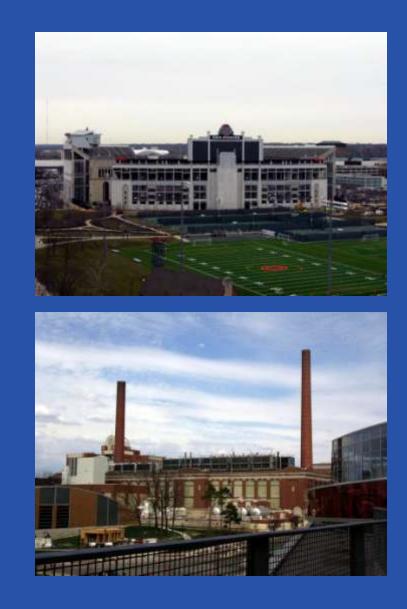
The Ohio State University

Infrastructure Master Plan







What is an Infrastructure Master Plan? Ohio State and the IMP Scope The Architectural Master Plan says we have to serve HOW many buildings!? The game plan

Beyond Business as Usual

The Finale



What is an Infrastructure Master Plan (IMP)?

"The time is now to be proactive"

-Jim Riley, Texas A&M University Executive Director for Utilities & Energy Services An IMP is an easyto-follow road map that provides insight to facilities trying to maintain an efficient. reliable and sustainable utility infrastructure.



Ohio State Background



Founded in 1870

- Located two miles north of downtown Columbus
- Columbus Campus: 1,765 acre site with over 450 buildings
- One of the largest college campuses in the USA in terms of enrollment population
 - Approximately 56,000 students and 26,000 employees
 - 5 Regional Campuses in OH: Lima, Mansfield, Marion, Newark and Wooster



Ohio State Scope Evaluations



Five main areas of campus to evaluate:

- Health Sciences District
- St. John Arena & North Residential District
- Academic Core North
- Herrick Dr. Research Corridor & River Housing
- Athletics District

Systems to be evaluated:

- Steam and Condensate
- Chilled Water
- District Electrical Service
- Natural Gas
- Domestic Water



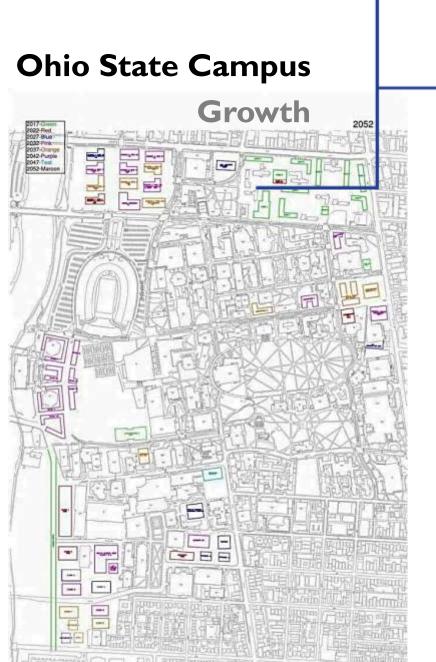
Ohio State Scope Plan Goals



Provide a 40 year road map for the University that includes benefits related to capacity, reliability, efficiency, and emissions by:

- Establishing a baseline and GATHERING DATA
- Reviewing and analyzing production and distribution options with modeling
- Evaluating enhancements such as thermal energy storage (TES), combined heat and power (CHP), geothermal and others deemed appropriate for OSU during the evaluations
- Developing life cycle cost analysis with sensitivity





Aggressive Architectural Master Plan, which serves as the source of developing load growth

22.7M SF becomes 34.9M SF

Nearly 55% Growth

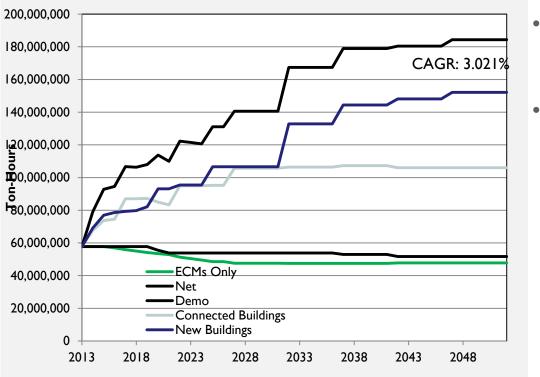
Fiscal Year	Total Square Footage Added
Existing	22,685,282
2017	3,236,549
2022	1,979,600
2032	3,295,297
2052	3,730,724
Total	34,927,452 ft ²



