

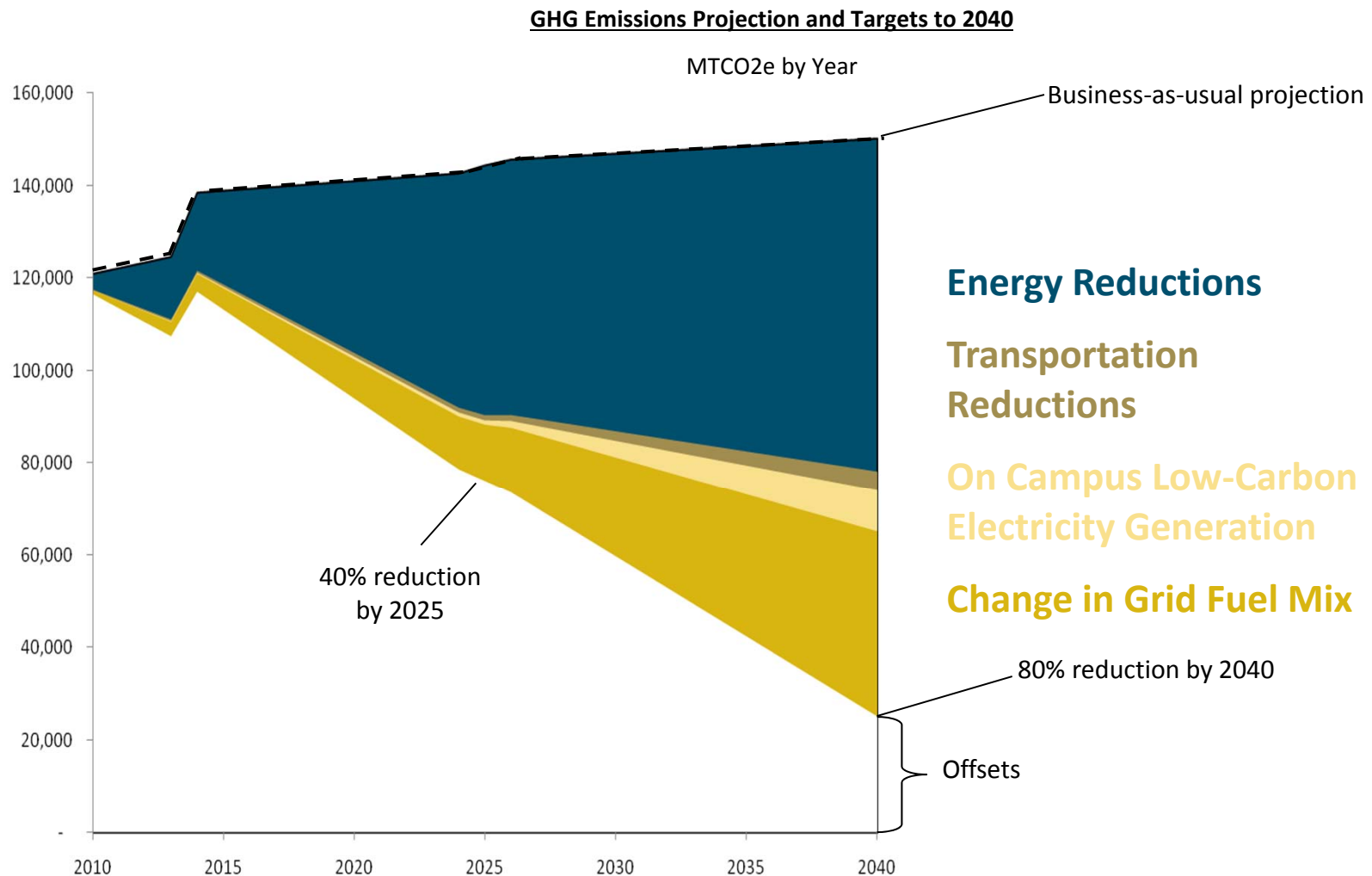
Implementing Climate Action Plan Energy Efficiency Goals at The George Washington University

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Agenda

- Climate Action Plan (CAP) Goals
- Eco-Building Program (EBP)
- Gelman Library and Neighboring Buildings
 - Scope of 2nd Floor Renovation Project
 - Scope of Added EBP Projects
- Project Execution and Results
- Conclusions and Recommendations

