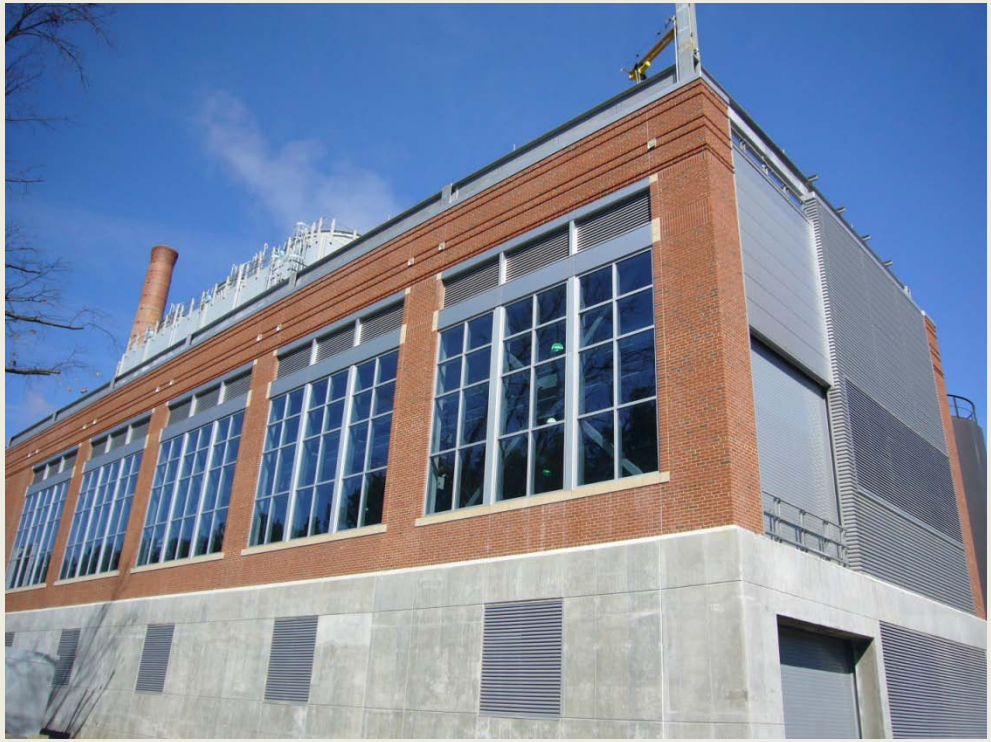
GovEnergy
www.govenergy.gov

· August 15-18, 2010 · Dallas, Texas ·
· Dallas Convention Center ·

Chiller Plant Efficiency and Design Trends

Presentation Outline

- Introduction
- Efficiency 101
- Efficiency Application
- Design Trends
- Q&A

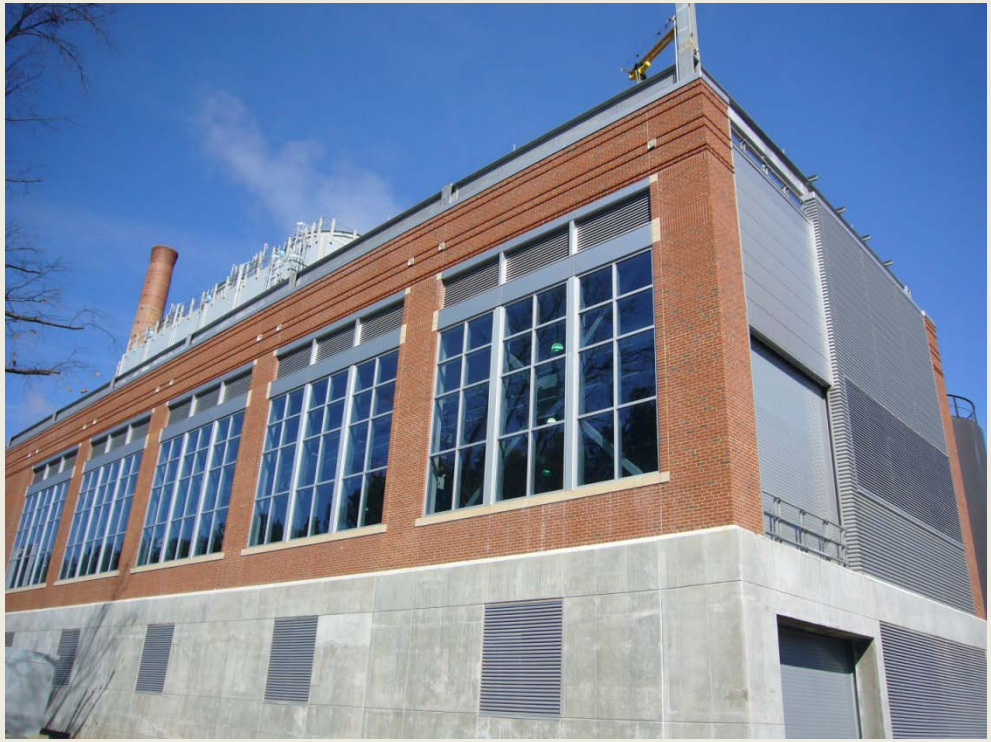


Introduction

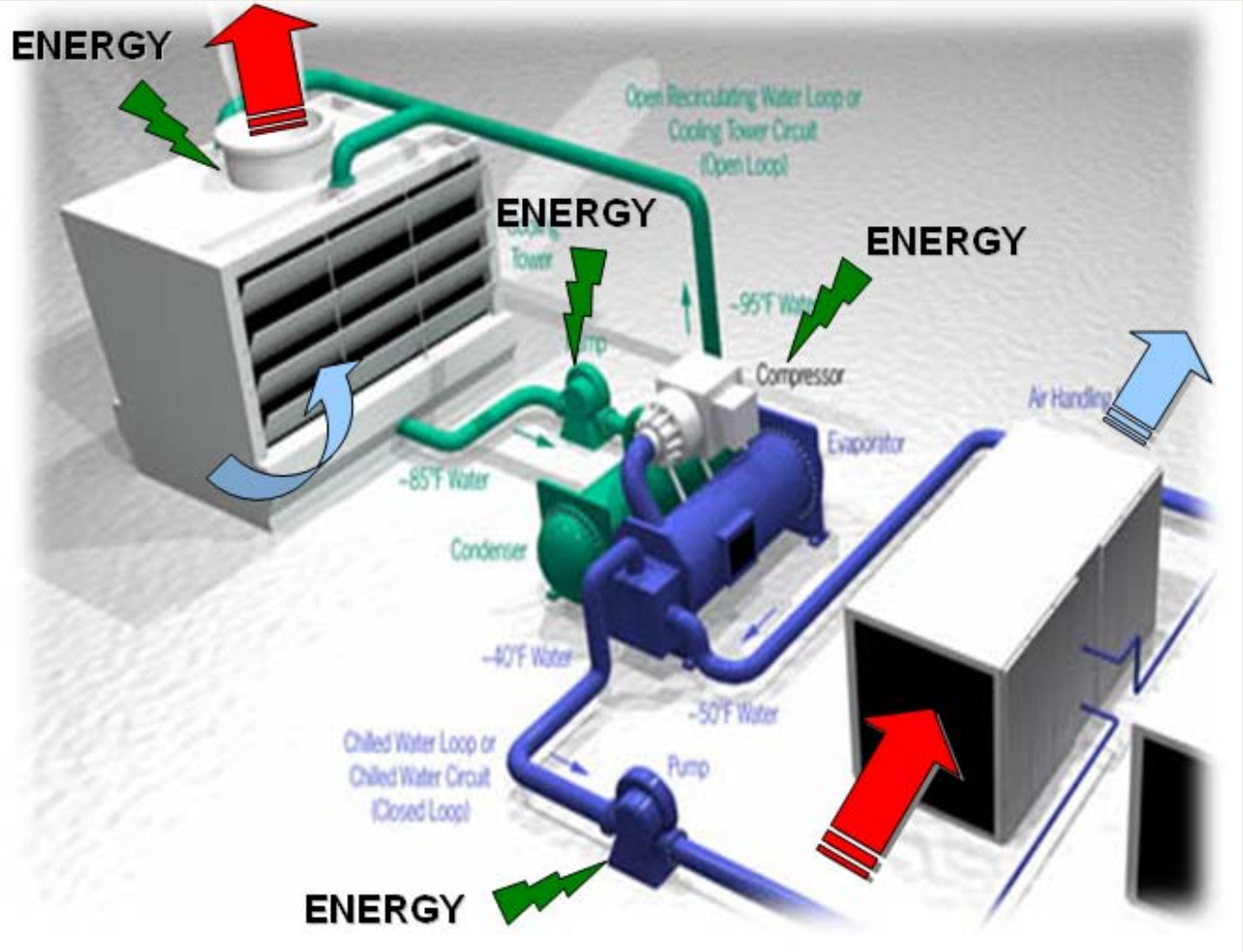
- Greg Carnathan, PE, CEM, LEED AP
- RMF Engineering Inc., Established in 1983, 160 FTE
- Nationally Recognized for Infrastructure Engineering:
  - *Chilled Water, Electric, Steam, Hot Water, Gas*
- Primary Clients:
  - *State & Federal Government, Colleges & Universities, Healthcare Commercial & Industrial*

