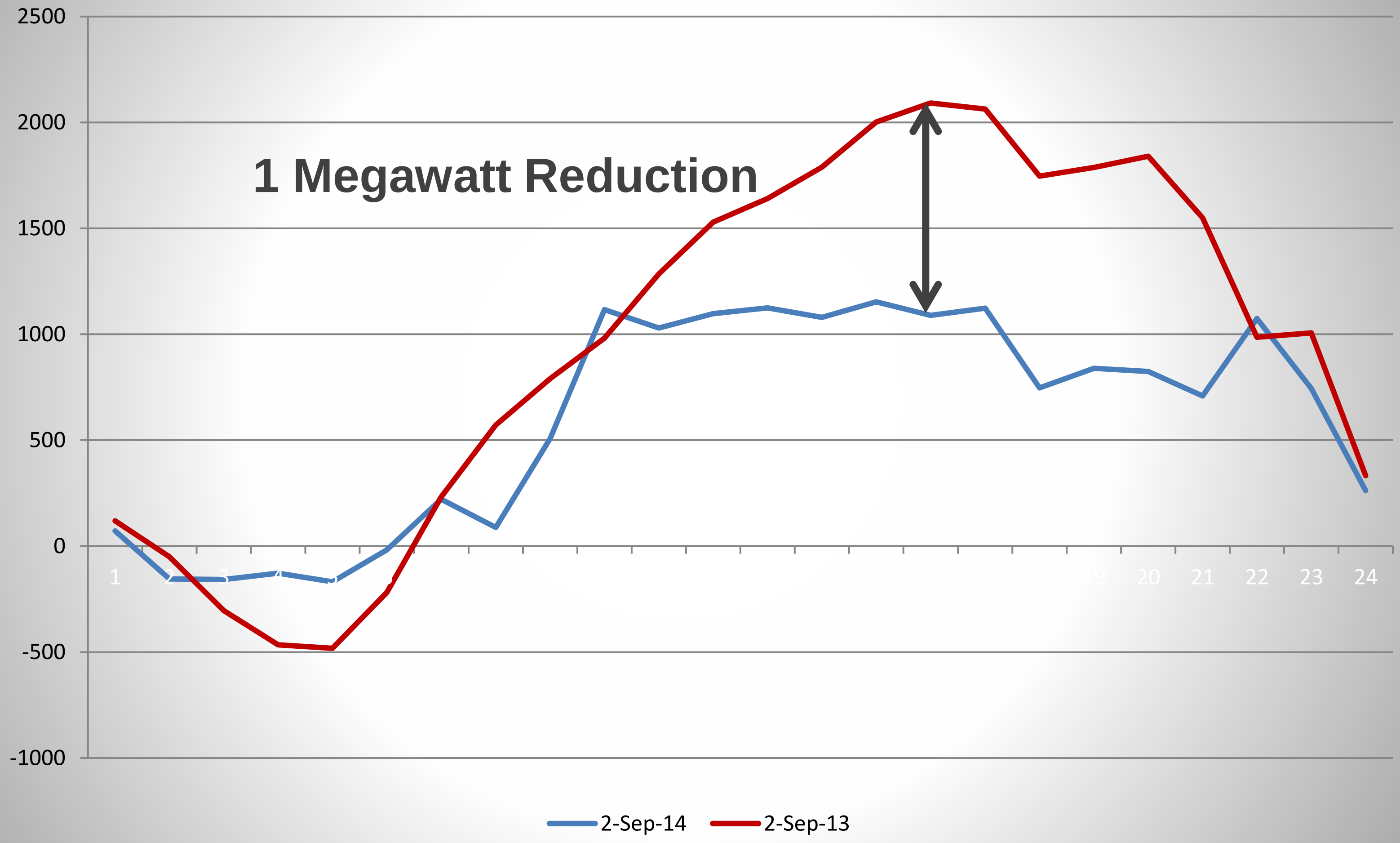




And this tank must be built during the Summer break



The Payoff – Energy Cost Savings and Increased Cooling Capacity



The TES tank provided the additional cooling capacity for the campus expansion AND reduced the overall electrical load by 1 MW

