Managing Data Centers in Multi-Use Environments

May 28, 2015

Today's Presenters

- Jordon Dagg, Schneider Electric
- Steve Hammond, National Renewable Energy Laboratory
- Bill (William) Lakos, Michigan State University

Jordon Dagg, Schneider Electric

DOE Better Buildings Summit

Data Centers in Multi Use Buildings

Jordon Dagg, IT Director
North America Region

May 28th, 2015

Schneider Electric

€ 24.9B
Global Sales

43%
of revenue in new economies

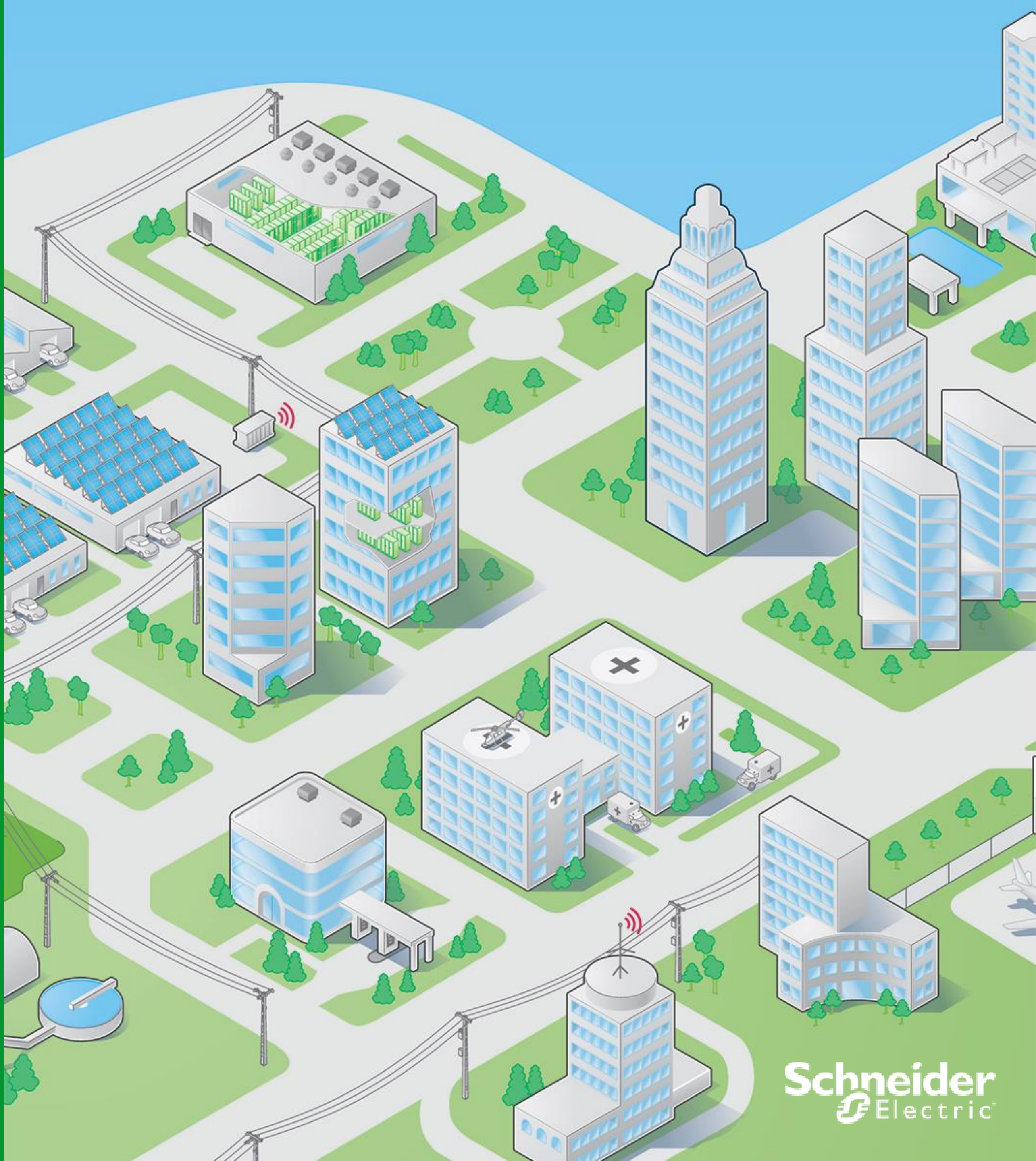
170 000+
employees in 100+ countries