The Campus Load Projections

Development

- New Building 8760 profiles built from University recommended "Go-By" buildings
- Energy Conservation Measures assumed to meet the University's energy efficiency goals



- New Buildings 2.5% reduction from "go-by" every IOYRS.
- Existing Buildings: (now through 2025)

SERVICE	PROJECTED ENERGY SAVINGS
Electrical	16.0%
Chilled Water	10.0%
Steam	24.5%

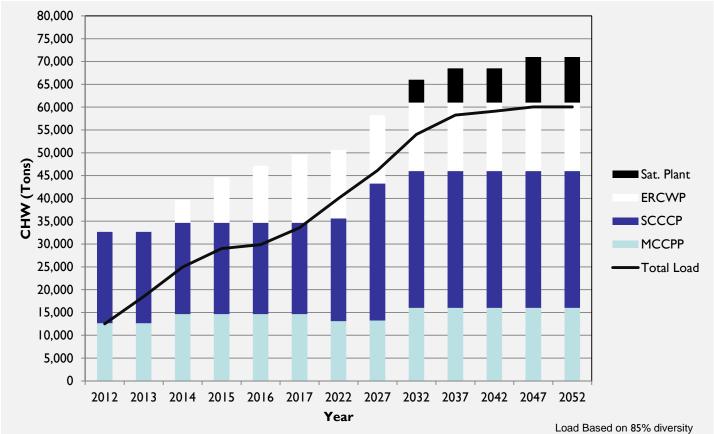


Campus

Chilled Water

Main Campus CHW future load projections versus plant capacity

• A new facility will be required in the South Health Sciences District by 2032.

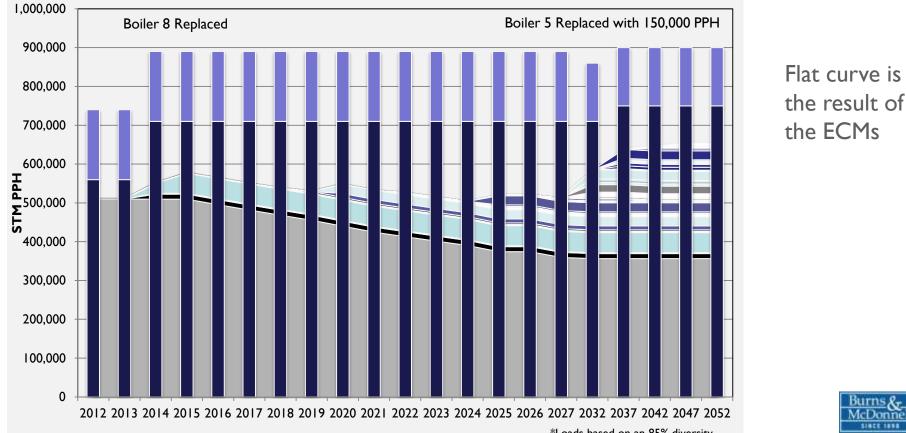






Main Campus STM future load projections versus plant capacity.

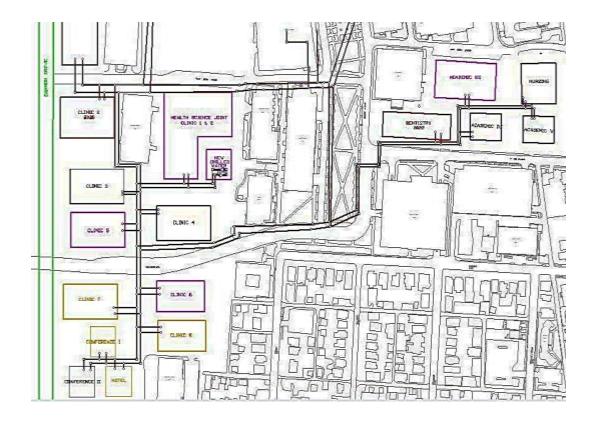
• Coal Boiler 8 will be replaced in 2014 and Boiler 5 will require replacement in 2037.



