Lake Source Cooling at Cornell: 15 years of Renewable Cooling

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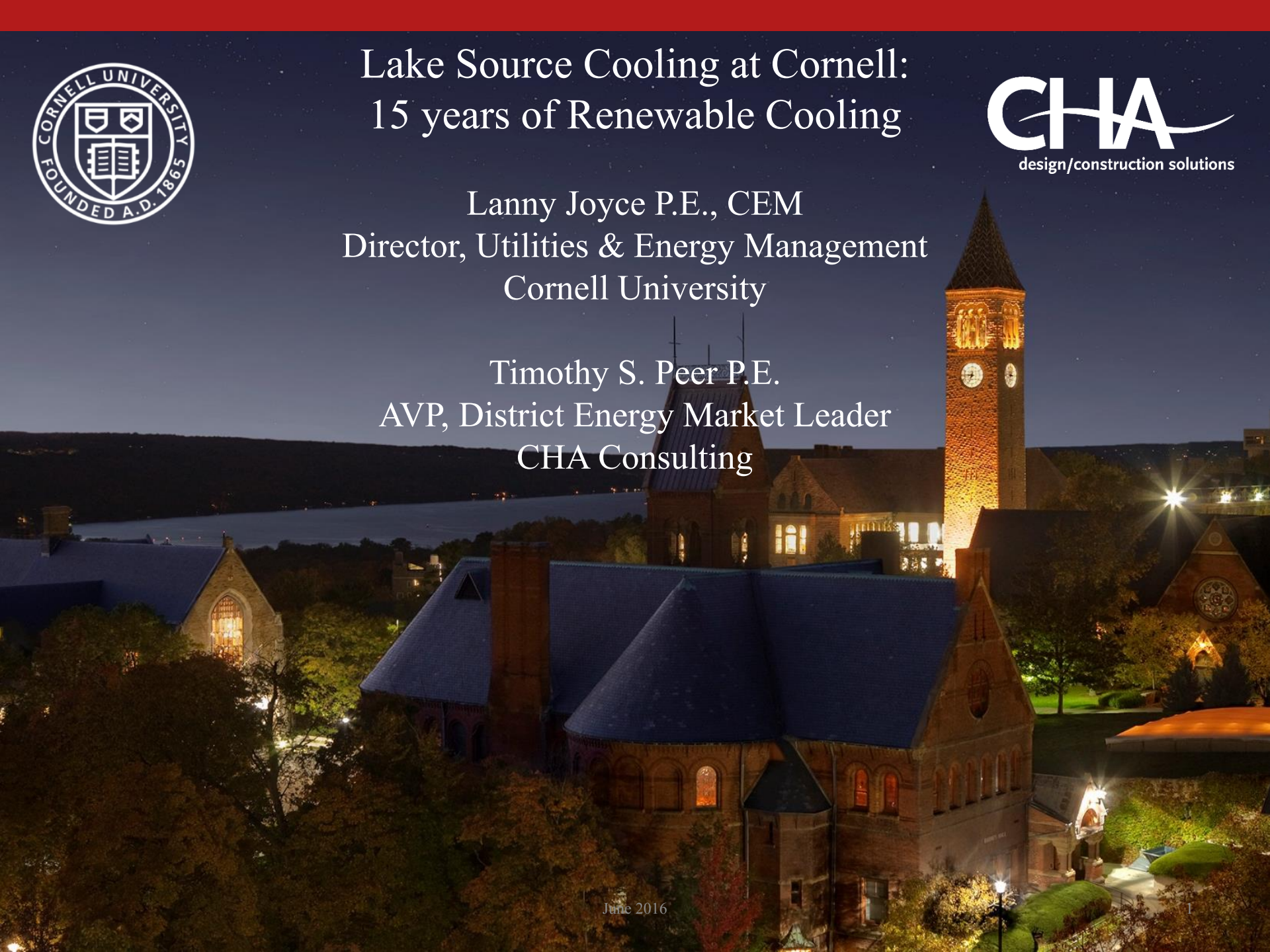


Agenda

- Overview of Cornell energy use
- Lake Source Cooling
- Review of 15 years of operation
- Cleaning of the intake in 2015
- The future