North America

2013:	US$6.22bn
2003:	US$2.58bn
	29,300
	46

Our Approach

1) Establish a Baseline
2) Transition
3) Transformation
4) Results
5) What’s Next



Step 1: Establish Baseline

Baseline Power Consumption

Baseline (2012)	IT Equip (kW)	DC Facilities (kW)	Total (kW)
STL DC	111	77	188
Lexington DC	89	150	239
72 Distributed Sites	231	394	625
	431	621	1052

Step 2: Transition

Baseline:

- > **Lexington Data Center**
  - > Built in the 1980s
  - > Purposely built for availability not efficiency
  - > Multi-tenant outsourced DC
  - > Perimeter cooling, raised floor plenum
  - > 2N Legacy UPS, CRAC, Power Distribution

- > Older and less efficient IT Equipment
  - > Mainframe technology
  - > Tape Library Unit
  - > Minimal Virtualization and older Wintel Servers

Target:

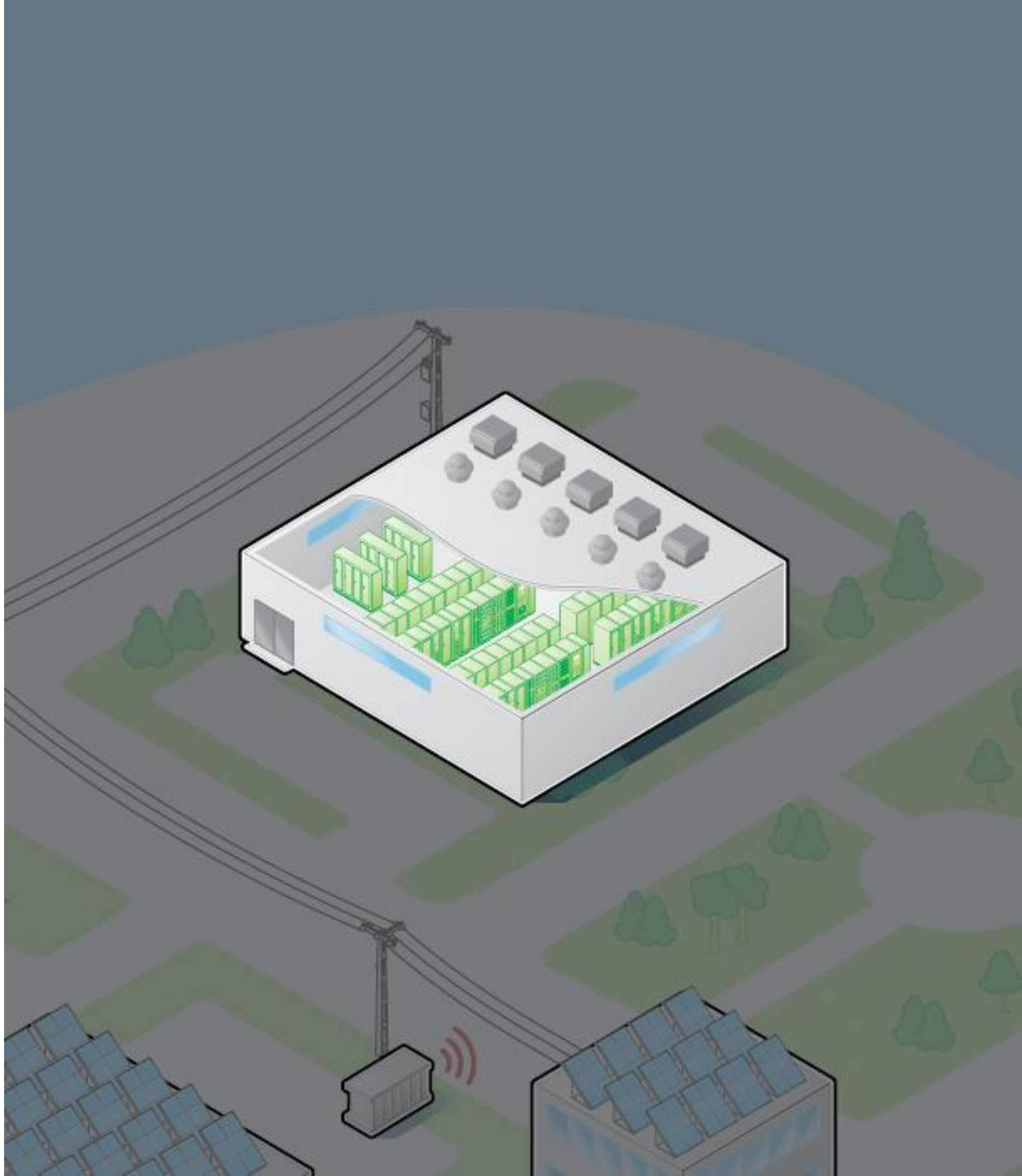
- > **St. Louis Data Center**
  - Schneider Electric Owned DC – Multi Tenant Facility
  - Close coupled cooling (In-Row)
  - Modular High Efficiency UPS units
  - Hot Aisle Containment w/ blanking panels
  - Modular PDUs
  - N+1 CRAC