^{*}Loads based on an 85% diversity factor

Energy

Production Modeling



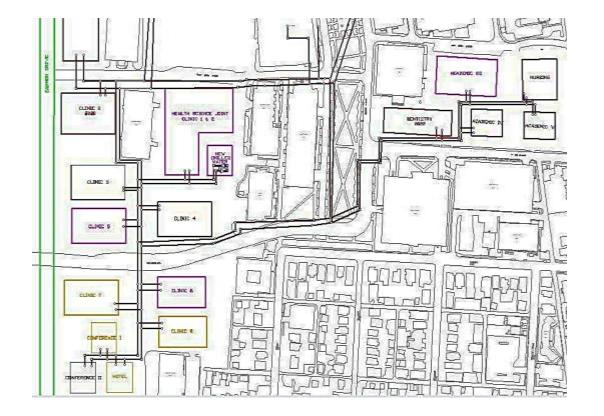
Develop Production Energy Models:

- Models were developed for ELECT and NG existing and projected consumptions
- Basis for LCC energy portion of evaluations and assigned costs developed from actual billing data provided by the University
- Accounted for ECMs and other items such as Ohio State's commitment to higher condensate return percentages.



How Does it Get There?

Distribution Modeling



Expand/Develop Hydraulic Flow Models:

- Models were developed or expanded for CHW, STM, CD, DW, and NG
 - Ohio State actively manages models!
- Expanded to serve future buildings throughout campus
- Alleviated problematic areas such as low pressures, choke points, and high velocities
- Over \$133M in distribution projects planned over 40YRS



Ohio State's Commitment To Distribution



Major Utility Corridors

• STM/CD and CHW will be routed in tunnels

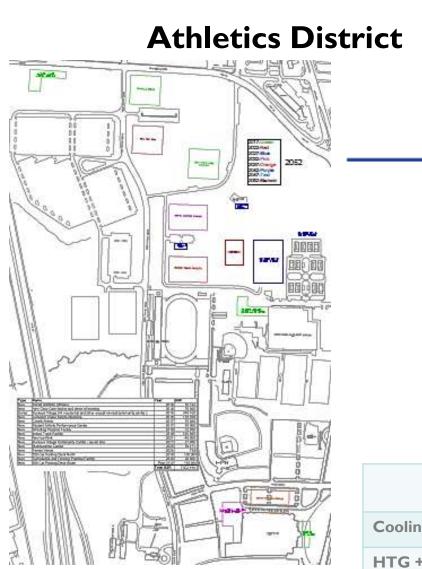
Branch Piping

- STM/CD in removable top concrete trench boxes
- CHW direct buried HDPE

This is the key to long term system resiliency but at a cost that needs to be planned/ budgeted for in an IMP.

 A lack of planning leads to the reaction syndrome where cheap/quick repairs result in system vulnerability





Significant New Growth

- Stand Alone, Tie to Central, or New CUP?
- Low Density (Buildings)
- Low and sporadic loading at athletic type facilities
- LCC not even close
 - Distribution costs could not be overcome despite energy and O&M savings