Cornell Energy Use

Central Energy Plant provides

Electric for
14,000,000 GSF
220 buildings

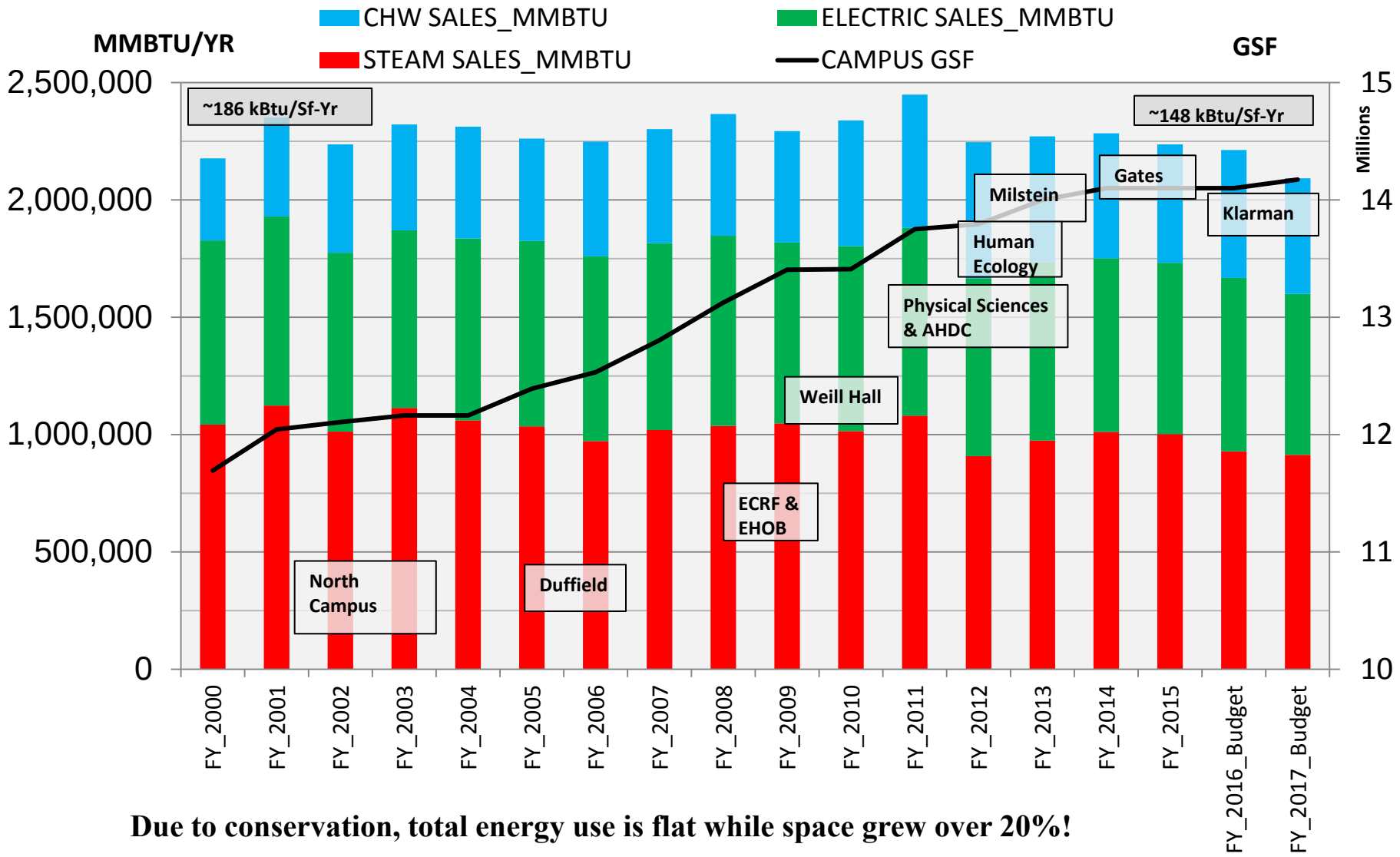
Steam for
12,800,000 GSF
150 buildings

Cooling for
8,700,000 GSF
100 buildings

Campus Building Power Needs

	Peak		Average		Minimum	
	US	Metric	US	Metric	US	Metric
Steam	380 mmBTU/hr	110 MWth	100 mmBTU/hr	32 MWth	60 mmBTU/hr	18 MWth
Electric	35 MWe	35 MWe	22 MWe	22 MWe	20 MWe	20 MWe
Chilled Water	25 ktons	7 MWth	4.5 ktons	1.3 MWth	3 ktons	.85 MWth

Energy Use vs Building Space



Due to conservation, total energy use is flat while space grew over 20%!

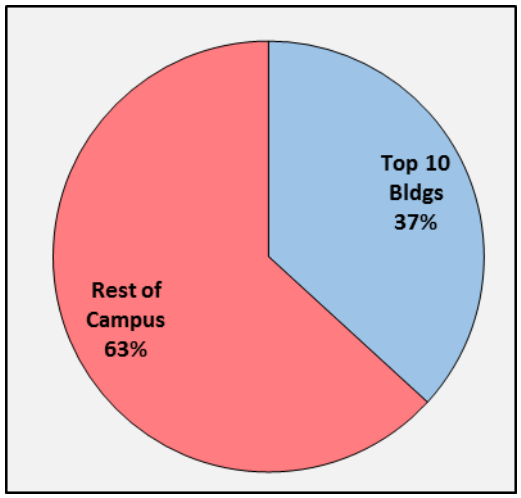
Chilled Water Use

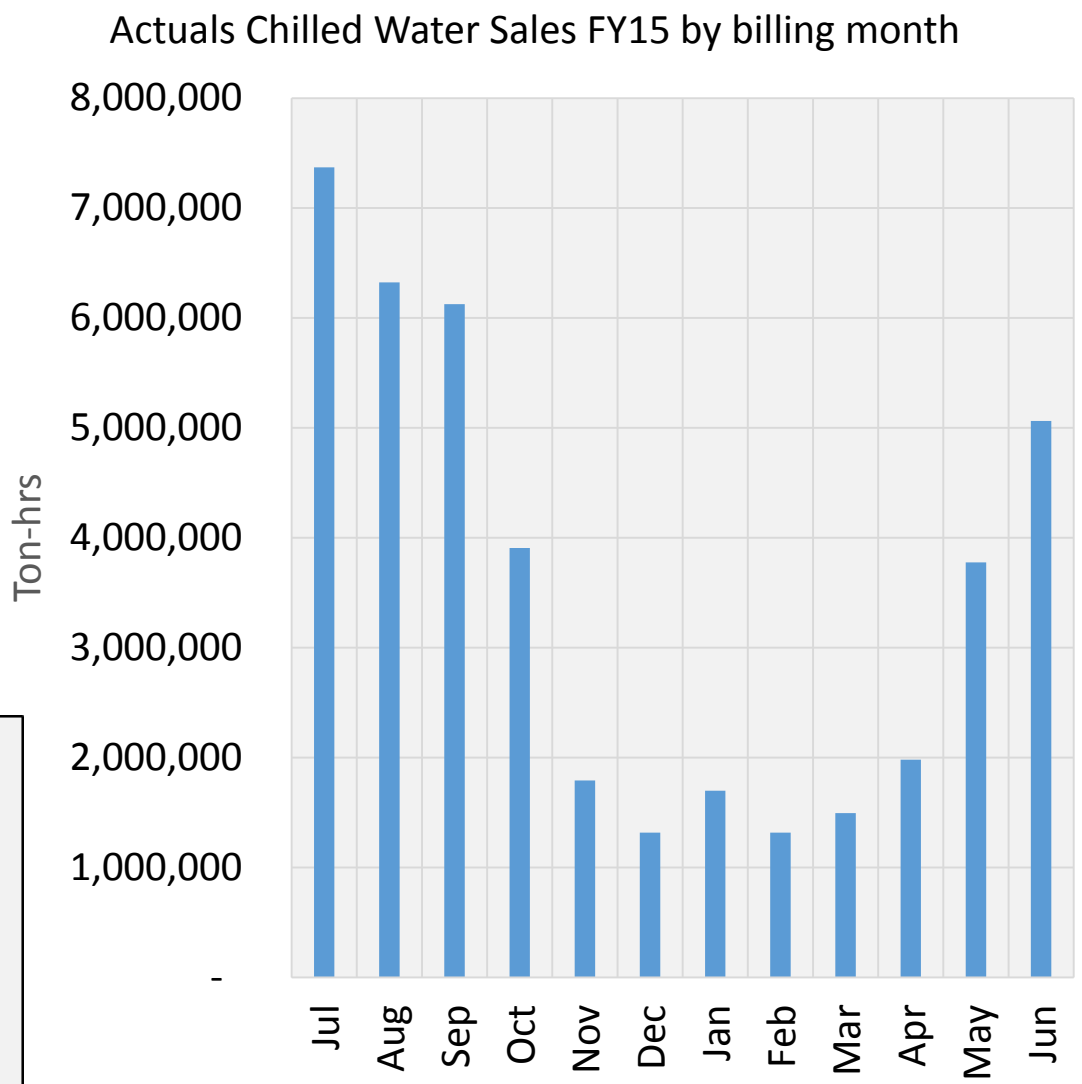
Metered Building sales:
42 million ton-hrs