Presentation Outline

- Introduction
- Efficiency 101
- Efficiency Application
- Design Trends
- Q&A



Efficiency 101



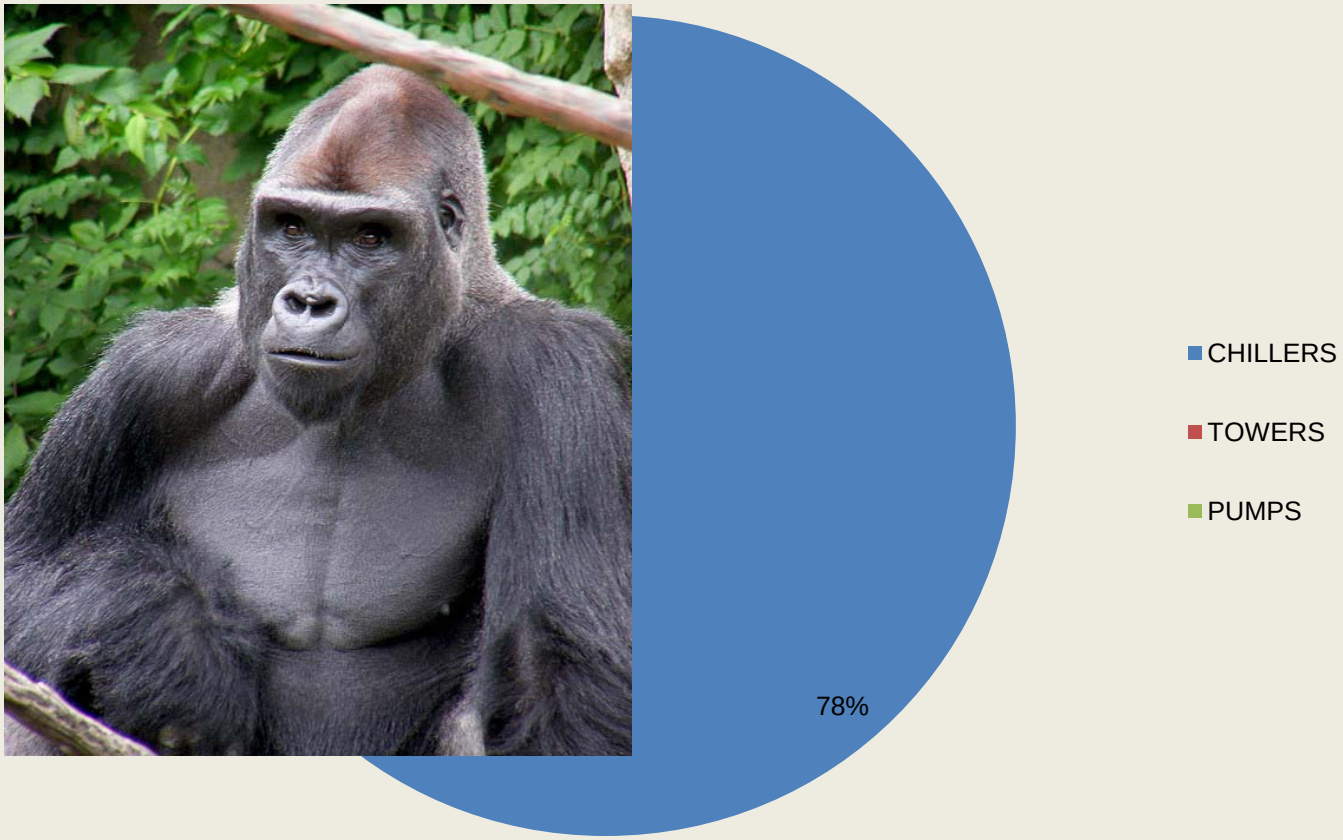
GovEnergy 2010

Efficiency 101

GovEnergy 2010

Efficiency 101

ENERGY USE AT 100% LOAD

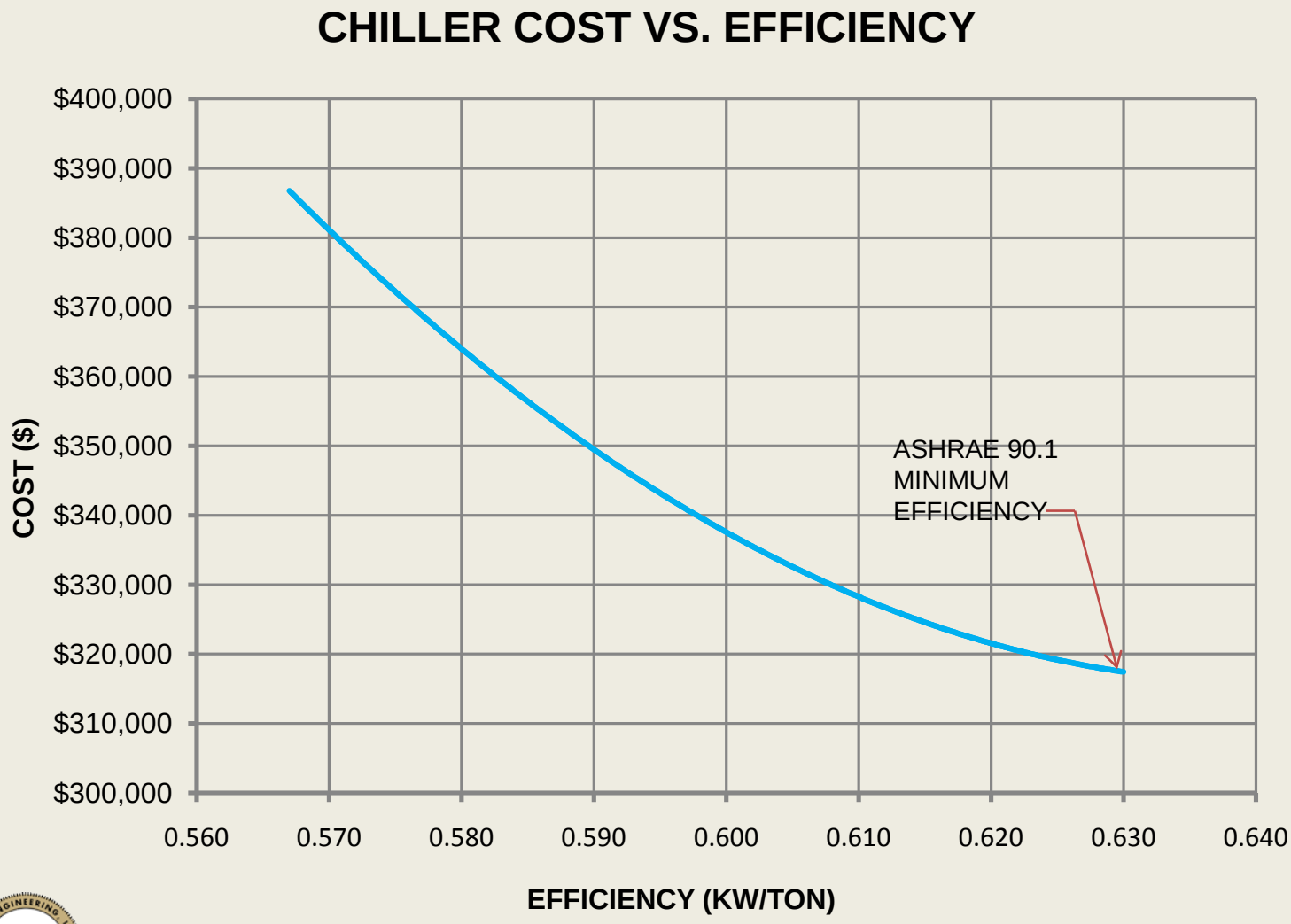