MIAMI UNIVERSITY

OXFORD, OH • EST. 1809

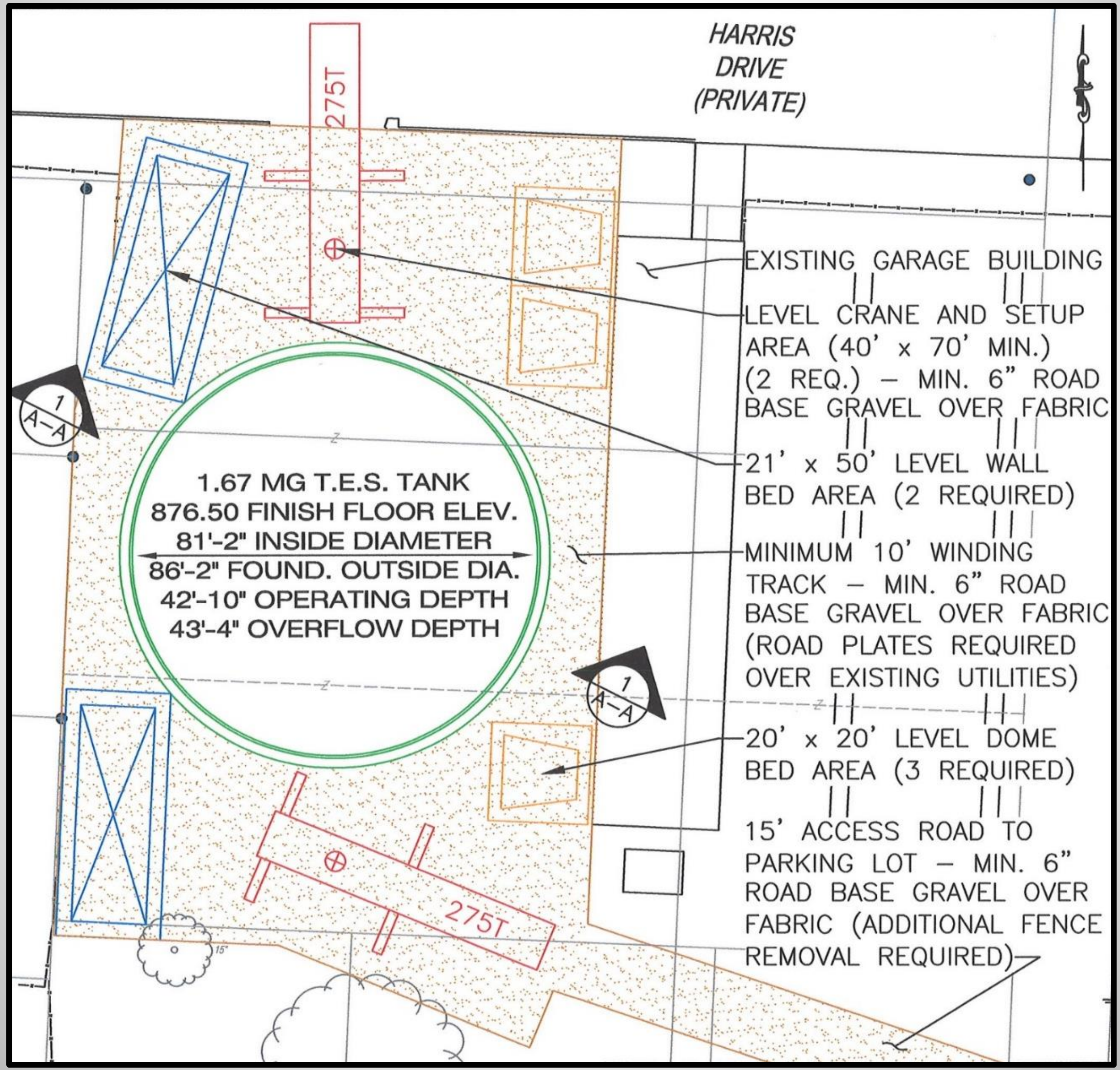
- Public university in OH
- 2018 – a campus expansion
- University has a continuous sustainability effort including lowering the operating costs
- Included a 1,680,000-gallon (15,500 ton-hour) TES tank

Some of the Project Challenges

- TES tank location is adjacent to a residential area
- Wedged in between the central plant and boundary line