About 47% of usage occurs in July/Aug/Sept

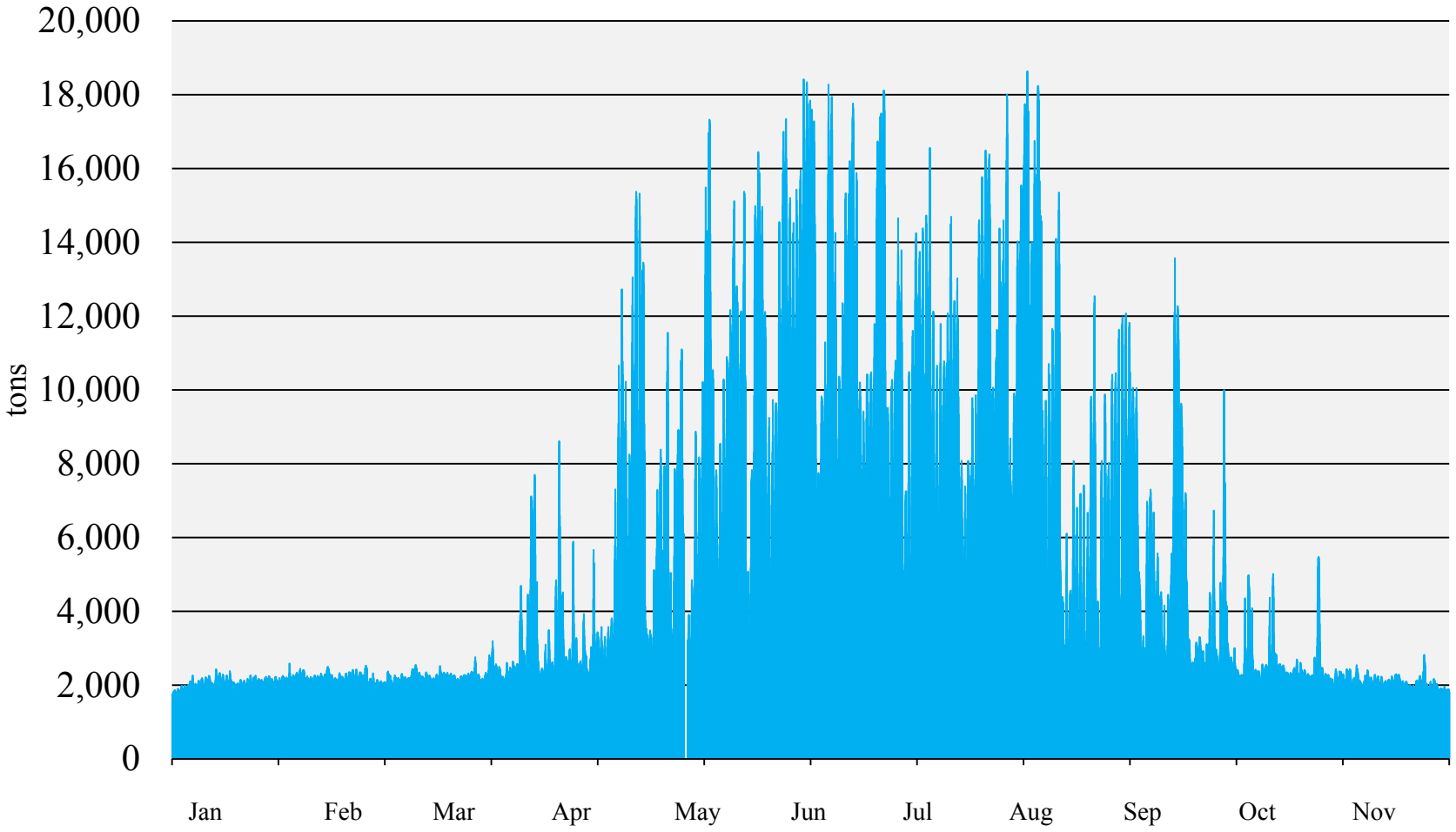
Winter usage for process cooling and some space cooling

Peak load is 25,000 tons
(1 ton is the heat rate required to melt one ton of ice in a day)