Climate Action Plan Goals



Eco-Building Program

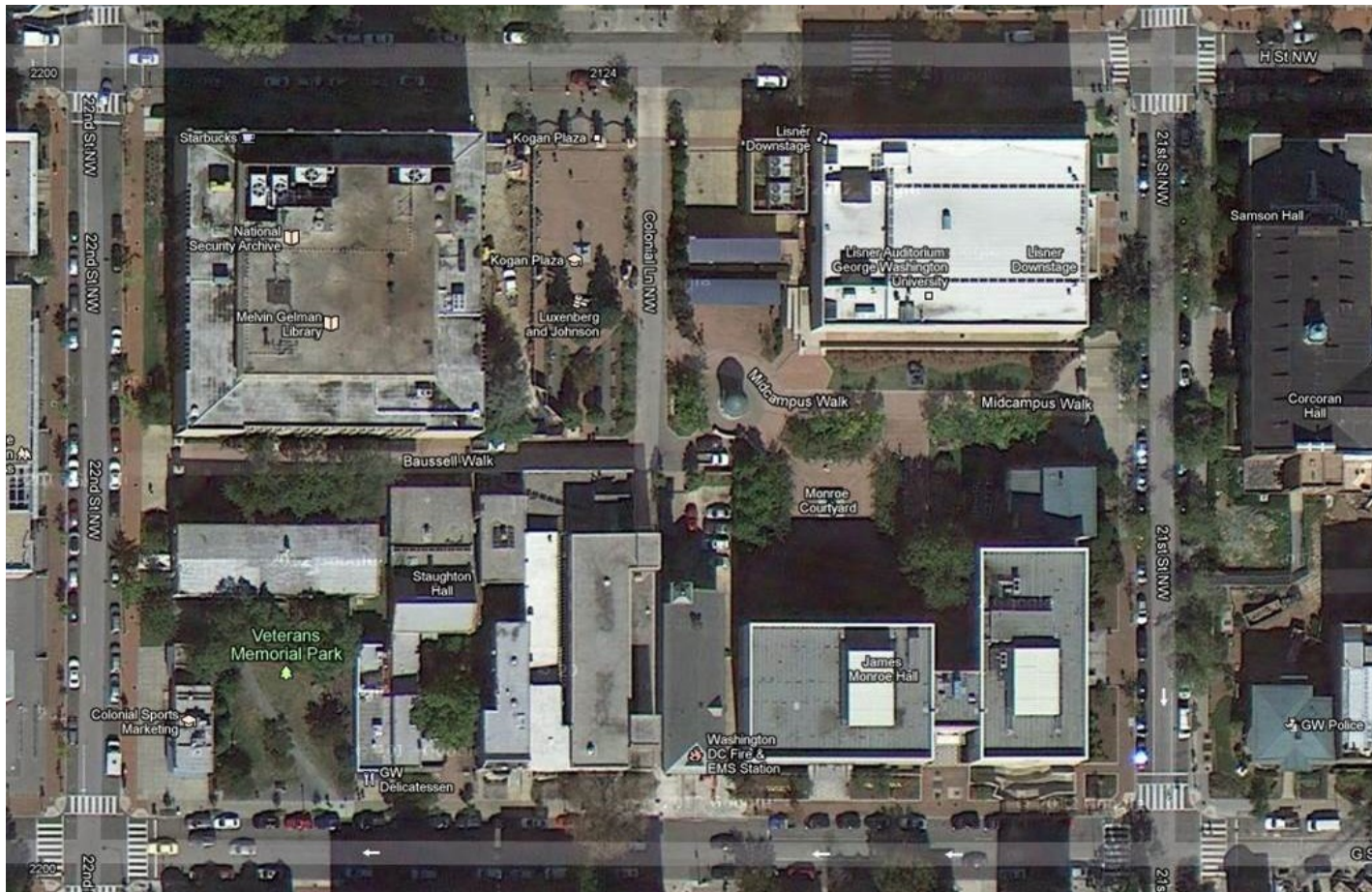
- Perform energy and water saving projects to reduce environmental impact and GHG emissions
- Self-managed energy savings performance contract (ESPC) style project
- Modernize HVAC and controls equipment, particularly where planned capital improvement projects were not HVAC focused
- Add utility meter pulse counters or submeters to verify results, and kiosks to share results with campus community

Gelman Library

- Opened in 1973, it normally operates 24/7/365
- Currently 245,953 sq. ft., with eight floors and a mechanical penthouse
- The boilers heat an additional 219,040 sq. ft. in ten neighboring buildings



Gelman Block Plan View



2nd Floor Renovation

- Occurred May 2012 to August 2013, with limited work and commissioning extending into early 2014
- All floors except 2nd floor remained occupied
- Relocate entrance from North to East side
- Renovate 2nd floor and part of 1st floor to relocate main circulation desk area to 2nd floor
- Replace HVAC system for 2nd floor with chilled beams and the associated penthouse AHU
- Replace some lighting with LEDs
- Remove exterior loading dock and rebuild an interior receiving area, adding 1,665 sq. ft.
- Renovate four elevators and their controls