GovEnergy 2010

Efficiency 101

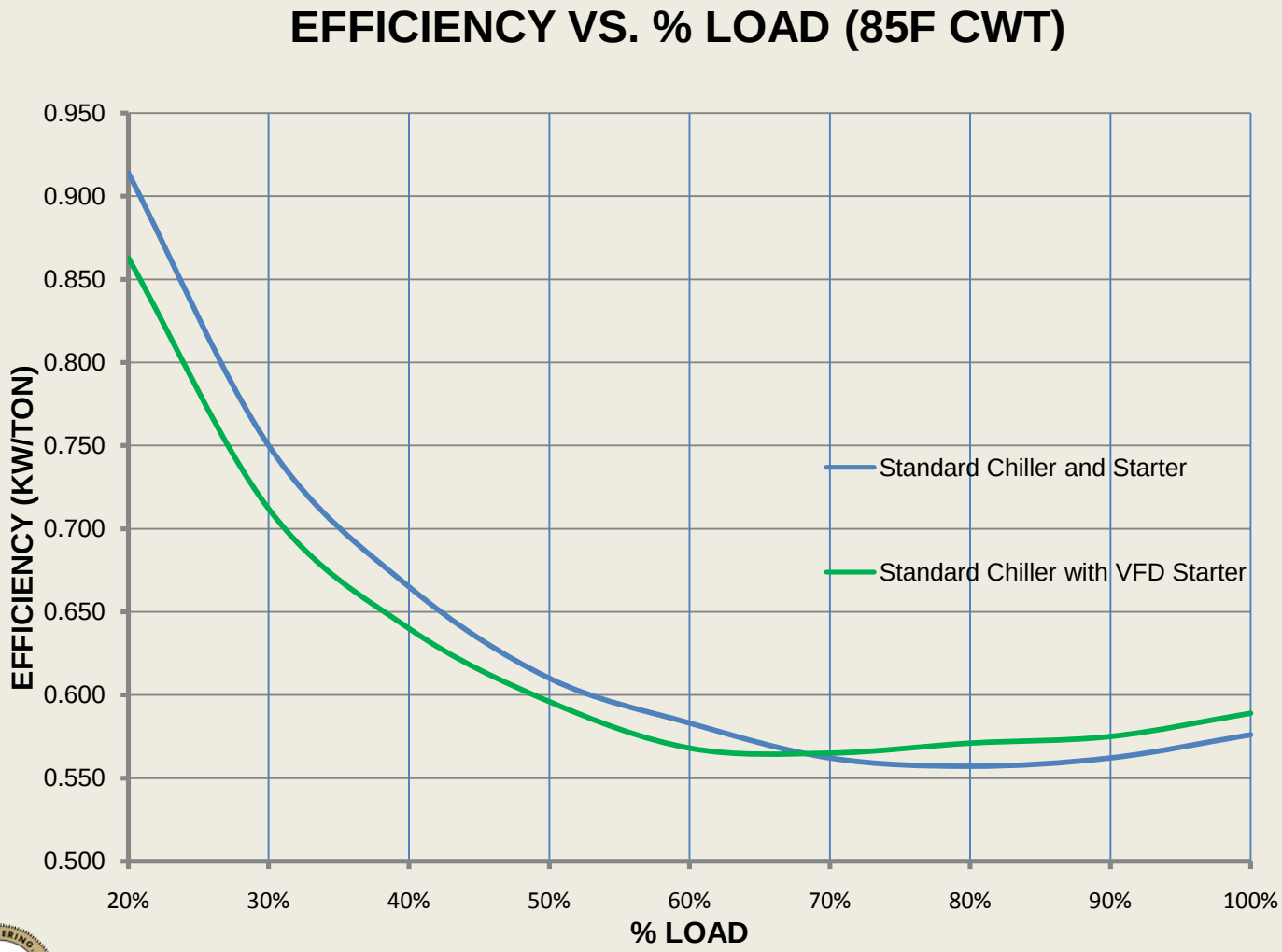
- Custom Chiller Selection
  - Compressor + Motor Size
  - Motor Controller
  - HX Surface Area
    - Shell Size
    - Tube Bundle Type
    - Number of Tubes
    - Tube Thickness