- > IT Equipment – Technology Refresh
  - Advanced energy efficient IT Infrastructure
  - All new VCE V-Block architecture
  - 80+% Virtualization onto VCE V-Block

Step 2: Transition

Post Transition Power Consumption

Post Transition	IT Equip (kW)	DC Facilities (kW)	Total (kW)
STL DC	160	112	272
Lexington DC	0	0	0
72 Distributed Sites	231	394	625
	391	506	897



Step 3: Transformation

Baseline:

- **Distributed Site Server Rooms**
  - Typical available space in a facility not specifically designed to house IT equipment
  - Facility cooling, split system cooling or none
  - No hot aisle / cold aisle configuration
  - Poor air flow
  - In rack UPS or no UPS on site
- Older and less efficient IT Equipment
  - Minimal Virtualization
  - Older Wintel or Unix Servers

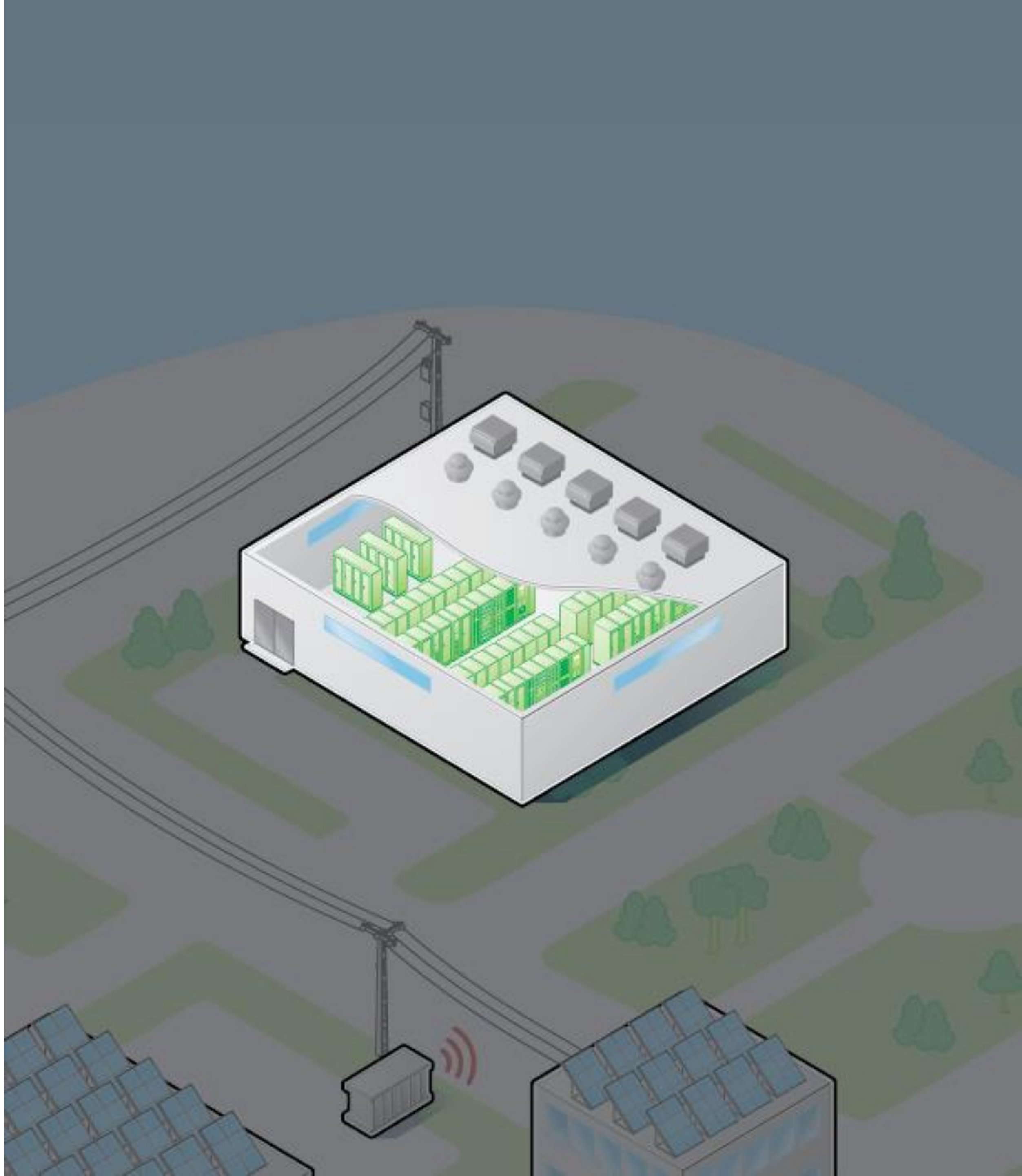
Target:

- **72 Distributed Remote sites**
- **Move eligible Servers to St. Louis DC or retire**
  - **Reduces foot print in remote sites**
- **Newer, More Efficient IT Equipment**
  - **80+% Virtualization**
- **Recycle Program for decommissioned servers**

