Data Center Modeling Demonstration

You CAN Manage What You MODEL

Lawrence Livermore National Laboratory (LLNL)

Silicon Valley Leadership Group

5th Annual Data Center Efficiency Summit

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Introduction

- Purpose
  - LLNL Data Center Master Plan
  - Key Competency – Benchmarking/Modeling
- Goals – Improve Overall Operations of B112 Enterprise Data Center
  - Evaluate optimization scenarios
  - Investigate efficiency improvements
    - Improve operational set point
    - Make building improvements
    - Identify consolidation
  - Present Results at SVLG
  - Develop whitepaper
- Team: LLNL, LBNL, Syska Hennessy, Romonet, California Energy Commission, DOE
- Timeline: August-October 2012
- Tool: Romonet Modeling Software

Master Plan Charter:
Develop projects to improve optimization of LLNL's data centers and reduce energy intensity

Data Center Site

Computer Room

UPS Room

Chiller Room

Data Center Modeling Demonstration

- Introduction
- Model Construction
- Evaluate Model Accuracy
- Use Model to Forecast Efficiency
- Observations
- Plans

LLNL Data Center Overview

- Building Information
  - Original Construction 1965, Retrofitted in 2007
  - 15,500 Sqft of Raised Floor
  - 14,000 Sqft of Infrastructure Space
- Electrical System
  - 2N UPS Systems (1,000 kVA Modules)
  - 2N & N Critical Power Distribution
  - 20 – PDUs on the Raised Floor

IT Loads	2N (kW)	N (kW)
Capacity	630	480
Current Load	325	7 (*Aug 2012)

- Mechanical Systems
  - Chilled Water System
  - N+1 Design
  - CRAH and AHU feeding under floor – Constant Speed Fans

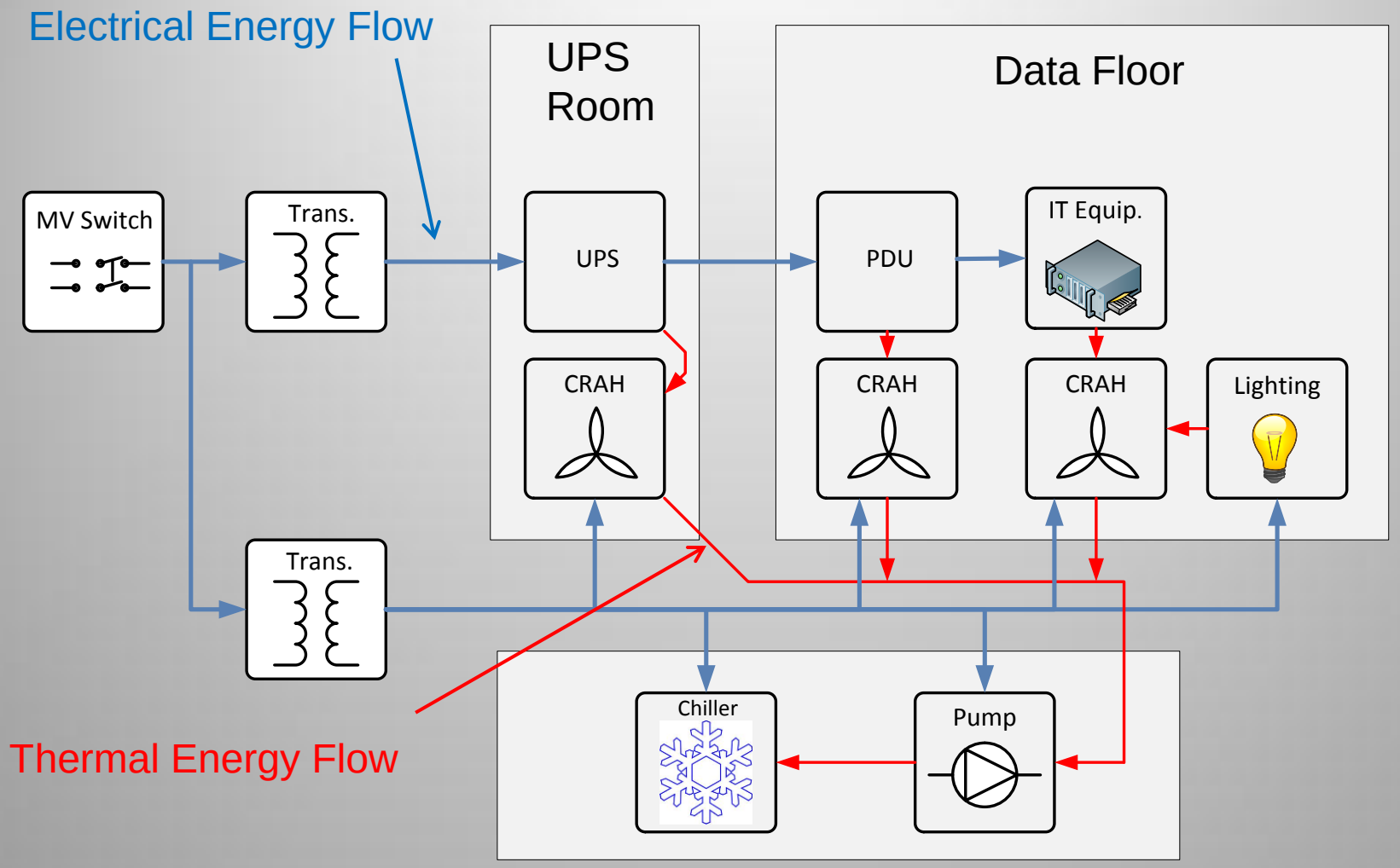
* value during site visit, IT equipment load currently higher and expanding