Efficiency 101



GovEnergy 2010

Efficiency 101



GovEnergy 2010

Efficiency 101

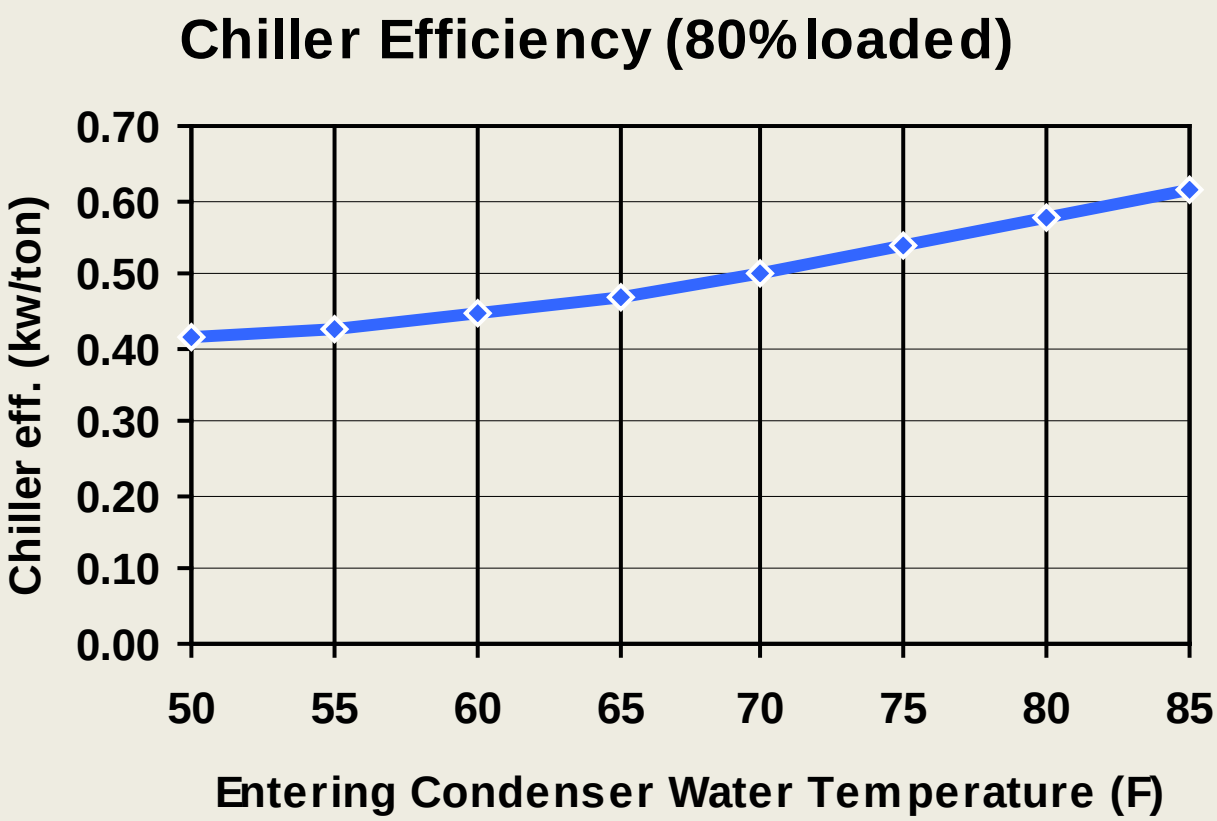
NEW 1200 TON TRANE CHILLER W/ WYE DELTA

% LOAD	CONDENSER WATER TEMP (F)				
	65	70	75	80	85
100	0.432	0.460	0.494	0.532	0.576
90	0.416	0.447	0.482	0.520	0.562
80	0.412	0.443	0.477	0.516	0.557
70	0.415	0.448	0.482	0.520	0.562
60	0.423	0.456	0.491	0.531	0.583
50	0.439	0.475	0.512	0.561	0.610
40	0.468	0.508	0.551	0.601	0.665
30	0.521	0.569	0.623	0.677	0.750
20	0.628	0.687	0.745	0.815	0.914
10	0.865	0.942	1.038	1.137	1.291

NEW 1200 TON CHILLER - TRANE VFD

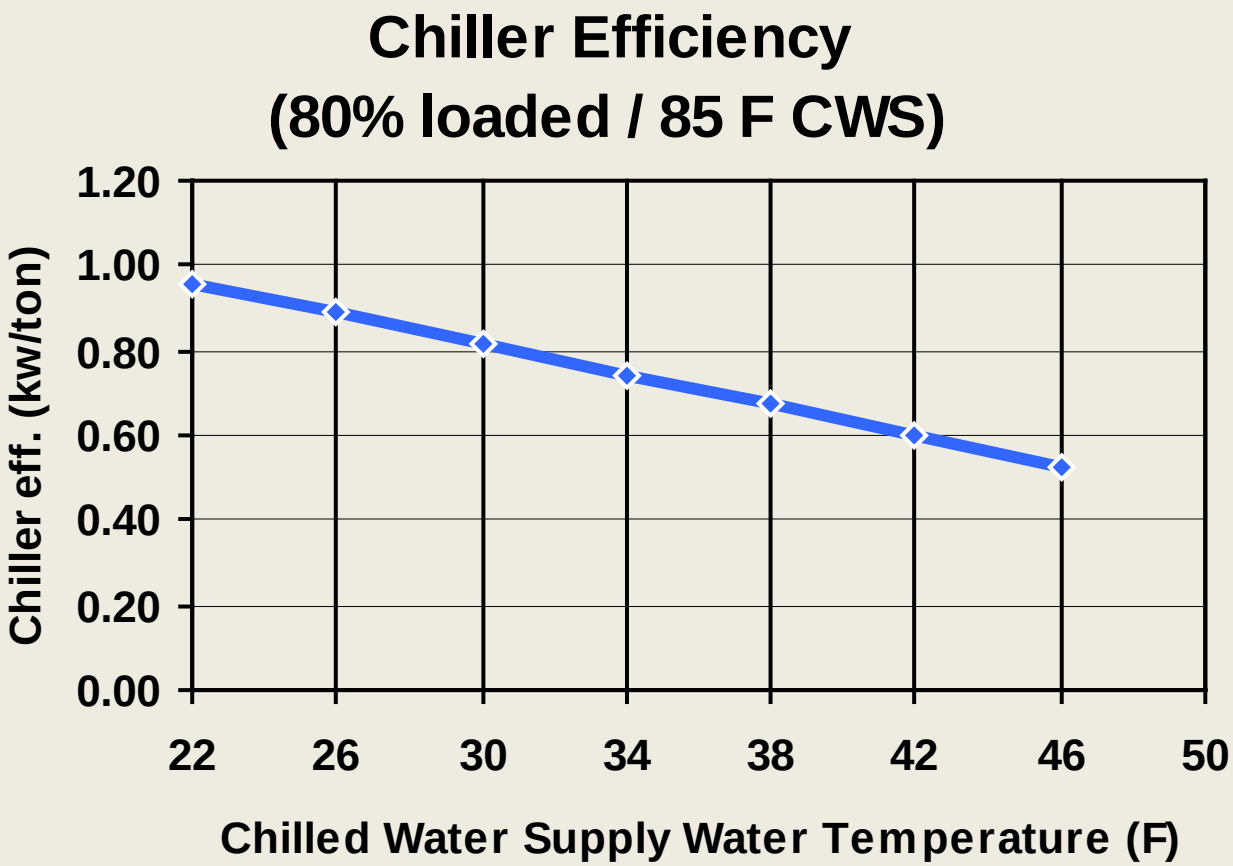
% LOAD	CONDENSER WATER TEMP (F)				
	65	70	75	80	85
100	0.439	0.471	0.512	0.540	0.589
90	0.387	0.424	0.469	0.520	0.575
80	0.363	0.408	0.459	0.514	0.571
70	0.349	0.397	0.447	0.504	0.565
60	0.337	0.390	0.446	0.506	0.568
50	0.335	0.392	0.455	0.524	0.596
40	0.347	0.412	0.482	0.557	0.640
30	0.373	0.450	0.533	0.618	0.712
20	0.442	0.537	0.640	0.750	0.863
10	0.631	0.768	0.915	1.072	1.239