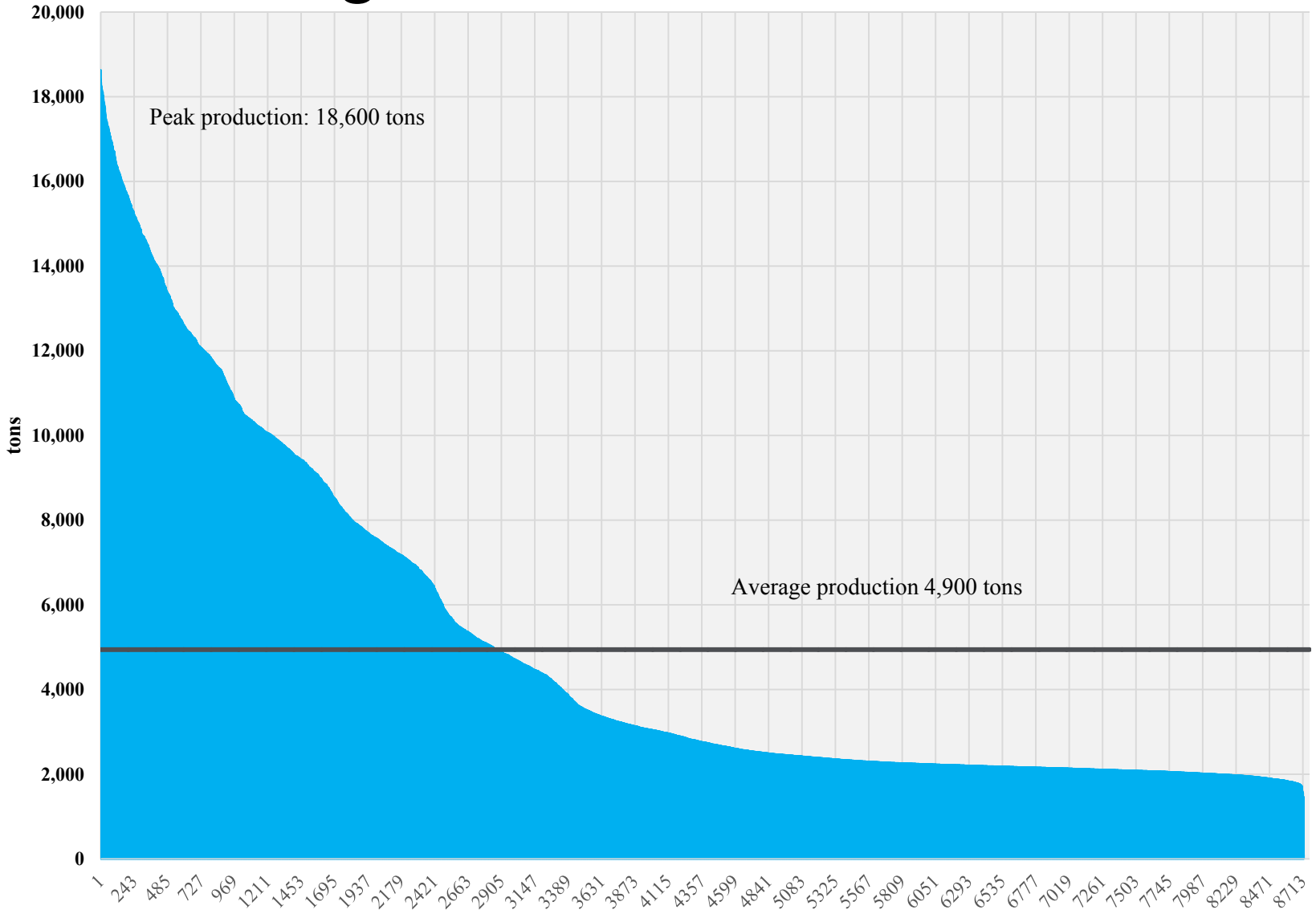




Hourly LSC CHW Generation CY 2014



LSC Cooling Load Duration Curve CY 2014



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Background on LSC

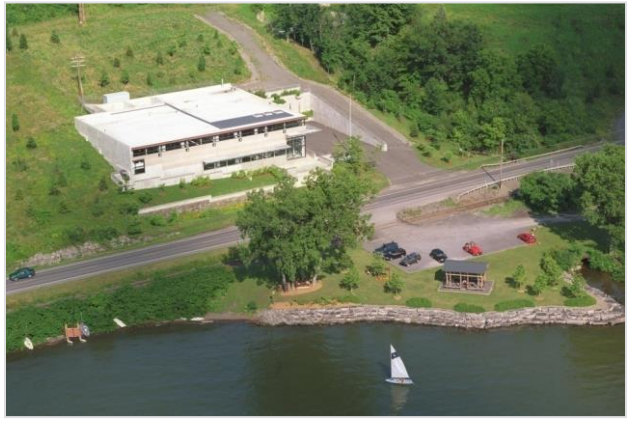
- The Chilled Water district energy system started in 1963
- By the mid 1990s, refrigerant phase out/renewal/load growth/rising energy costs required major change
- Replacing all chillers with new was the base case: first cost up to $35M
- Lake Source Cooling was higher first cost, $58M; but lower operating cost, saves electric cost (85%), and avoids exposure to volatility in electric prices
- LSC also avoids 7000 tons annual CO2 emissions

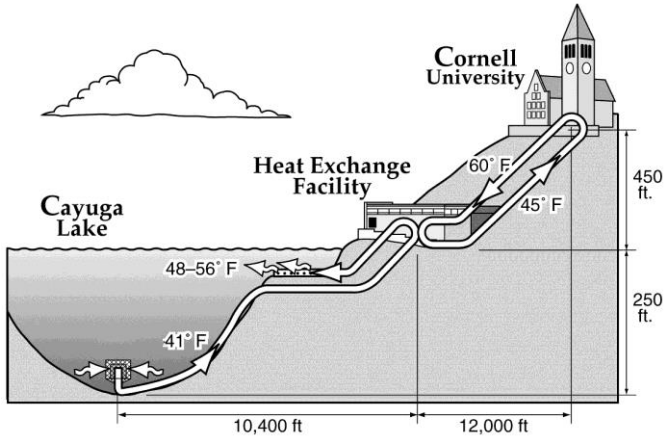
LSC Facts

- On-line FY 2001 (July, 2001)
- Saves cost, chw cost to campus flat since 2001
- 100 year design life vs 40 year chillers
- ~85% less electric energy versus chillers
- ~10% campus annual electric usage reduction
- 10MW reduction in peak electric demand (TST 5 MW)
- Reduction in regional GHG and other air pollutants
- Winner of 7 major state/national/international innovation and energy efficiency awards
- Long term monitoring has shown LSC does not harm Cayuga Lake, within natural variability