Project Process - What We Did

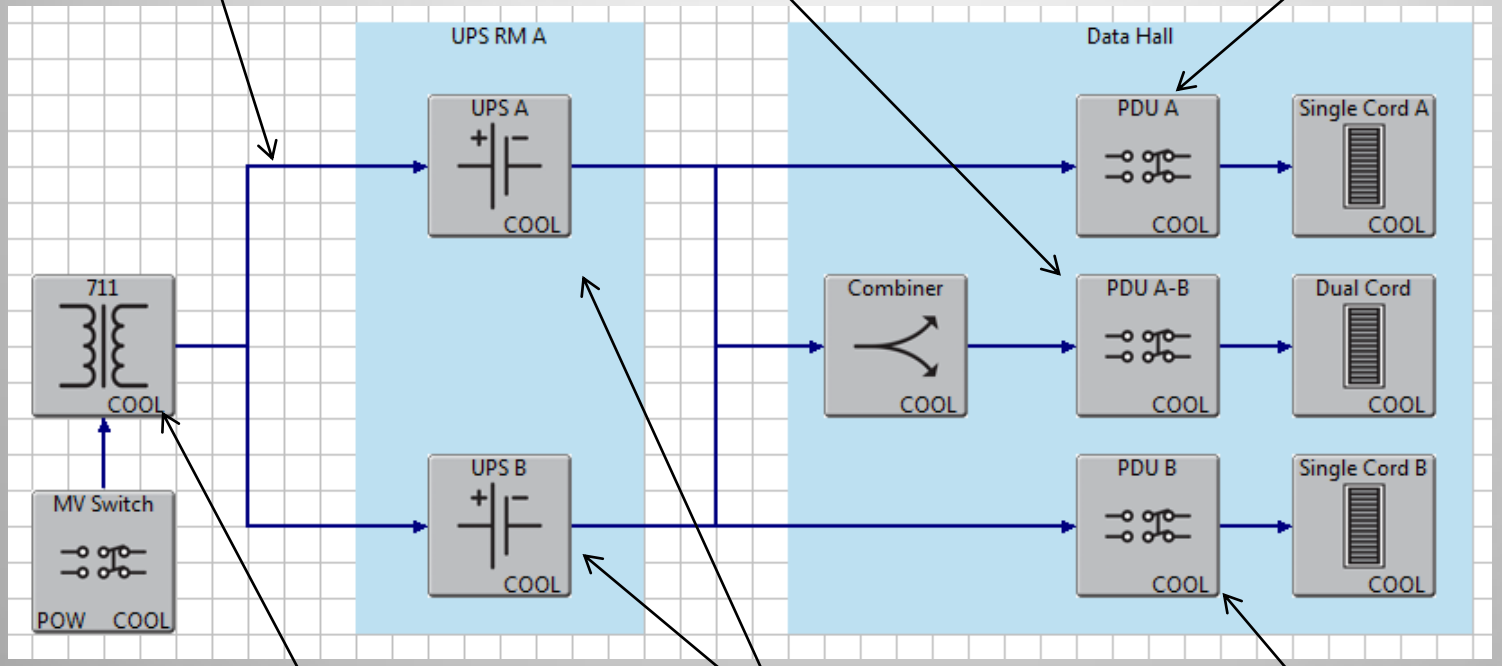
- Survey site
- Create baseline model
- Compare baseline model results to

  meter readings (actual IT power was the model input)
- Calibrate model (adjust component performance toward actual)
- Model with actual IT loads to investigate accuracy
- Model “What If” scenarios