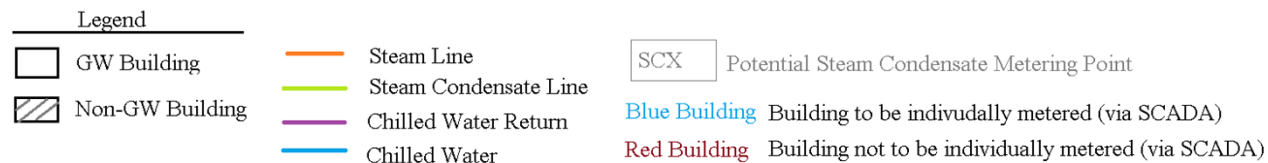
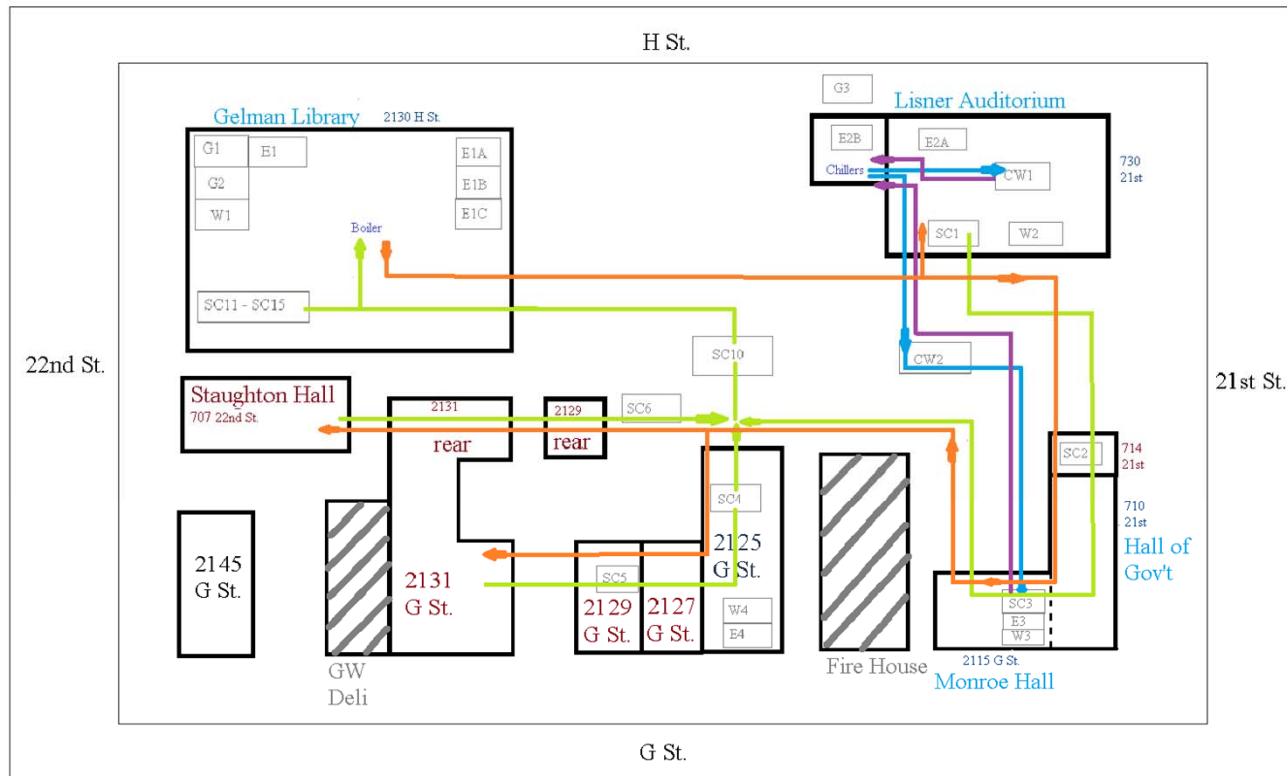
2nd Floor Renovation



Added Eco-Building Program Projects

- Replace three more AHUs and rebuild another AHU
- Change all AHUs from constant to variable speed
- Add oxygen trim controls to boilers
- Replace two absorption chillers with centrifugal chillers (400 tons each; R-134a) and upgrade electrical switchgear and motor control center
- Change all water pumps from constant to variable speed
- Add occupancy sensors and replace T8 lighting/ballasts
- Add SCADA overlay to controls and additional metering

Utility Line and Meter Diagram



Utility Metering Scheme

	Gelman Library	Lisner Auditorium	Monroe Hall & Hall of Government	2125 G St	SW Complex Buildings
Total Electric (kWh)	E1	E2A + CHW _L	E3 + CHW _H	E4	E5
Total Gas (kBTU)	$G1 * \left(\frac{SF_G}{Total\ Steam} \right)$	$G1 * \left(\frac{SF_L}{Total\ Steam} \right) + G2$	$G1 * \left(\frac{SF_H}{Total\ Steam} \right)$	$G1 * \left(\frac{SF_2}{Total\ Steam} \right)$	$G1 * \left(\frac{SF_0}{Total\ Steam} \right) + G5$
Chiller Electrical (kWh)	E1A	E2B			
Other Electrical Loads (kWh)	E1B and 1-(E1A+E1B)				

Project Participants

Role	2 nd Floor Renovation	Added Eco-Building Program Projects	
		AHU Rebuild-Replacement	Chiller Replacement
GW Project Manager	Josh Thigpen	Bob Oakley	Bob Oakley
Architect	Cox Graae and Spack	None	None
Engineer	Potomac Energy Group	Potomac Energy Group	GPI
General Contractor	Donohoe	Donohoe	Tishman
Mechanical Subcontractor(s)	Shapiro and Duncan	Shapiro and Duncan, ACT, and Capital Boiler Works	WE Bowers
Controls Subcontractor	JCI	JCI	JCI
SCADA Subcontractor	Schneider Electric	Schneider Electric	Schneider Electric

- Many people were involved, and they worked well together.
- The prevailing attitude was “what can I do to help” today?