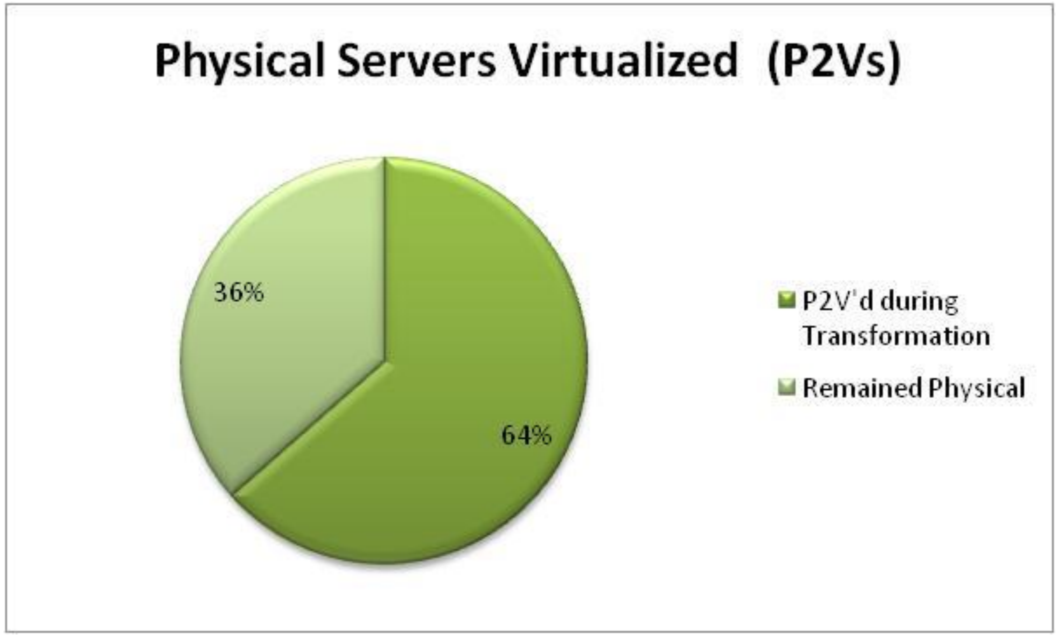
Step 3: Transformation

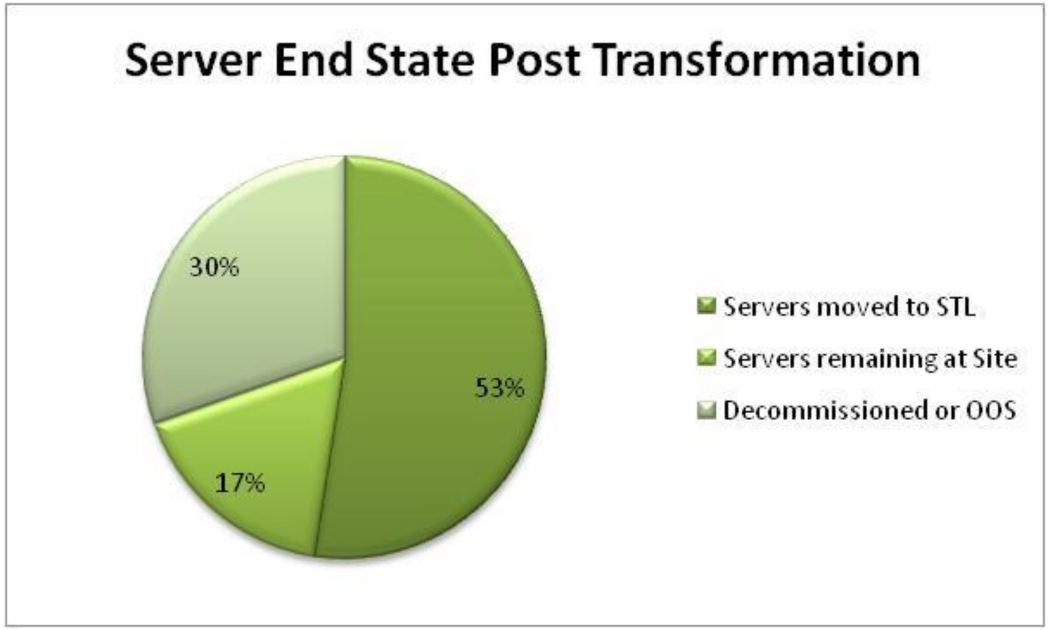
EOY 2014 Power Consumption

EOY 2014	IT Equip (kW)	DC Facilities (kW)	Total (kW)
STL DC	160	112	272
Lexington DC	0	0	0
72 Distributed Sites	170	289	459
	330	401	731