Lake Source Cooling

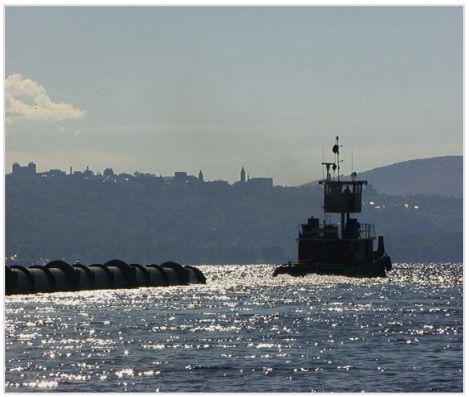
- Started service 2000
- ~ 0.1 kw/ton annual avg
  - (86% savings)
- Truly "renewable" cooling



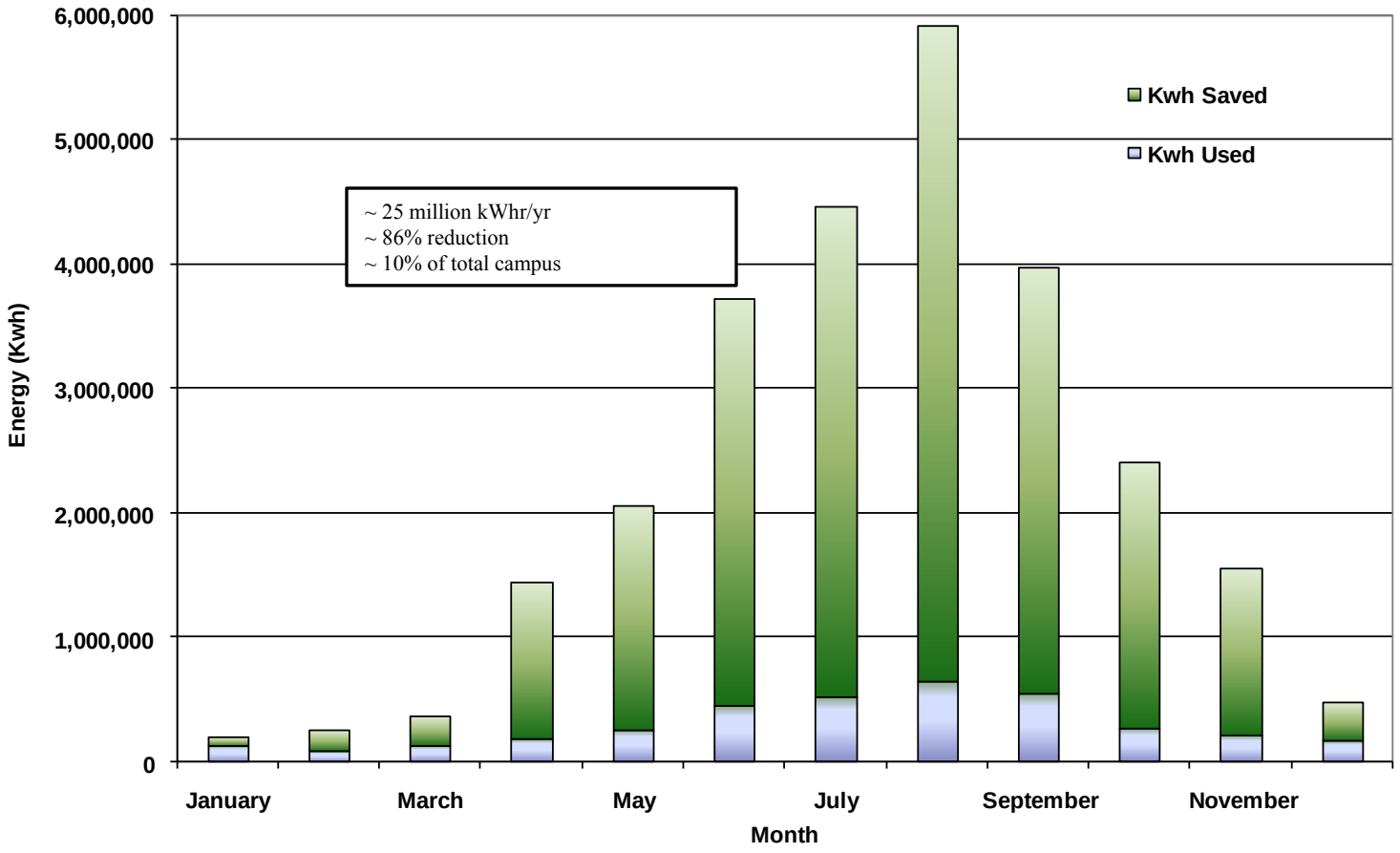


- Full automation (un-peopled)
- Saves over 25 million kwh/yr
  - 10% of campus use
- District cooling system CFC free
- 32,000 gpm peak flow, 15-20,000 tons based on deltaT, all variable speed

Lake Source Cooling



Lake Source Cooling Energy Savings



LSC Benefits

Community

- $1M to Ithaca City Schools, avoided cooling costs
- $1M to the City of Ithaca in new infrastructure
- New Town of Ithaca park on the lake shore
- Ithaca City Schools athletic field flood control

Environment

- Pollution reduction from the elec/water/sewer savings
- Focus on Cayuga Lake science and health
- New lake science/knowledge is guiding regulation and management of Cayuga Lake