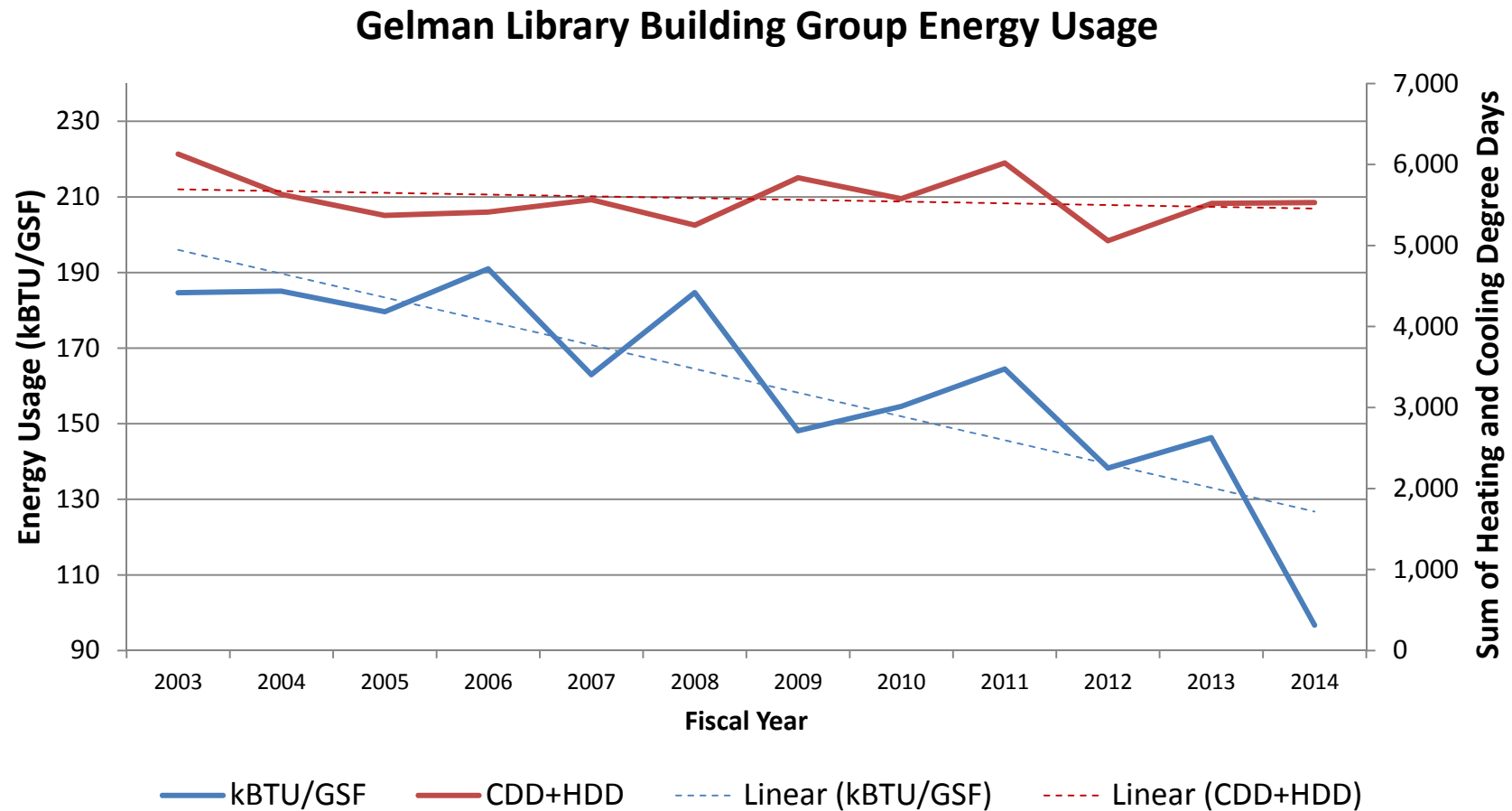
Unanticipated Obstacles Overcome

- Removing and replacing a pre-cast wall.
- A chiller failure, leading to use of a temporary one setup within 24 hours.
- Building and using a temporary AHU.
- An archway gate entrance was removed, twice.
- Rented copper electrical cables were stolen.
- A leaky condensate collection tank was replaced.
- A set of condensate submeters was replaced.