Step 3: Transformation

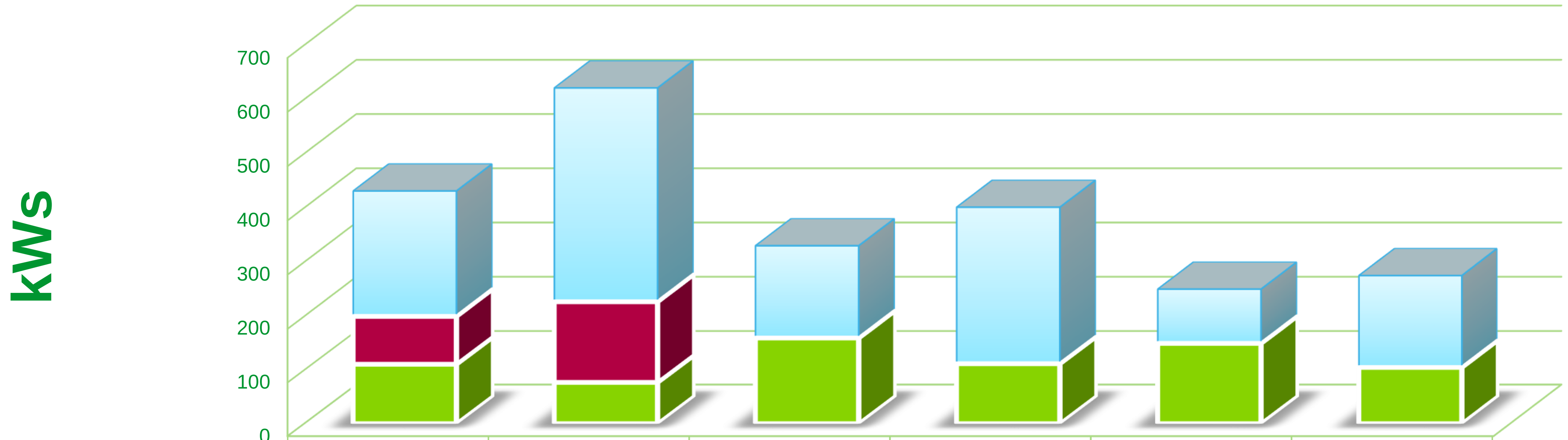




- 2014 Observations:
  - Decommissioned server numbers are higher than expected
  - Green implications of Transformation are far exceeding predictions
  - 206 Physical servers have been removed from the environment to date as a result of virtualization, consolidation or decommissioning
  - 60% of servers in original baseline have been transformed to date

Step 4: Results

Energy Consumption Supporting IT Compute



	Baseline		EOY 2014		Proposed End	
	IT Equipment (kW)	DC Facilities (kW)	IT Equipment (kW)	DC Facilities (kW)	IT Equipment (kW)	DC Facilities (kW)
72 Distributed Sites	231	394	170	289	100	170
Lexington DC *	89	150	0	0	0	0
STL DC	111	77	160	112	150	105

What’s Next?

Remote Monitoring & Management

> Live Data and Control Management
> Related feedback on existing and new technologies for both IT and Infrastructure
    > Manage IT Load – Real Time
    > Related Infrastructure
> Investment decisions based on real time data
  > Provides accurate analysis for Business Case and next generation investment
  > Better partnership with other tenants
  > Collaboration between Facility, Security and IT

Schneider Electric

Thank you!