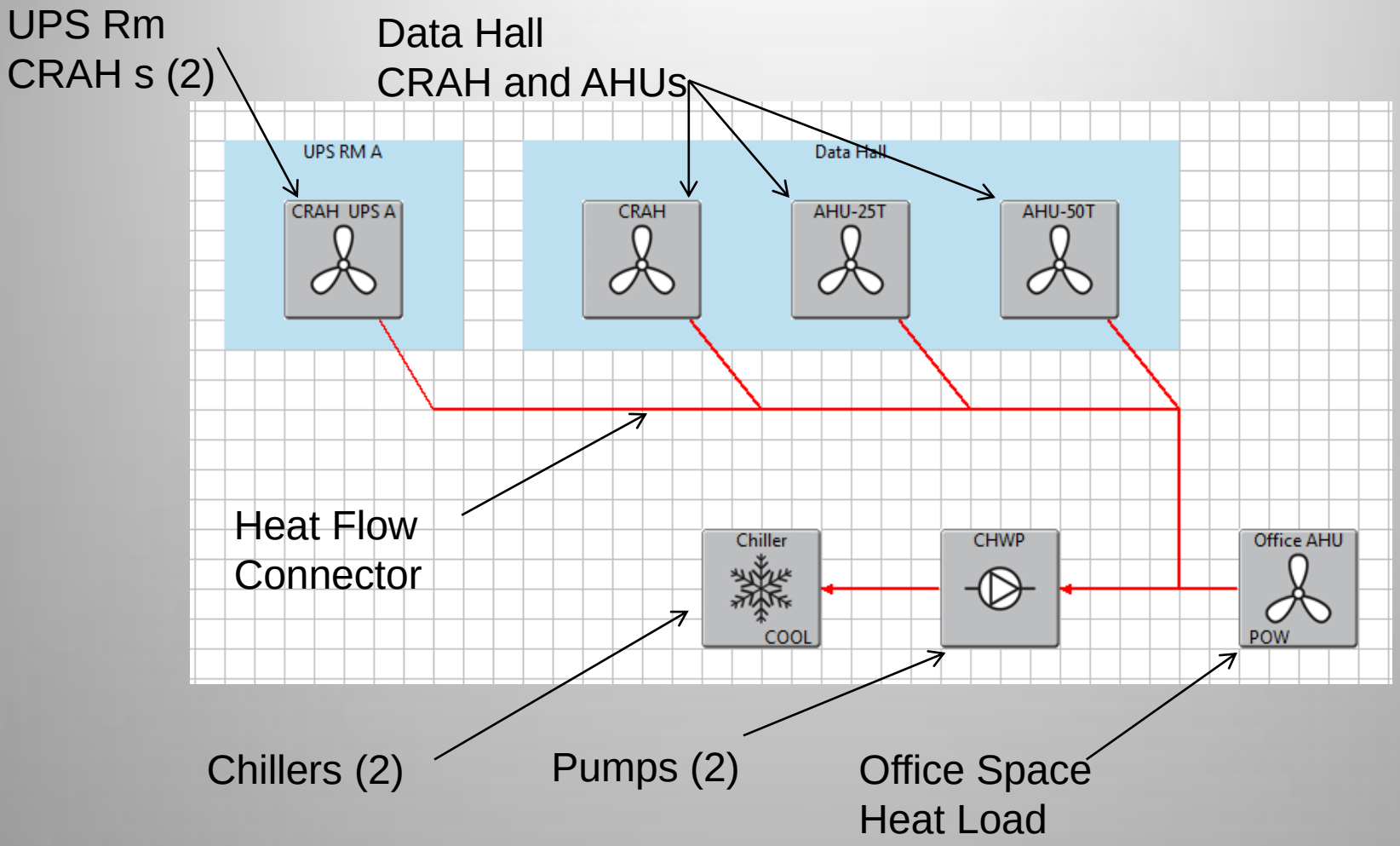
Example: Model Construction



Model Construction – Critical Electrical Dist.