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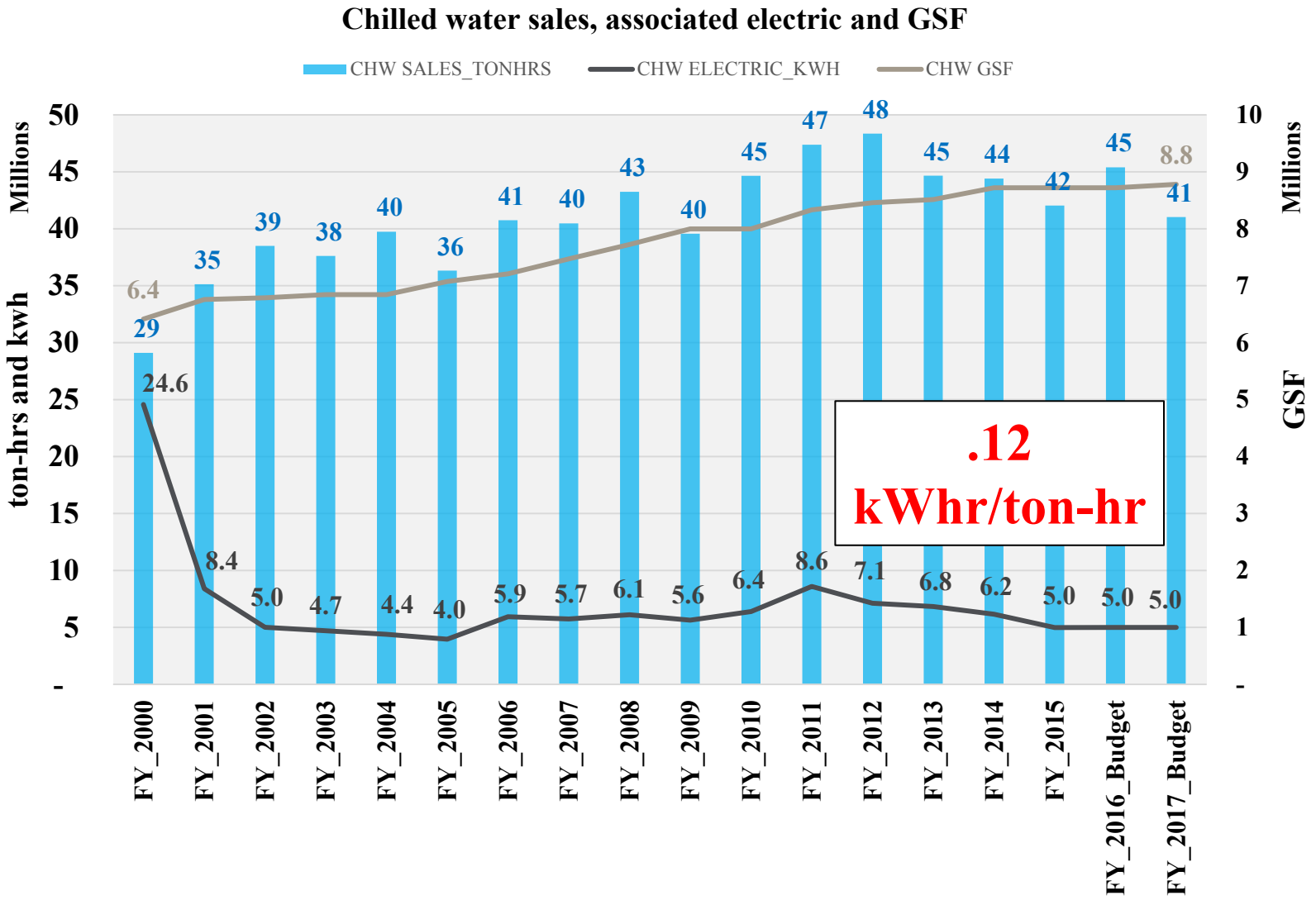
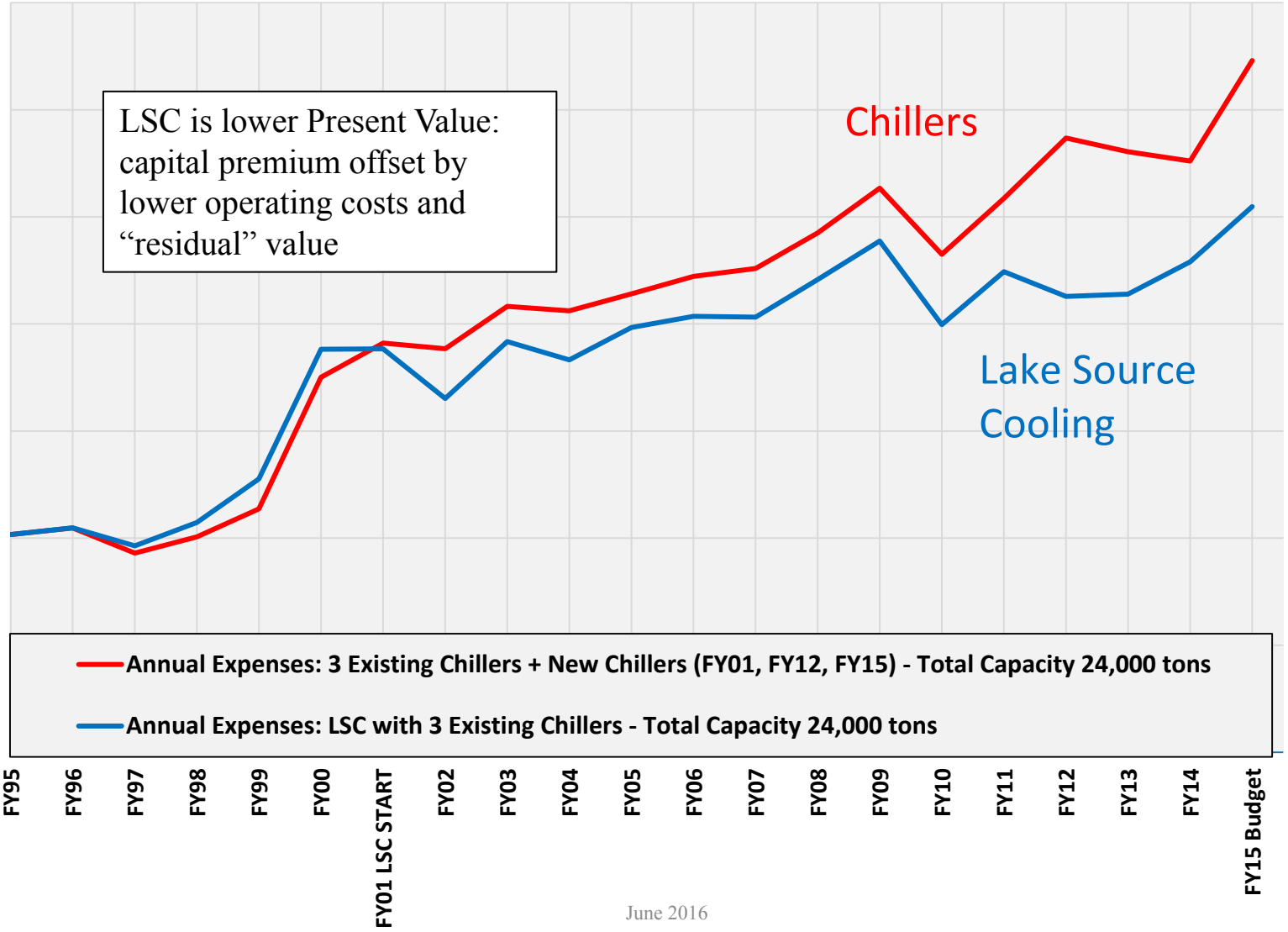
Campus CHW Over Time