Efficiency 101



GovEnergy 2010

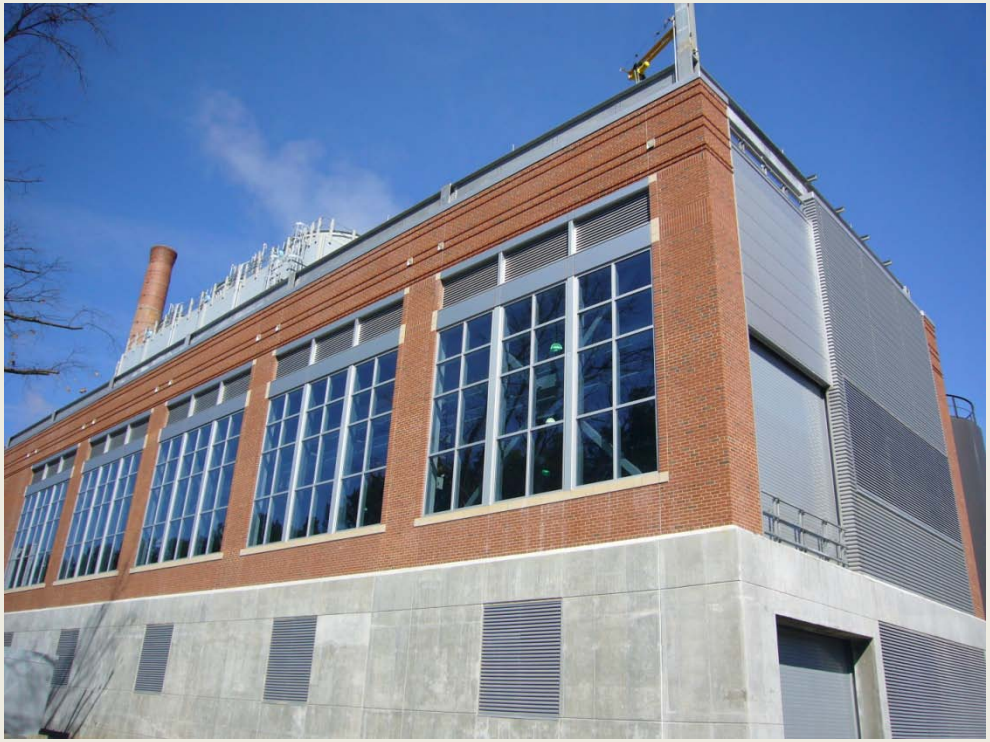
Efficiency 101



GovEnergy 2010

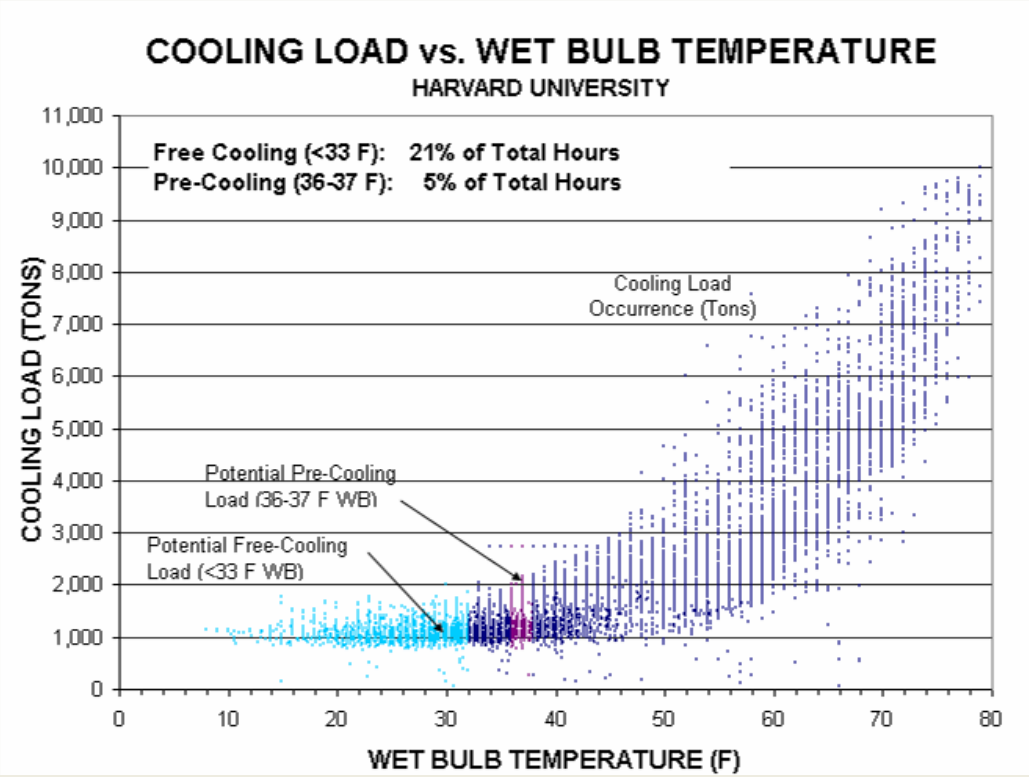
Presentation Outline

- Introduction
- Efficiency 101
- Efficiency Application
- Design Trends
- Q&A



Efficiency Application

- Chiller Selection
  - Bidding Strategy
- Chiller Sizes
  - Custom Load Profile
  - Custom Operational Modeling



GovEnergy 2010

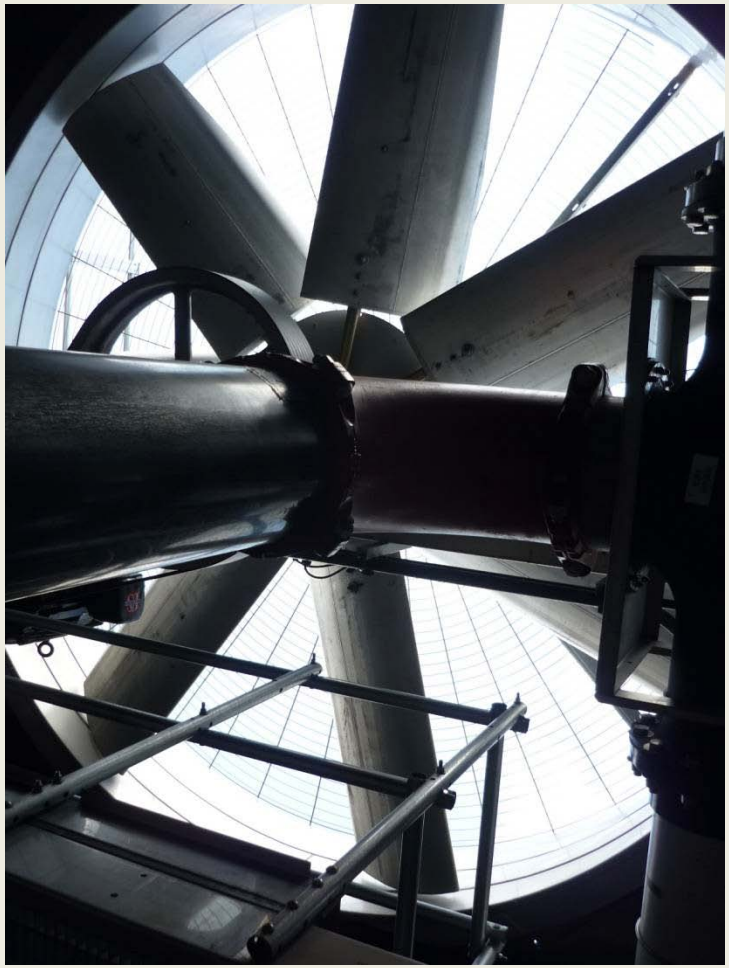
Efficiency Application

- Reduce Entering Condenser Water Temp (Relief)
  - 1.5-2.5% Chiller efficiency improvement per degree lowered
  - Fan Control (<85F)
  - Run more Towers
  - Buy more Tower
  - Engineer Turndown w/ Nozzles and Weirs (50% often possible)