- … and the TES tank will be visible to students and neighbors

Construction Management is Critical



Tank Floor within 10 Feet of Plant and Property Line

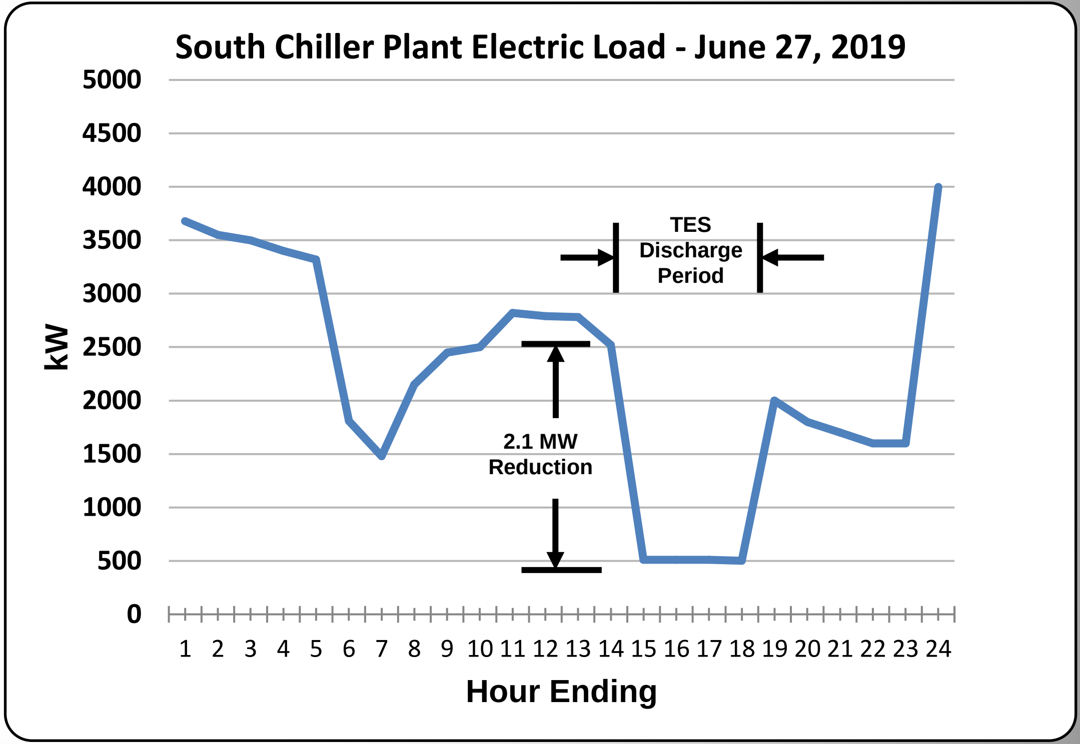
Exterior of TES Tank Architecturally Enhanced

View from the campus side

View from the residential side

The Payoff – Energy Cost Savings and Increased Peak Cooling Capacity

- Chillers with 3,500 tons of cooling capacity can be de-energize for 4.5 hours.
- With a chiller plant efficiency of 0.60 kW/ton on a Peak Load day, de-energizing the chiller equipment **reduces the electric load by ≈2.1 MW's.**
- Over **$200,000** in annual energy related cost savings



Information on this slide is courtesy of Tim LaGrange, Associate Director of Physical Plant, at Miami University

MT. SAC
Mt. San Antonio College

- Public University in southern CA
- In 2018, a future campus expansion required a new central plant, and a
- 2,000,000-gallon (20,000 ton-hour) TES tank to take advantage of CA incentives and electric rates

One of the Biggest Challenges – Make a 2.0 Million Gallon TES Tank Disappear

- Real estate is at a premium
- Tank location is adjacent to a residential area

To Make a Tank Disappear
Construct it Fully Buried Under a Parking Lot

Excavation and
Temporary Shoring

Cast-in-Place
Floor and Walls

Column-Supported
Flat Roof

Some considerations for building a fully buried TES tank:

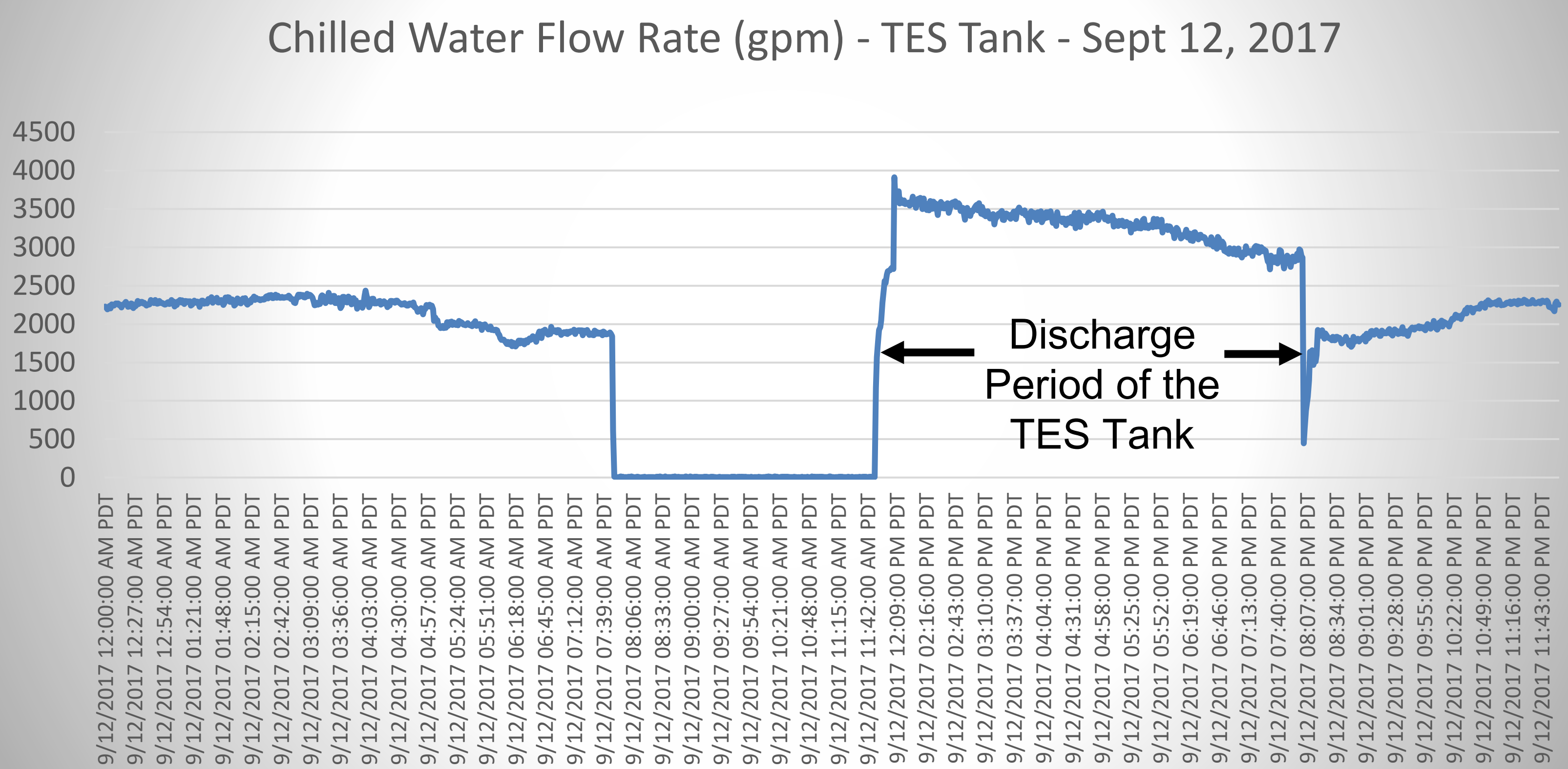
- Groundwater level – preferably below the tank floor
- Roof loading (HS20) – integrity to support a firetruck
- Internal diffuser system built around the support columns
- Water level in the tank with respect to the chilled water system

Students park vehicles on top of the TES Tank

Tank Access, Venting, and Instrumentation

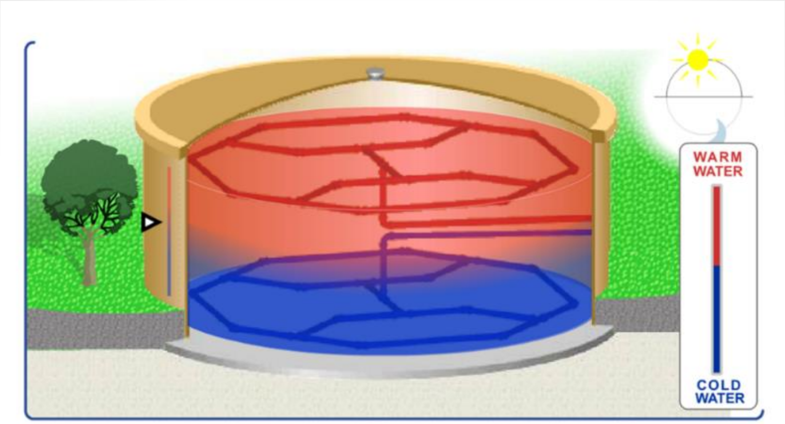
TES Tank Roof Perimeter

The Payoff – Peak Period Electric Load Reduction



Chiller equipment is de-energized during the discharge cycle - resulting in a ≈1.7 Megawatt reduction during peak period.

When Planning a TES Tank Project



Budgeting & ROI

- TES tank criteria (ton-hours, CHW ΔT, CHW flow rate)

Other Considerations

- Above ground, partially buried, fully buried
- Site limitations – work area, max. height
- Soil conditions – geotechnical report
- Exterior enhancements – painted logo, faux brick, etc.
- Approximate construction start date
- Special site constraints or schedule requirements

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