LSC vs. Chillers Annual Costs



LSC Operations

- PLC controls rock solid
- Initial flow changes stirred up system
- Differential pressure managed well
- Radial feed booster pump very effective
- Operated remotely via fiber IP link
- Very stable and easy to operate

LSC Maintenance and Reliability

- Vacuum priming system “tricky”
- Fall lake “stratification breakdown” event
- Lake inlet temp 33.5 F to 41.5 F
- Plate HX plugging by CHW debris
- Electric grid connection lightning issues
- PC’s for HMI/Server upgrades
- VSD’s lasting 10-15 years, then obsolete
- PLC now requires replacement
- “10 year” maintenance shutdown in 2010

Strategic Rebuild of LW Pumps

Factory rebuild of pumps and motors to ensure continued reliability – completed in 2010, 2012, & 2014

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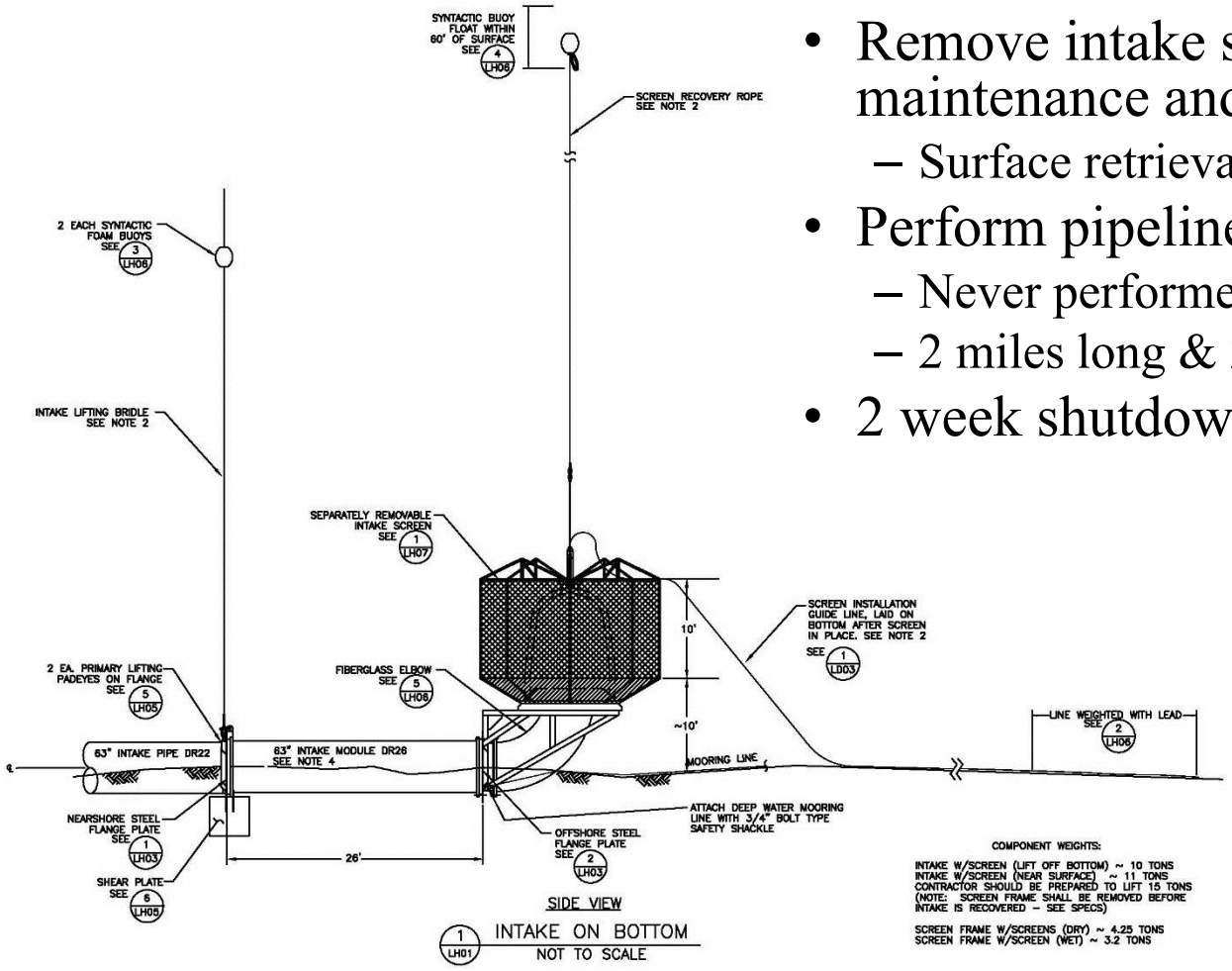
Intake Cleaning in 2015