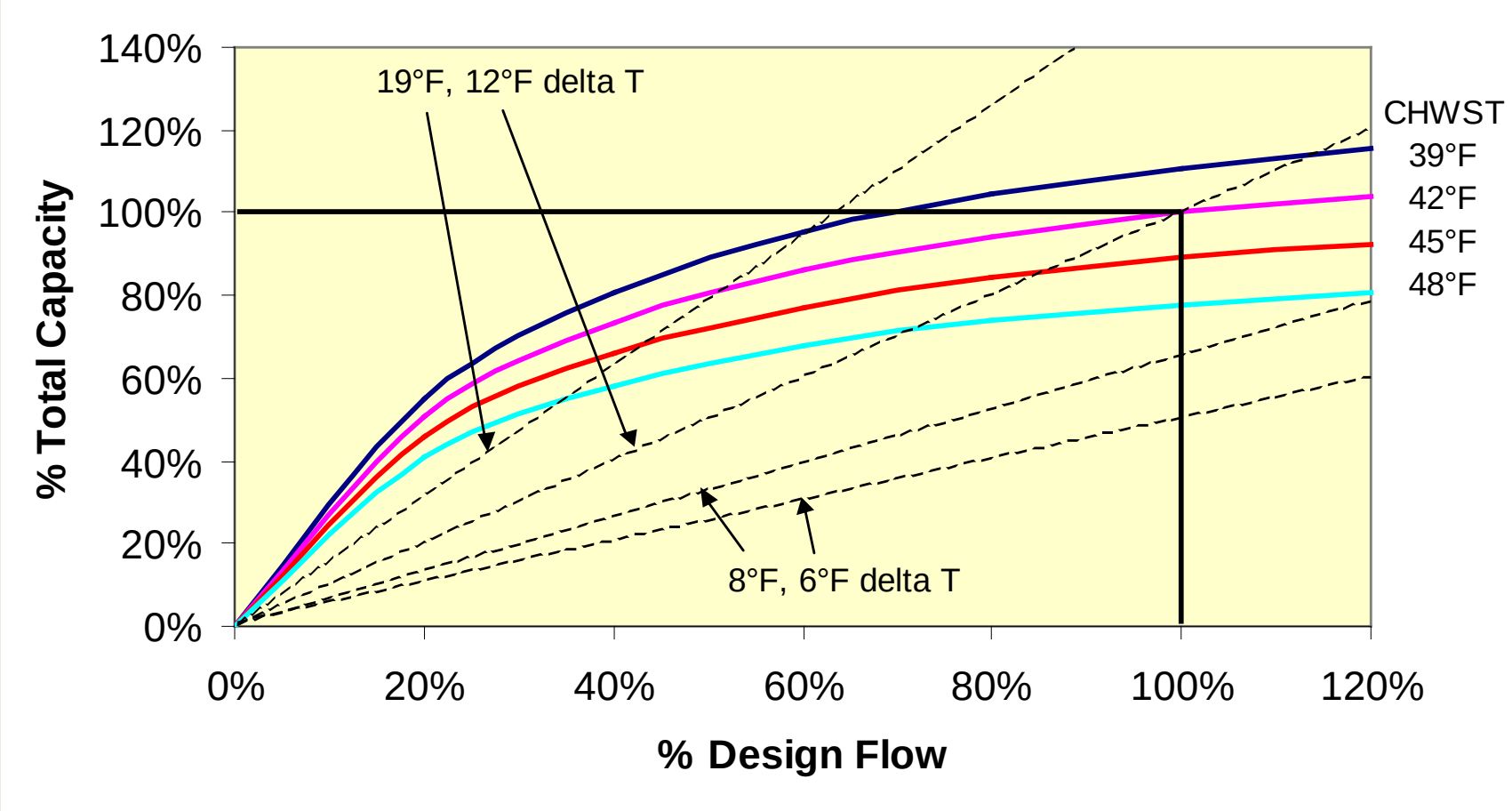
GovEnergy 2010

Efficiency Application

- Raise Chilled Water Supply Temperature
  - Chiller Energy reduced 3% per degree raised
  - Consider reset in cooler months if possible
  - Balancing act with coils
    - Coil performance
    - Delta T and Pumping Energy



Efficiency Application



GovEnergy 2010

Efficiency Application

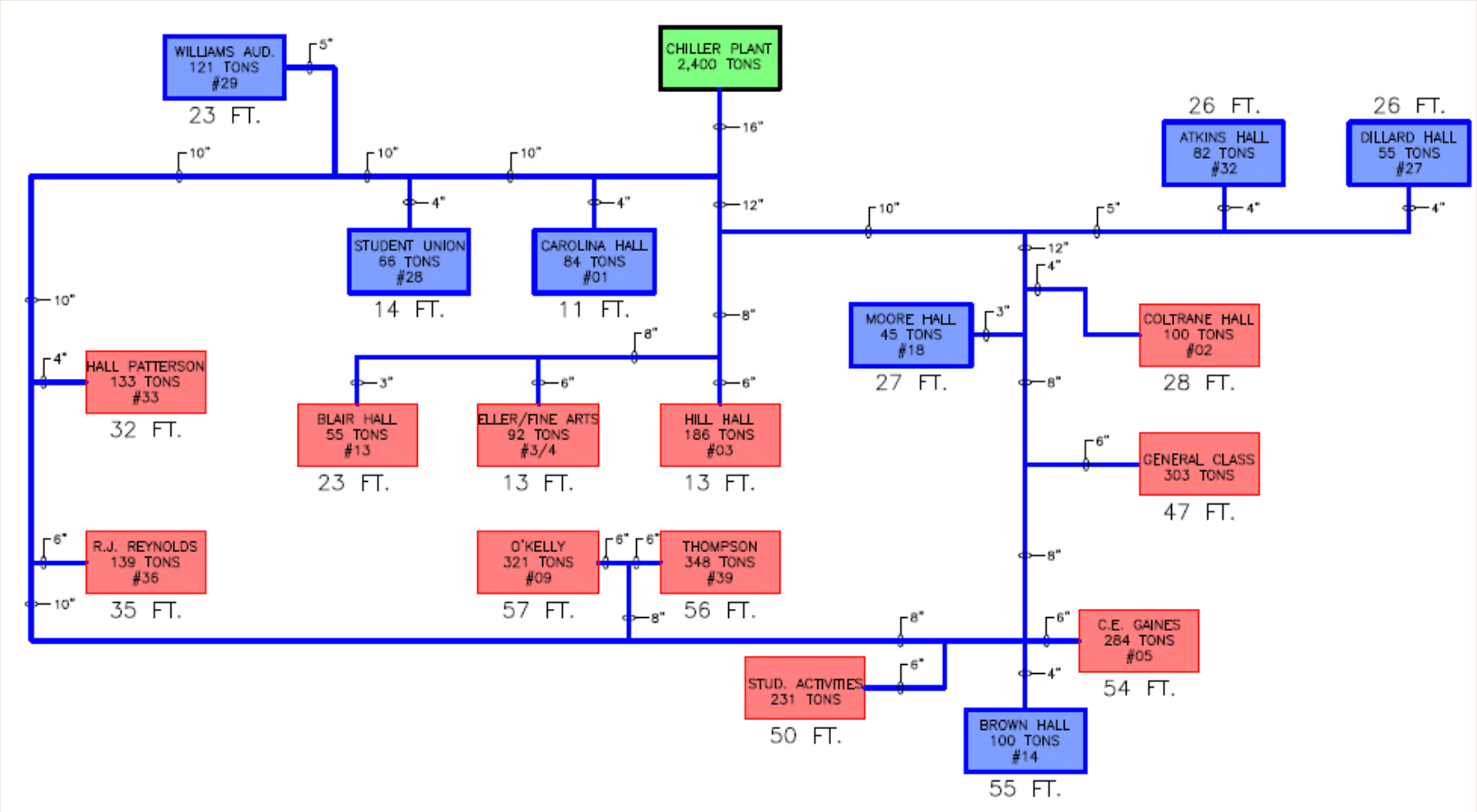
North Carolina State University	EWT	LWT
Chillers	52	42
Coils	44	58