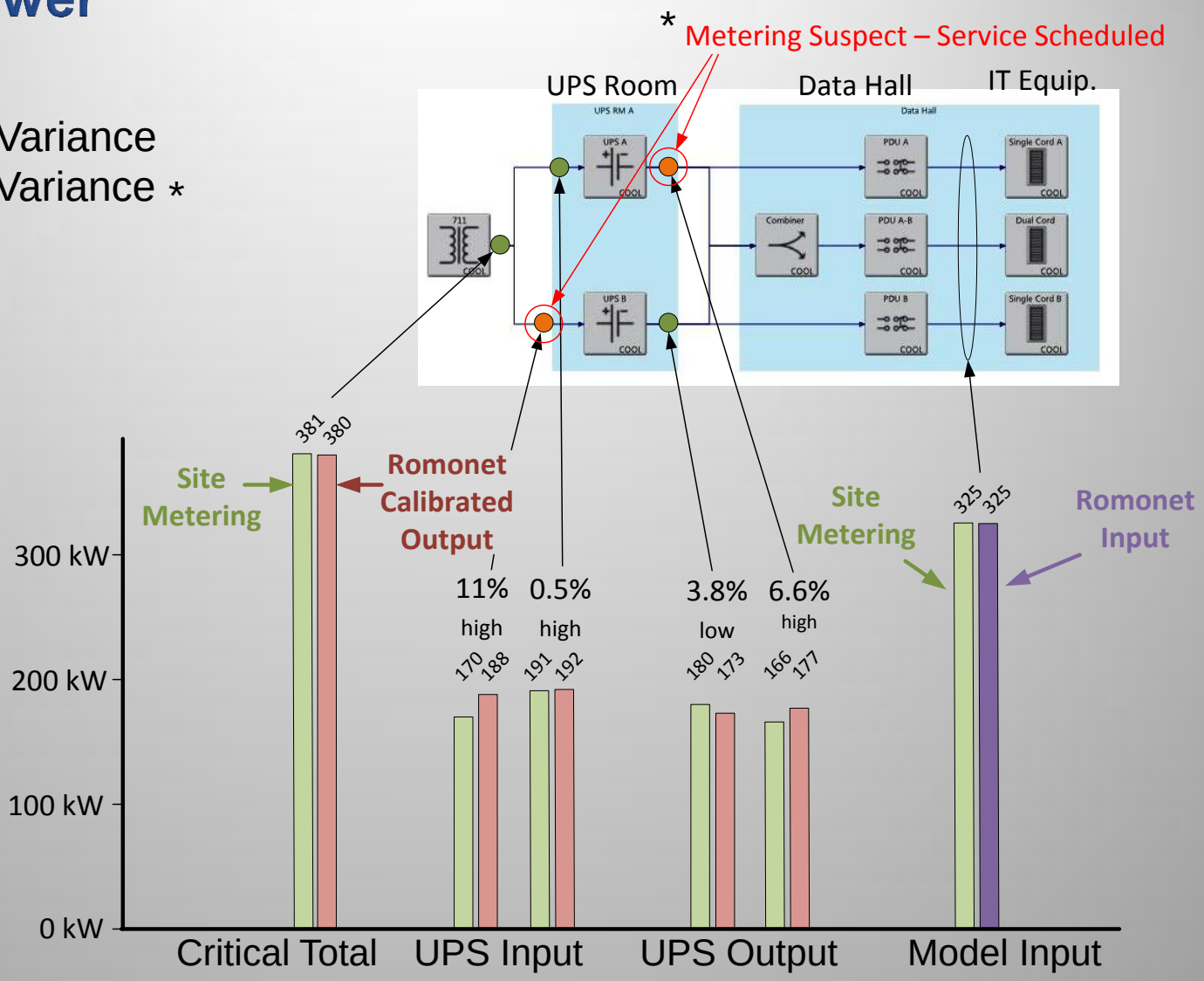
Model Construction - Mechanical



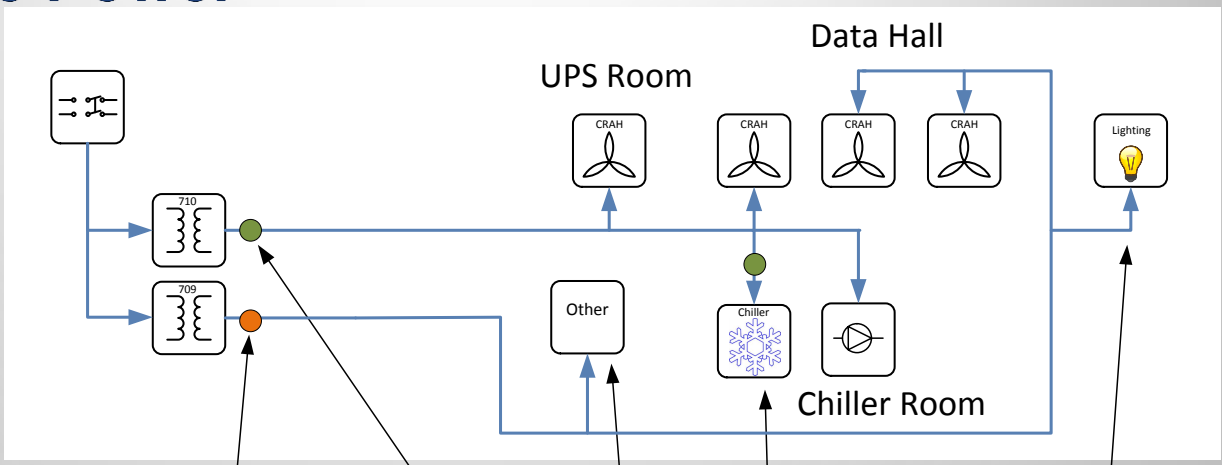
Comparison: Metering vs. Calibrated Romonet Results Critical Power