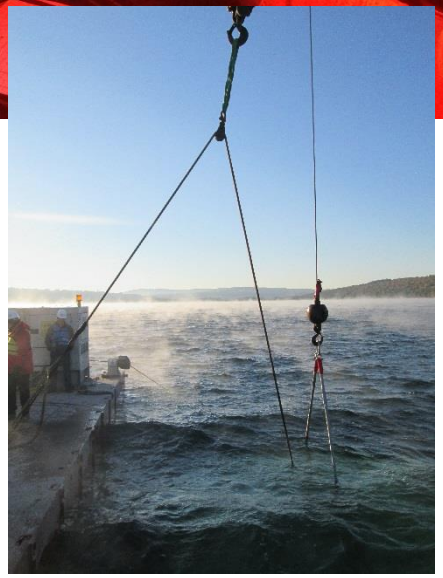


- Invasive freshwater mussel fouling
- Remove intake screen for maintenance and cleaning
  - Surface retrievable
- Perform pipeline "pigging" of intake
  - Never performed at this scale
  - 2 miles long & 250 ft deep
- 2 week shutdown early October 2015

Intake Cleaning

Intake Cleaning

Intake Screen Re-installation



Results


Intake Pipeline Cleaning 2015
All Data
Jul 14 Fouled
Oct 15 Cleaned
Poly. (Clean)
Poly. (Fouled)
dP (feet)
Flow (gpm)
20.000
18.000
16.000
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
0.000
5000.000
10000.000
15000.000
20000.000
25000.000
30000.000
35000.000
Before cleaning
After cleaning
New

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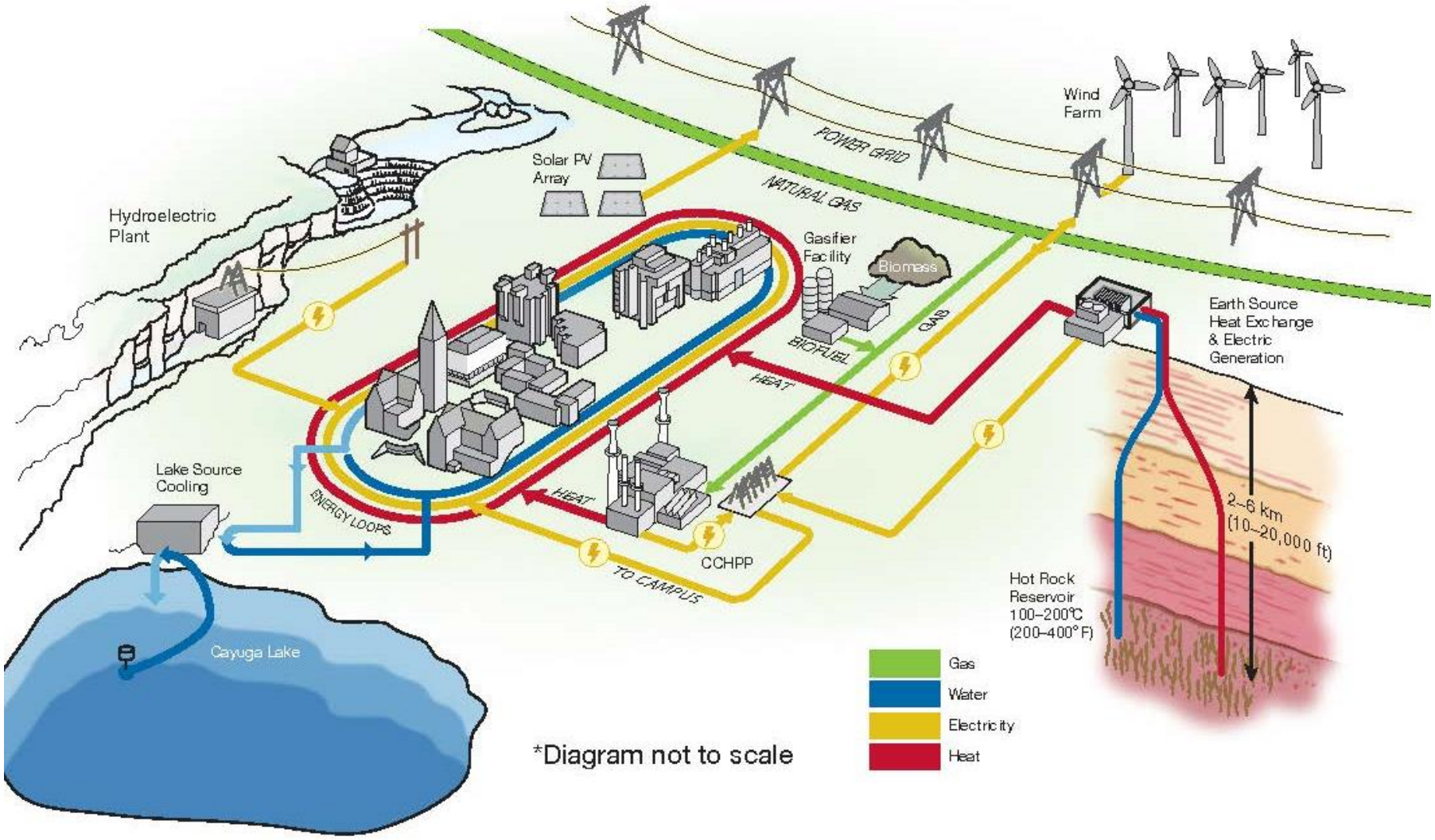
The Future and Energy at Cornell

- ACUPCC signatory, 2050 carbon neutrality goal
- LSC provides 99% of campus cooling
- 1.3 MW hydroplant re-licensing underway
- Energy conservation: aggressive and continuous
  - 25% reduction since 2000 following decades of work before
- Significant steps to increase renewable energy
  - On site solar PV very limited (up to 1 MW potential, currently ~100 kW)
  - Off site solar PV: 4 MWac operating, 6 MWac planned in 2016
  - Off site wind through PPA
  - Continue to purse third party solar, wind and hydro
  - Earth Source Heat (deep engineered geothermal) with peaking biogas

Cornell Energy Systems



Questions?

https://energyandsustainability.fs.cornell.edu/
http://portal.emcs.cornell.edu/

http://www.sustainablecampus.cornell.edu/