UNC-Chapel Hill	EWT	LWT
Chillers	56	42
Coils	45	59

Efficiency Application

- Reduce Pumping Costs
  - Delta T Collaborative
  - Add VFD, Run at BEP
  - Parallel Pump VFD Signals
  - Locate pinch points w/ Hydraulic Modeling

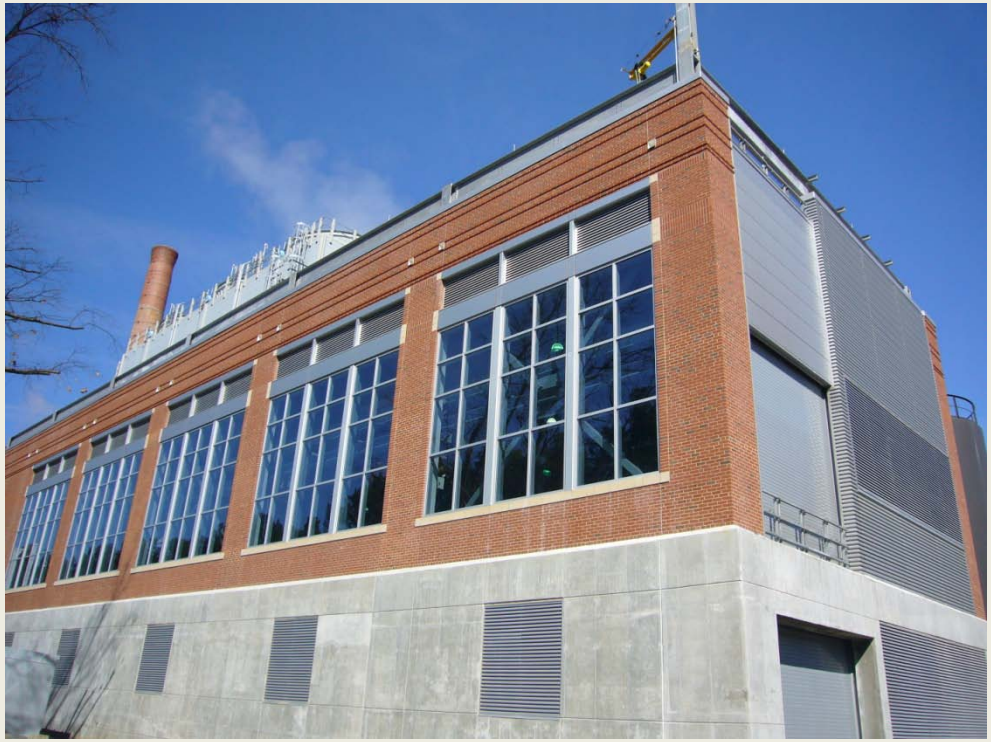
Efficiency Application



GovEnergy 2010

Presentation Outline

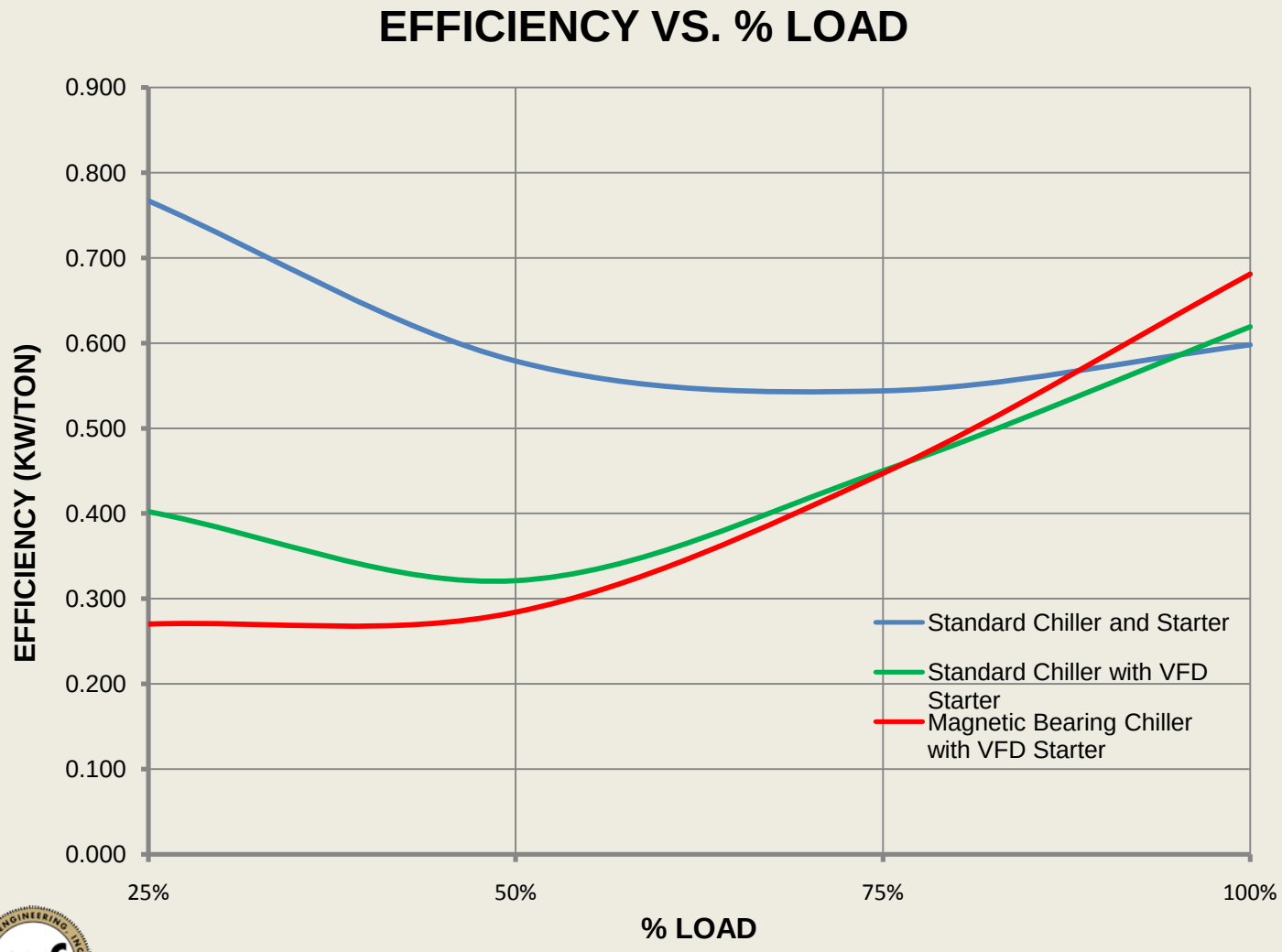
- Introduction
- Efficiency 101
- Efficiency Application
- Design Trends
- Q&A



Design Trends

- Small Efficient Chillers
  - Magnetic Bearing
  - 150-550 Tons
  - Excellent Part Load Performance

Design Trends



GovEnergy 2010

Design Trends

- All Variable Speed Plant
  - All Plant Equipment
  - Medium Voltage VFD's (4160V) $$$,$$$
  - Complicated Controls Sequencing

Design Trends

- Controls Optimization
  - Complicated Sequencing
  - Programmer needs more detail from engineer in sequence
  - Add-On Packages
    - Algorithm controls speed on each VFD
    - Cost advantage for central plants