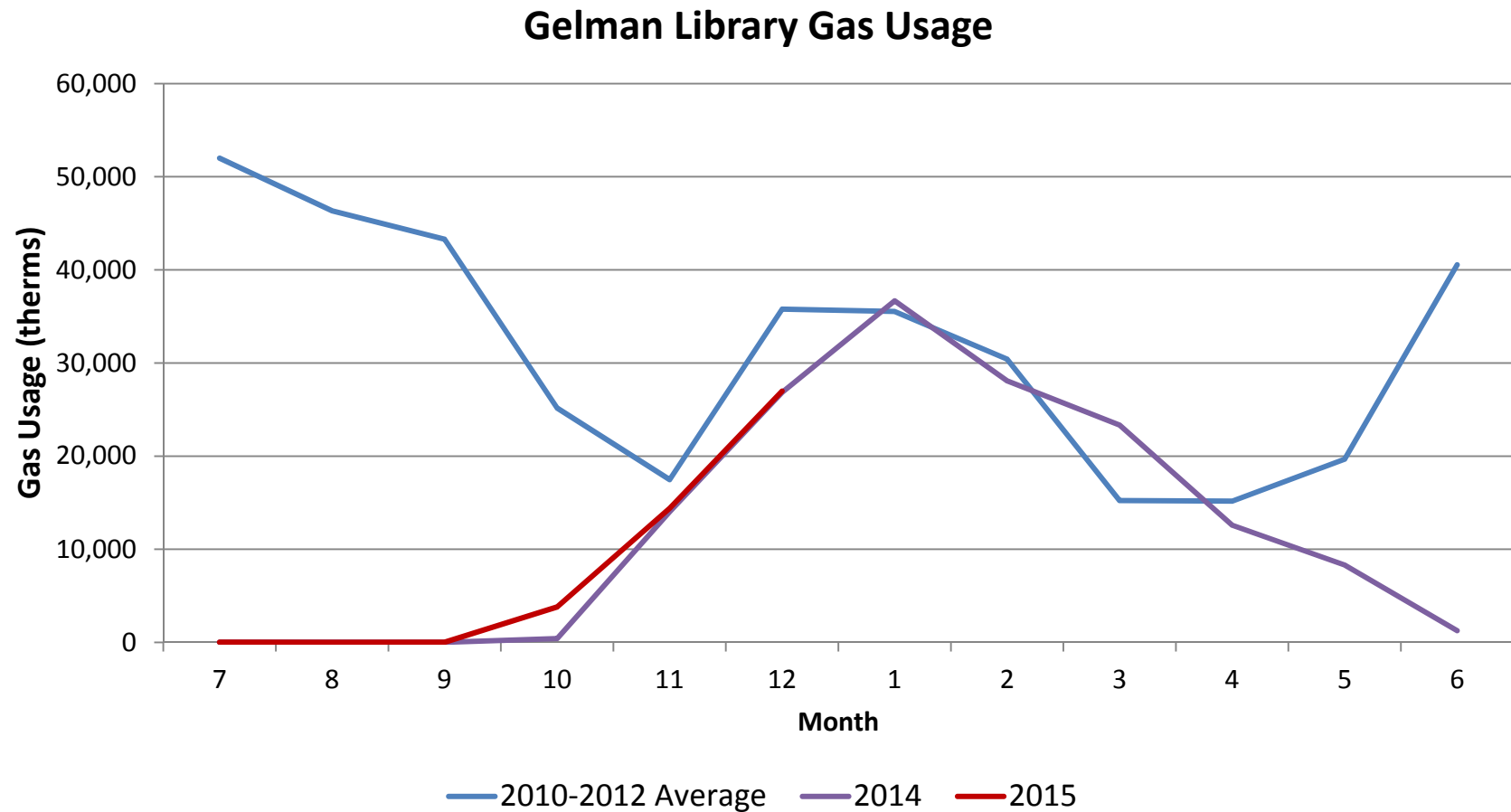
Gelman Library Penthouse



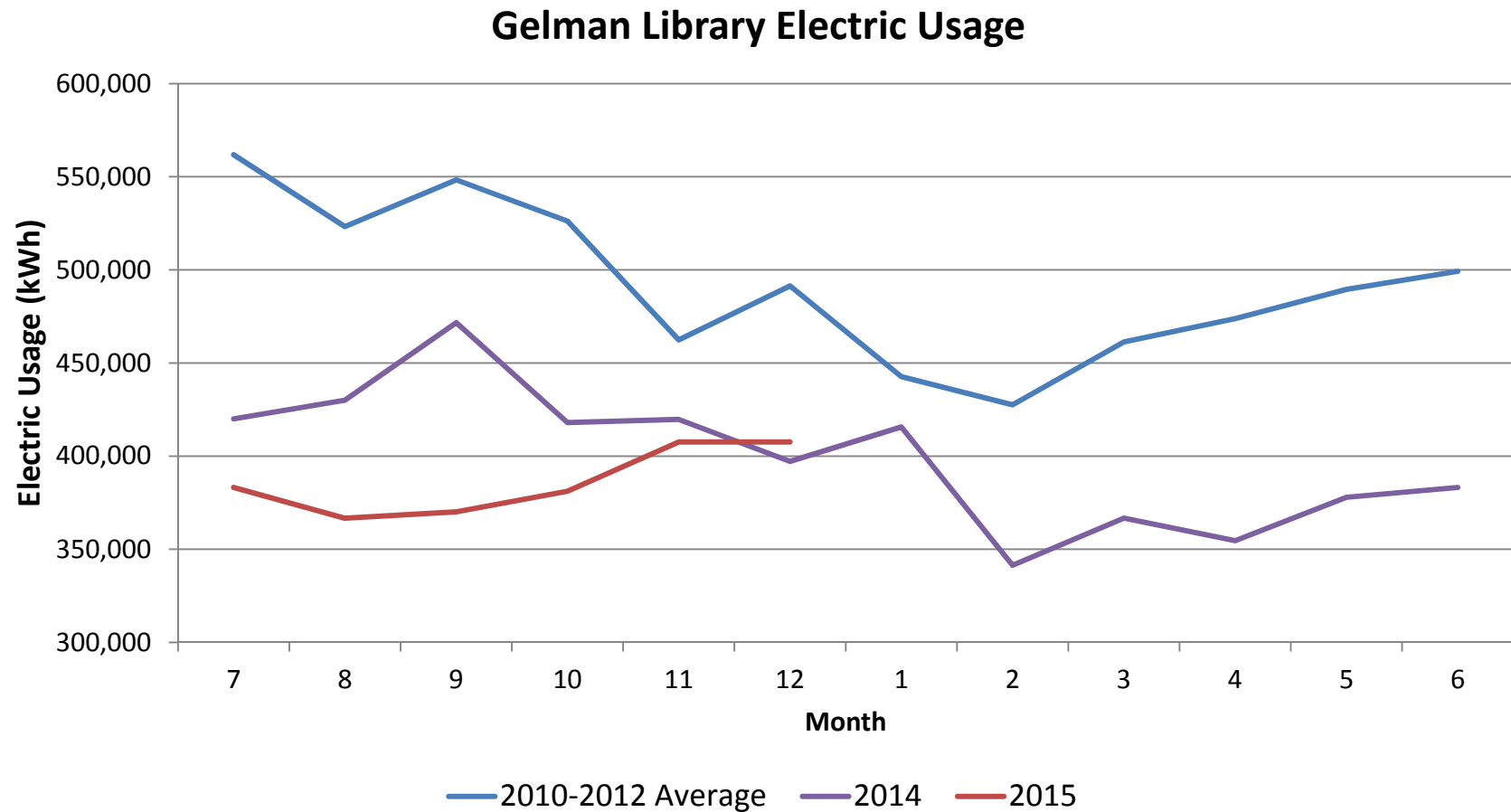
Baseline and Results



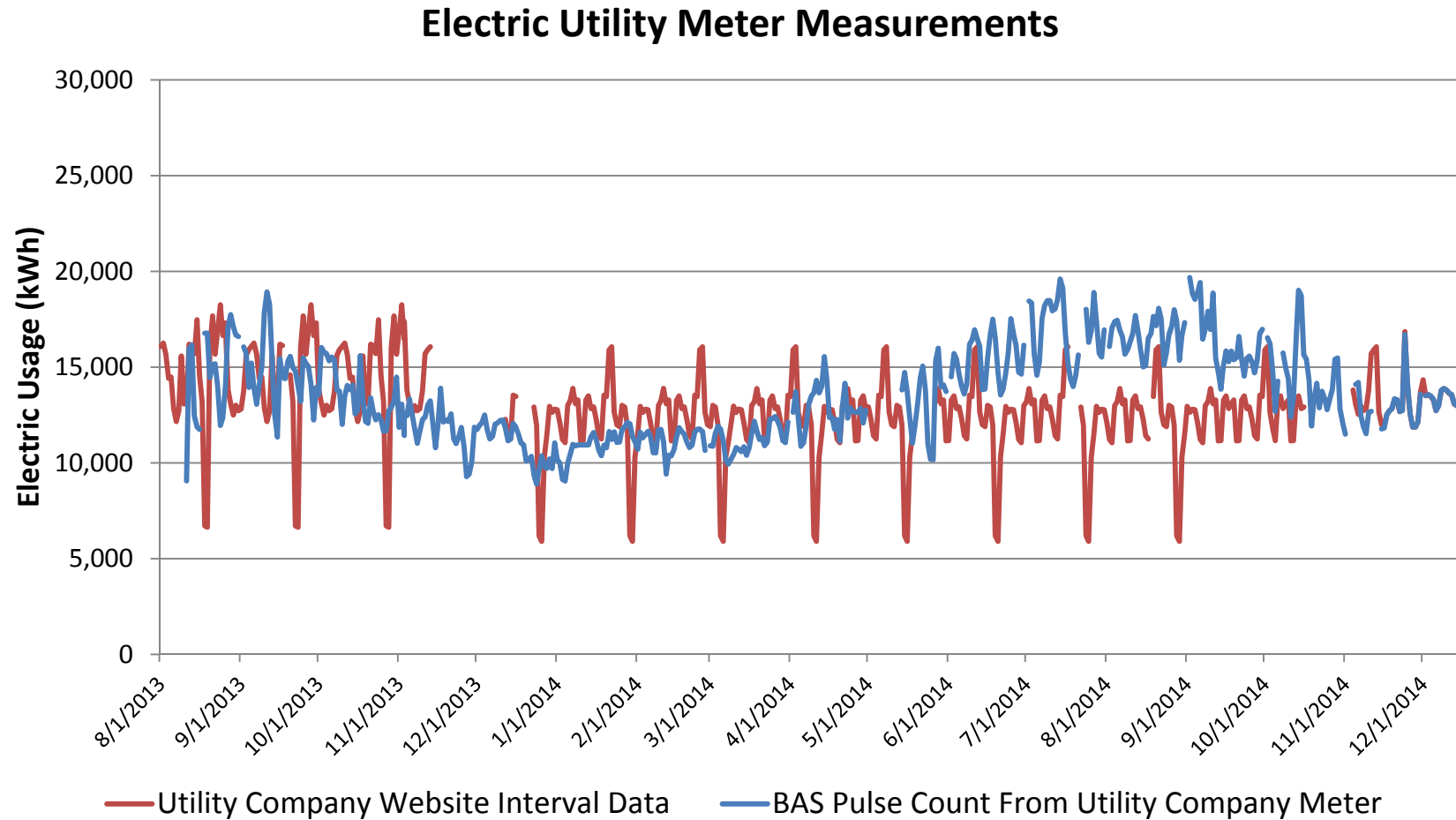
Baseline and Results



Baseline and Results

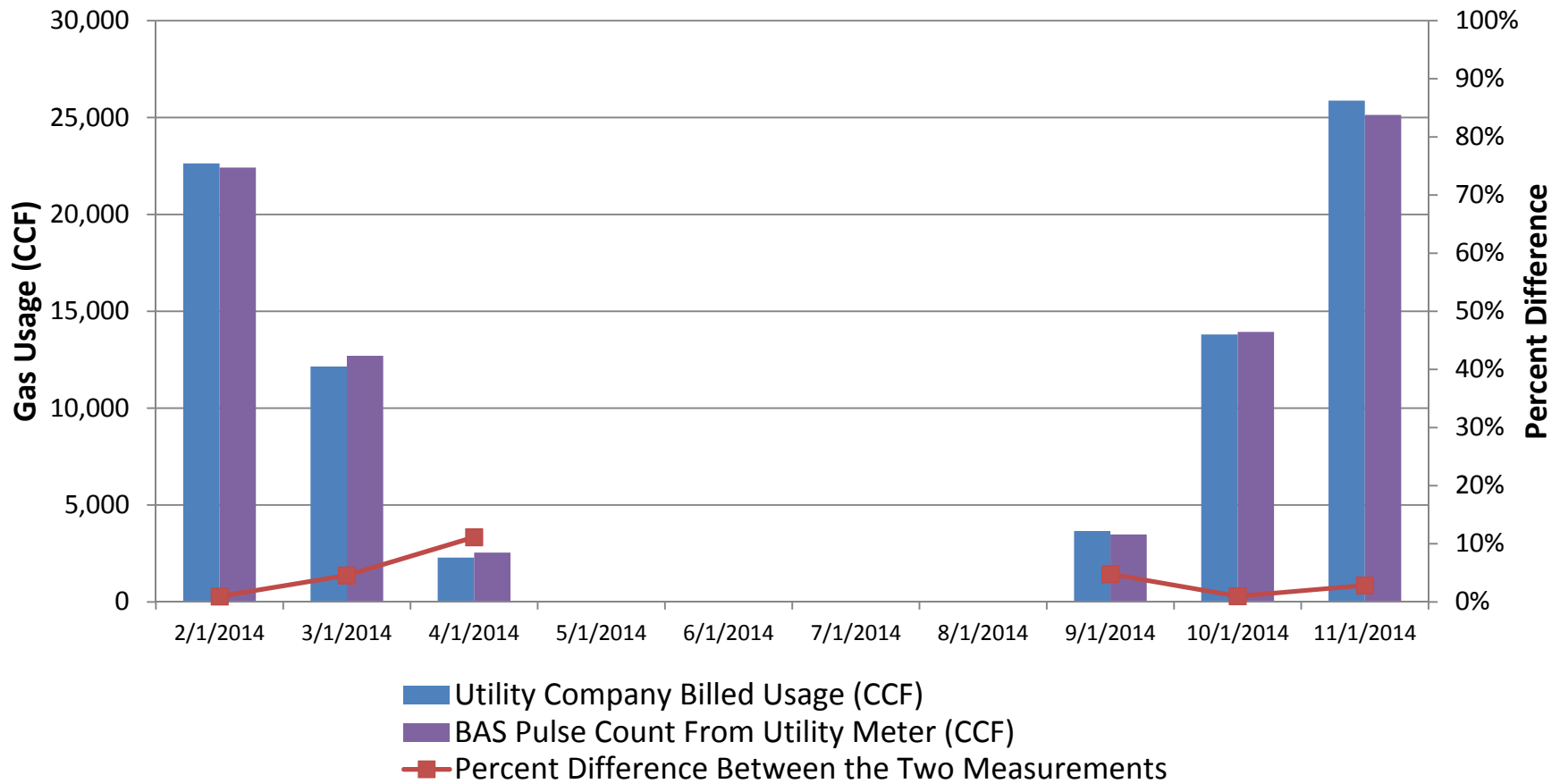


Data Source Differences

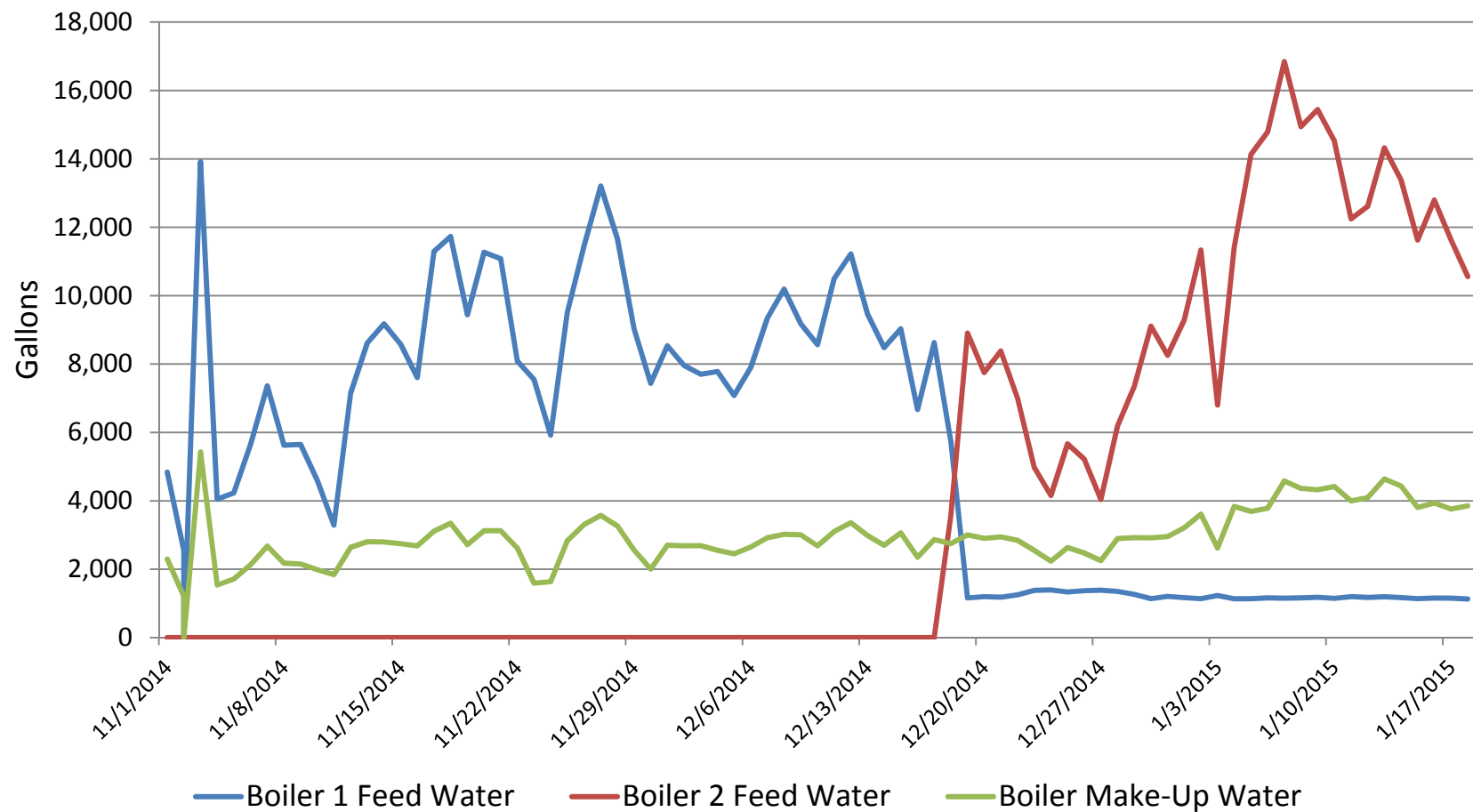


Data Source Differences

Gas Utility Meter Measurements



Boiler Feed Water and Make-Up



Conclusions

- Energy usage intensity (EUI) for entire block of buildings decreased from 152 to 97 kBTU/SF.
- Energy savings for entire block was 36% during first year after construction, and it was higher for library.
- Energy savings for entire block were primarily from reduced gas usage (~86%) rather than electric (~14%).
- Library water usage also decreased about 25% during first year after construction.
- There is much to be learned about utility usage and operating practices from analyzing building automation system historian data and trends.

Recommendations for Others Interested in Replicating This

- Use a project team with a “can do” attitude.
- Use a multi-disciplinary, multi-shop team.
- Be conservative with energy and water savings projections, and deliver what you promise.
- If measurement and verification are needed, consider installing duplicate meters or submeters without making the meter scheme too complicated.