<= 5% Variance

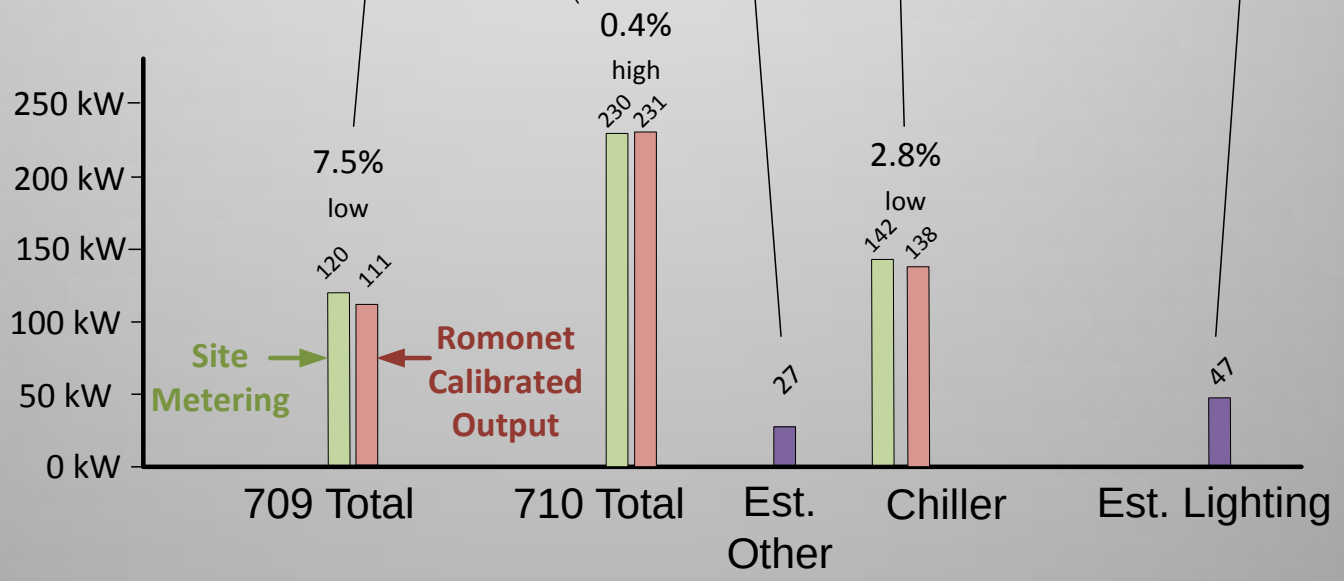
> 5% Variance *



Comparison: Metering vs. Calibrated Romonet Results Infrastructure Power



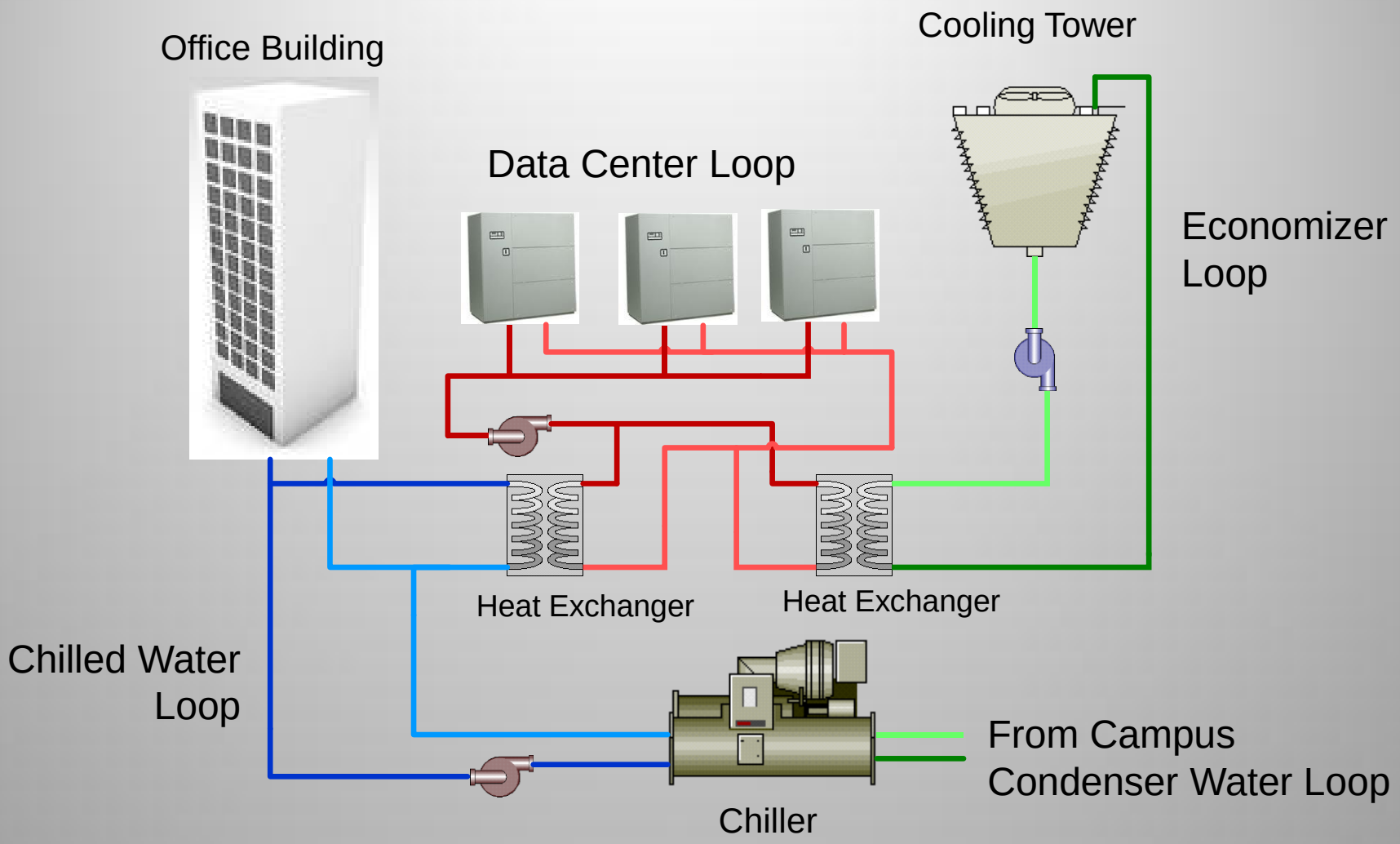
- <= 5% Variance
- > 5% Variance



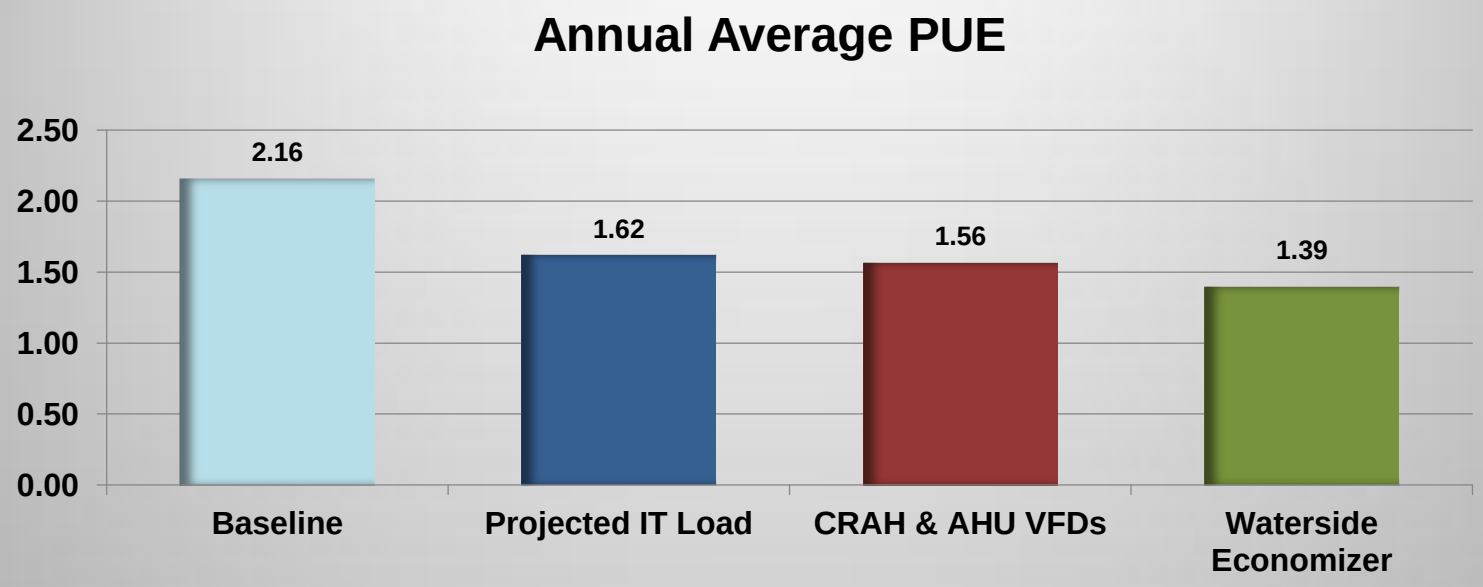
Investigate “What If” Using Romonet

- Increasing IT Load
  - Simulate IT load increase (332 kW to 1,110 kW)
- Adding CRAH / AHU Fan Speed Controls
- Adding Waterside Economizer
  - Dedicated Data Center Secondary Loop with elevated CHW Temperatures
  - Dedicated Data Center Cooling Tower