Design Trends

- Energy Monitoring
  - Operator Awareness
  - Dash Boards
  - Sub-meter Components
  - Measure and Trend Overall Plant KW/Ton
  - Measure and Trend KW/Ton on each chiller (Performance Tracking)

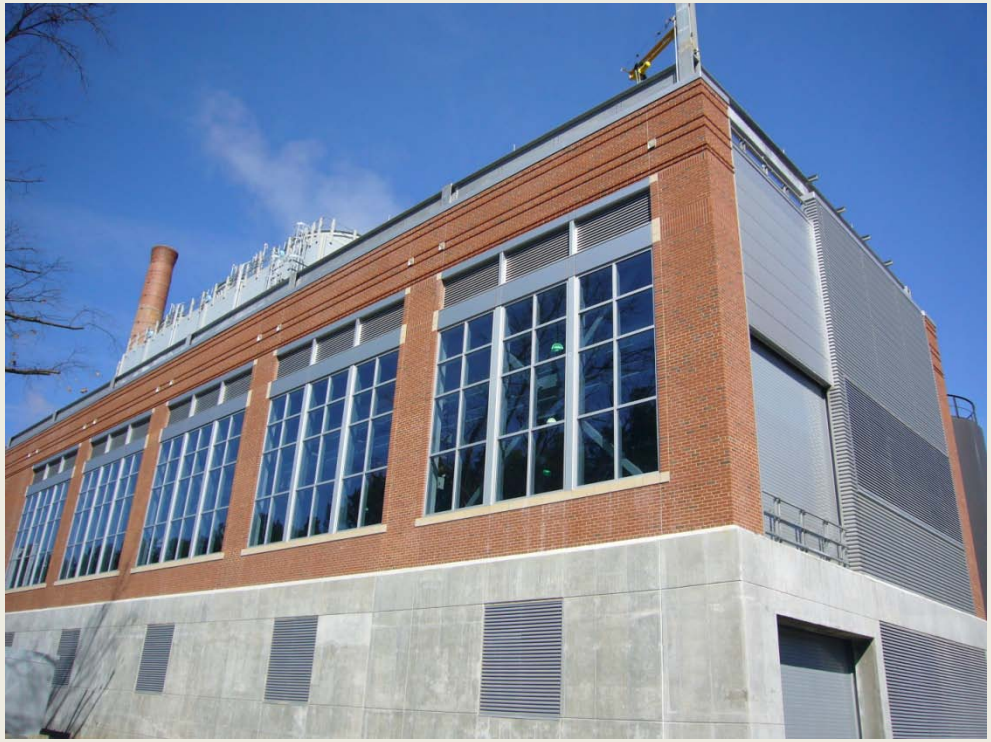
Design Trends

- LEED Considerations
  - LEED Certified Plants
  - LEED E&A COP Default
    - COP 4.4 = 0.8 KW/Ton
  - Water Savings
    - Cold Condensate
    - RO Filtration – Tower Blowdown

$$COP = \frac{Q_{out}(KW)}{Q_{in}(KW)}$$

Presentation Outline

- Introduction
- Efficiency 101
- Efficiency Application
- Design Trends
- Q&A



Thank You

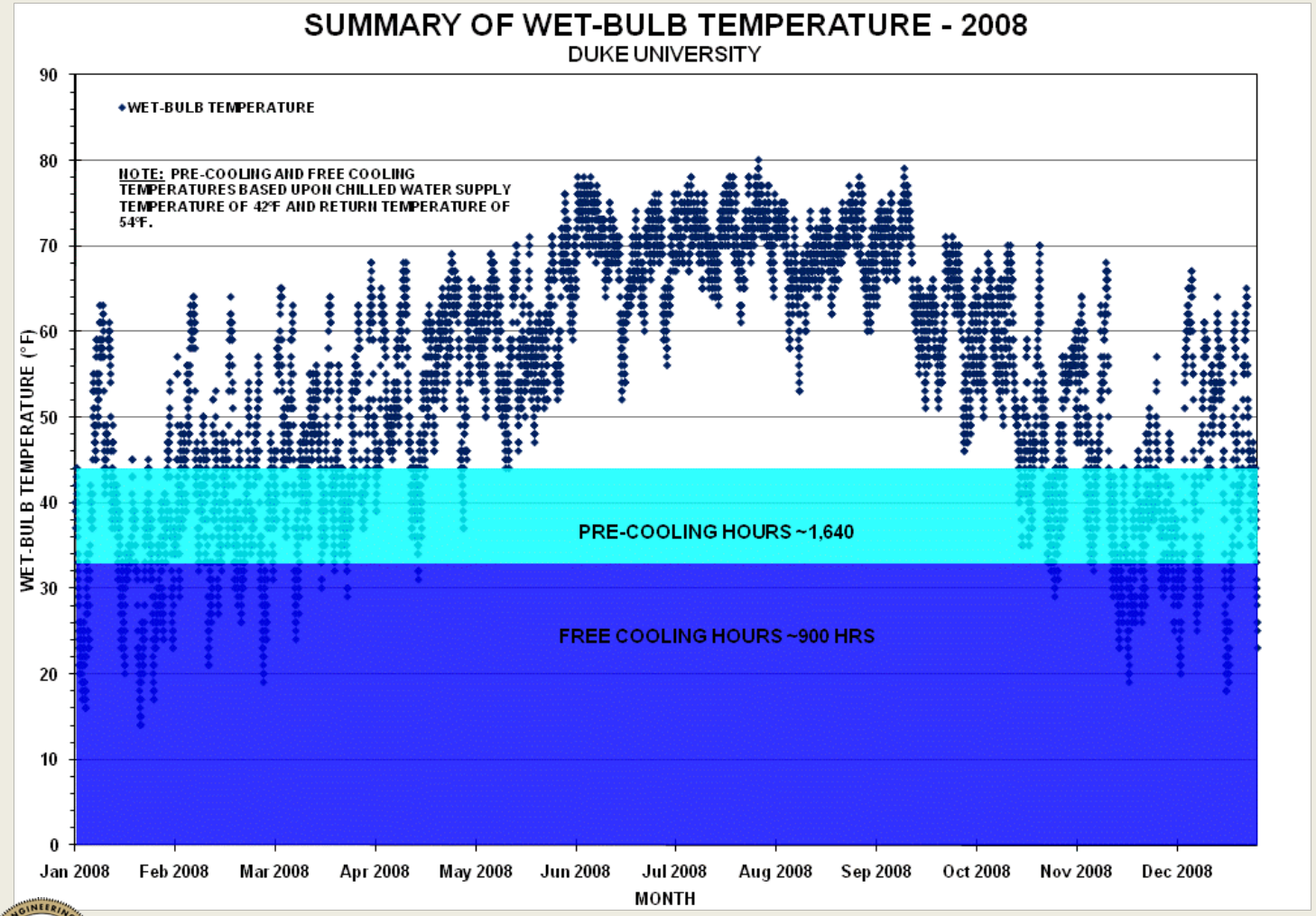
- Greg Carnathan, PE, CEM, LEED AP
  - RMF Engineering Inc.
  - gcarnath@rmf.com
  - 919-941-9876 (W)
  - 919-434-4782 (M)

Efficiency Application

- Pre-Cooling vs Free-Cooling
  - Water-Side Economizer
  - Free Cooling Operates in parallel w/ chiller (limited hours)
  - Pre-Cooling HX Operates in series or parallel w/ chiller (3x hours in NC)
  - Either system best with two condenser water loops

GovEnergy 2010

Efficiency Application



GovEnergy 2010