	Athletics	Academic CN
Cooling (ton/acre)	18	177
HTG + CLG (MBH/acre)	348	5,000



The Game Plan Project Development

Chiller Number	Replacement Capacity (Tons)	Replacement / Addition Year	Cost (2013 Dollars)	Cost Escalated to Install Year	•
		McCracken			
4	2,000	2023 Replacement	\$1,842,543	\$2,417,576	
6	2,000	2029 Replacement	\$1,842,543	\$2,803,647	
7	2,000	2029 Replacement	\$1,842,543	\$2,803,647	
8	2,000	2030 Replacement	\$1,842,543	\$2,873,738	
9	2,000	203 I Replacement	\$1,842,543	\$2,945,582	
10	2,000	203 I Replacement	\$1,842,543	\$2,945,582	
2&3	2,000	2032 Replacement	\$2,120,580	\$3,474,817	
4	2,000	2048 Replacement	\$1,842,543	\$4,482,05 I	
		SCCCP			
9	2,500	2020 New	\$2,640,415	\$3,217,089	
10	2,500	2025 New	\$2,640,415	\$3,639,84I	
H	2,500	2027 New	\$2,640,415	\$3,824,108	
12	2,500	2027 New	\$2,640,415	\$3,824,108	
1	2,500	2037 Replacement	\$2,591,190	\$4,803,92I	
2	2,500	2037 Replacement	\$2,591,190	\$4,803,92I	
3	2,500	2038 Replacement	\$2,591,190	\$4,924,019	
4	2,500	2038 Replacement	\$2,591,190	\$4,924,019	
5	2,500	2038 Replacement	\$2,591,190	\$4,924,019	
6	2,500	2039 Replacement	\$2,591,190	\$5,047,120	
7	2,500	2040 Replacement	\$2,591,190	\$5,173,298	

Business As Usual

- Equipment projected life expectancies used to plan major equipment replacements
- CHW load development along with chiller age tells us when Ohio State's CHW plants should replace or install new chillers
- The University has planned well for their STM growth. Closest production project in 2029
 - Replace existing 600# Boiler 5 with a 200# boiler (no more STM driven chillers.



Enhancement Projects Beyond BAU

Geothermal

- 3 Districts Analyzed
- Feasible project for a single building where central distribution offers many challenges.
- \$5M in annual energy savings

Other Opportunities:

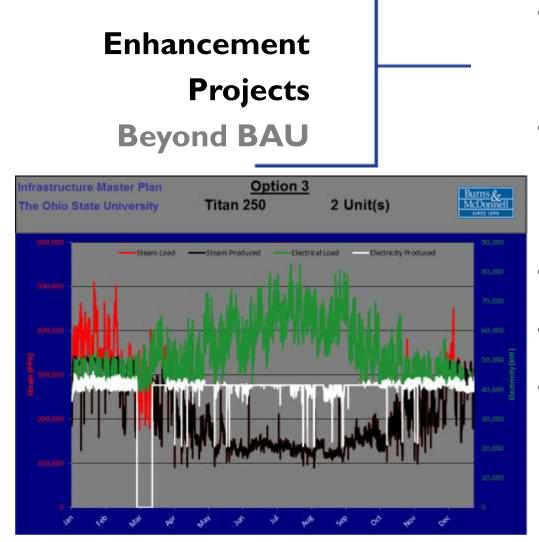
• Thermal Energy Storage

- Potential partial storage option installation in lieu of a new satellite CHW plant (or 3 x 2500T offset).
- 40YR LCC savings of over \$16M

Condensing Economizer

- 40YR LCC savings of \$14M
- Under 5YR payback
- Annual GHG emissions reduction of 10,000Tons
- Not recommended should CHP be implemented as CHP would require a separate stack.





Combined Heat & Power

- Initial screening process of best matching steam and electricity demands resulted in four options.
- Option with highest LCC Savings was two Titan 250s totaling 43.5MW and 326KPPH fired.
 - \$23.7M in 40YR LCC Savings
- \$86.6M all in Project Cost.
- IOYR simple payback
- CO2 Reduction 173M LBs (seen by utility). SB315 incentives from utility.
 - Permitting is a long process



The Finale Planning Roadmap

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40YR Roadmap:

- Provides Ohio State with one document for use in their capital planning efforts
- Gantt Chart that includes project start, duration, costs and detailed project descriptions
- Split in near term, mid term, and long term projects
- Near term: \$169M in projects
- Mid term: \$195M in additional projects
- Long term: \$176M in additional projects
- Total over \$541M in projects planned over 40YRS



Questions



The Ohio State University Infrastructure Master Plan



Thanks for Attending. Have a great Day.