Waterside Economizer Flow Diagram



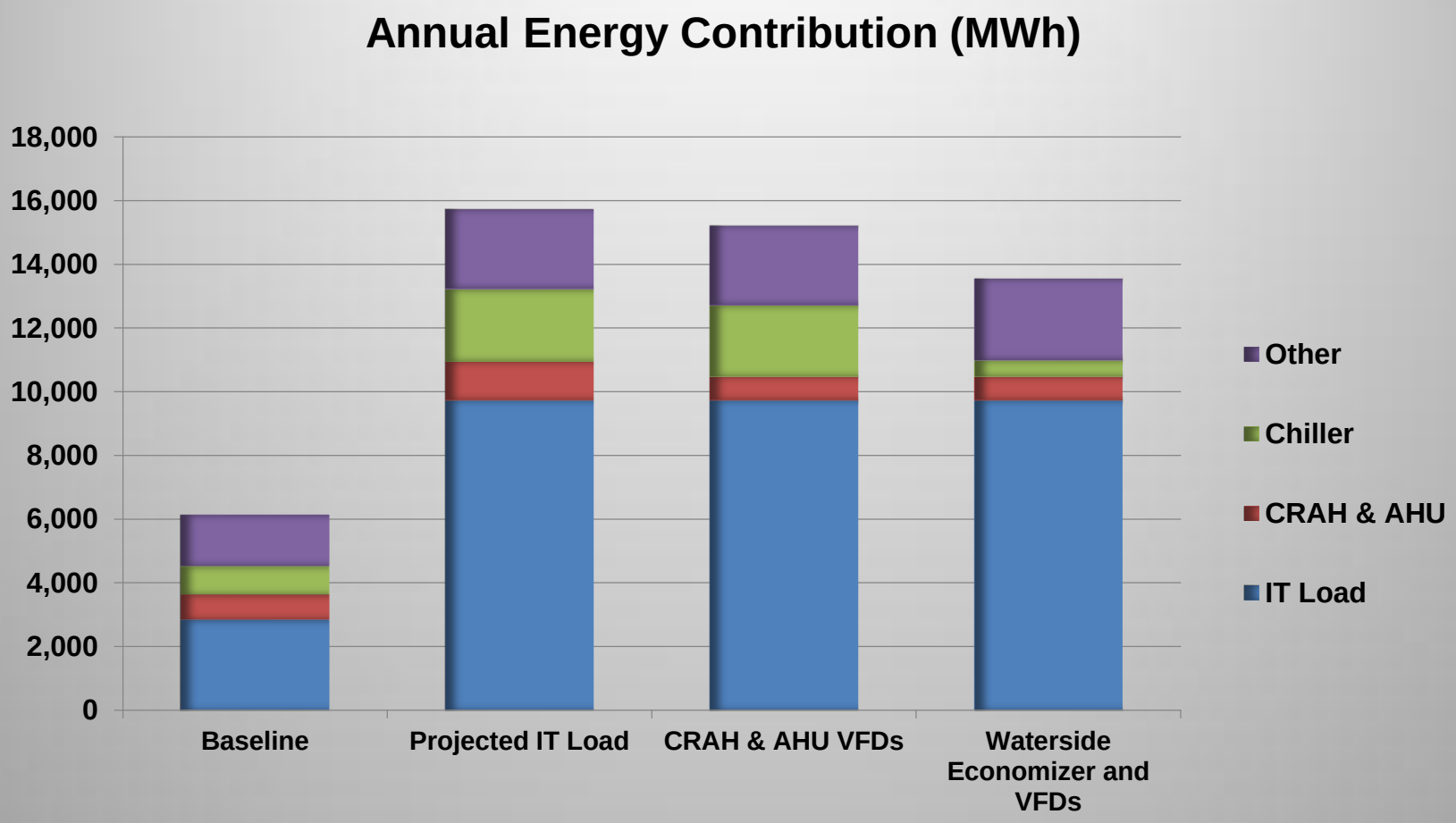
“What If” Analysis Comparison



Not Included:

- Boiler Room (humidification) Gas Energy (missing data, unable to reconcile)
- Gen. Set Testing (gen. sets not installed at this site)

“What If” Analysis Comparison



“What If” Analysis Comparison

	Infrastructure Project Capital Expenditure	Annual Energy Cost	Simple Pay Back
Baseline	$ 0	$ 400,000	
Projected IT Load	$ 0	$ 1,020,000	
CRAH & AHU VFDs	$ 161,000	$ 990,000	3 years
Waterside Economizer and VFDs	$ 1,700,000	$ 864,000	8 years

Energy cost $0.065/kWh

Project Effort to Date
(person days)

		LLNL	Syska
Model Development	Data Collection: Paper Survey	1	
	Site Visit #1	1	1
	Develop Base Model		3
Model Calibration	Site Visit #2	1	1
	Analysis & Model Adjustment		3
Sub-Total		3	8
Model Change and Run "What If"	CRAH & AHU Fan Speed Control	.5	1
	Waterside Economizer	.5	3
Sub-Total		1	4
Sub-Total		*4*	*12*
Total			*16*

Modeler Experience: Subject Expert, Modeling Training Complete

What Did We Learn?

- Labor Required
  - Syska, LLNL, LBNL, Romonet
- Metering Issues
  - Slight variance in total metering
  - Variances encountered in UPS metering
    - Need to address with vendor during next maintenance cycle
- Office Tower Load (temporary Btu metering)
- Site Cooling Tower Water (not included in PUE)
- Chiller Performance Information
  - Not separately metered
  - Temporary load logging installed
  - Coordination required with rotation sequence of chillers

Conclusions / What Next?

- Accuracy- Testing was limited (one set of conditions): model accuracy deemed sufficient for “What If” investigation.
- The project uncovered a number of unknown metering issues.
- Adding IT load will provide the best ROI, in comparison other projects investigated will provide a much longer payback period.
- Work with customers to expand humidity level requirements. (Turn off or reduce boiler function)

Questions – LLNL Data Center Master Plan Team

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