Appendix

Energy Efficiencies to EOY 2014

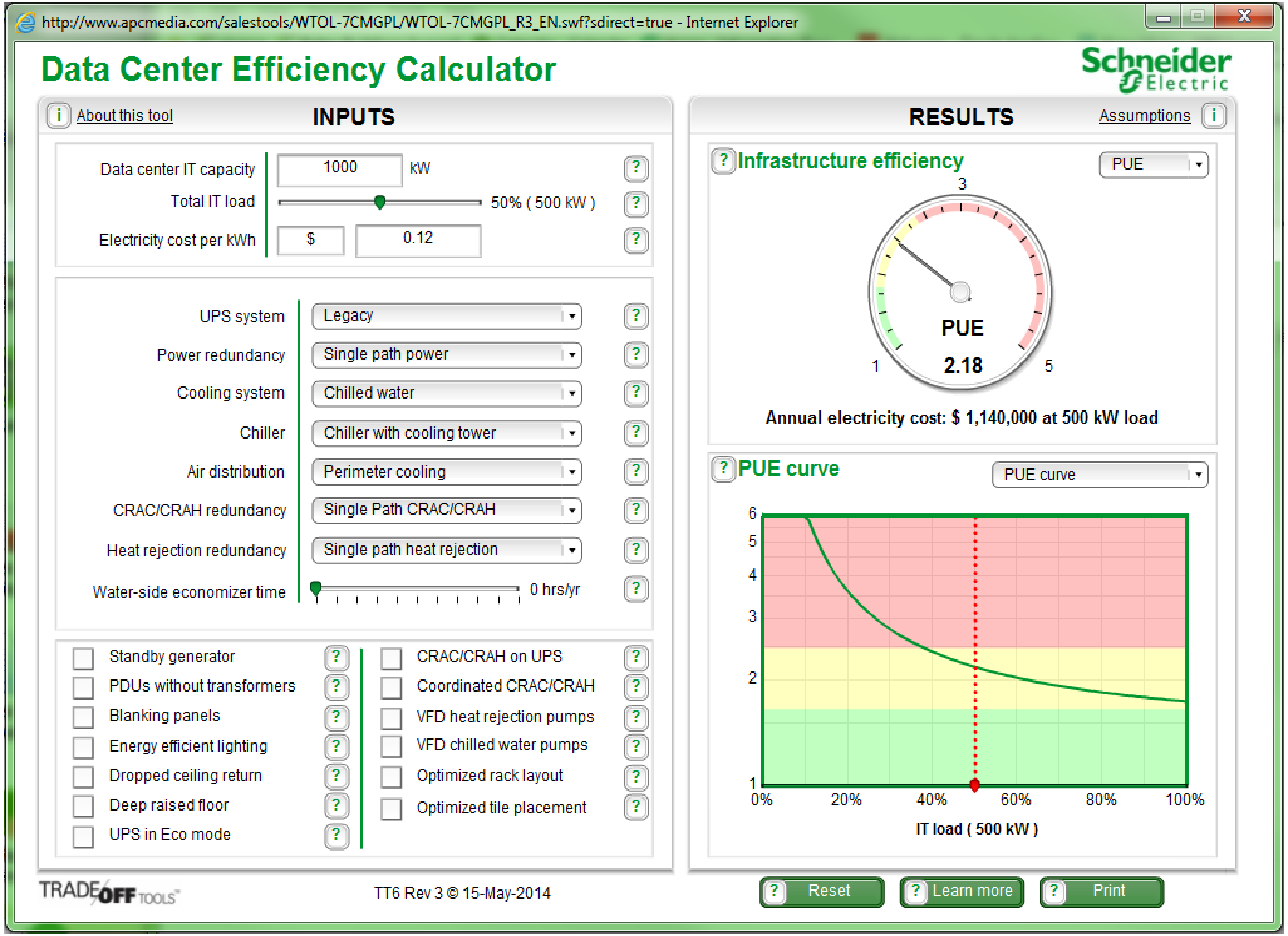
via consolidation, virtualization, decommissioning and centralization efforts

> Original Transition from Lexington DC to St. Louis
  - > Lexington was a multi tenant outsourced DC – St. Louis is a Multi Use Owned DC
  - > 145.8 kW of IT Equipment and Facilities Infrastructure load reduced
  - > 1,277,208 kWhs / year
  - > ~ 2.5 million lbs of CO_2 saved annually **

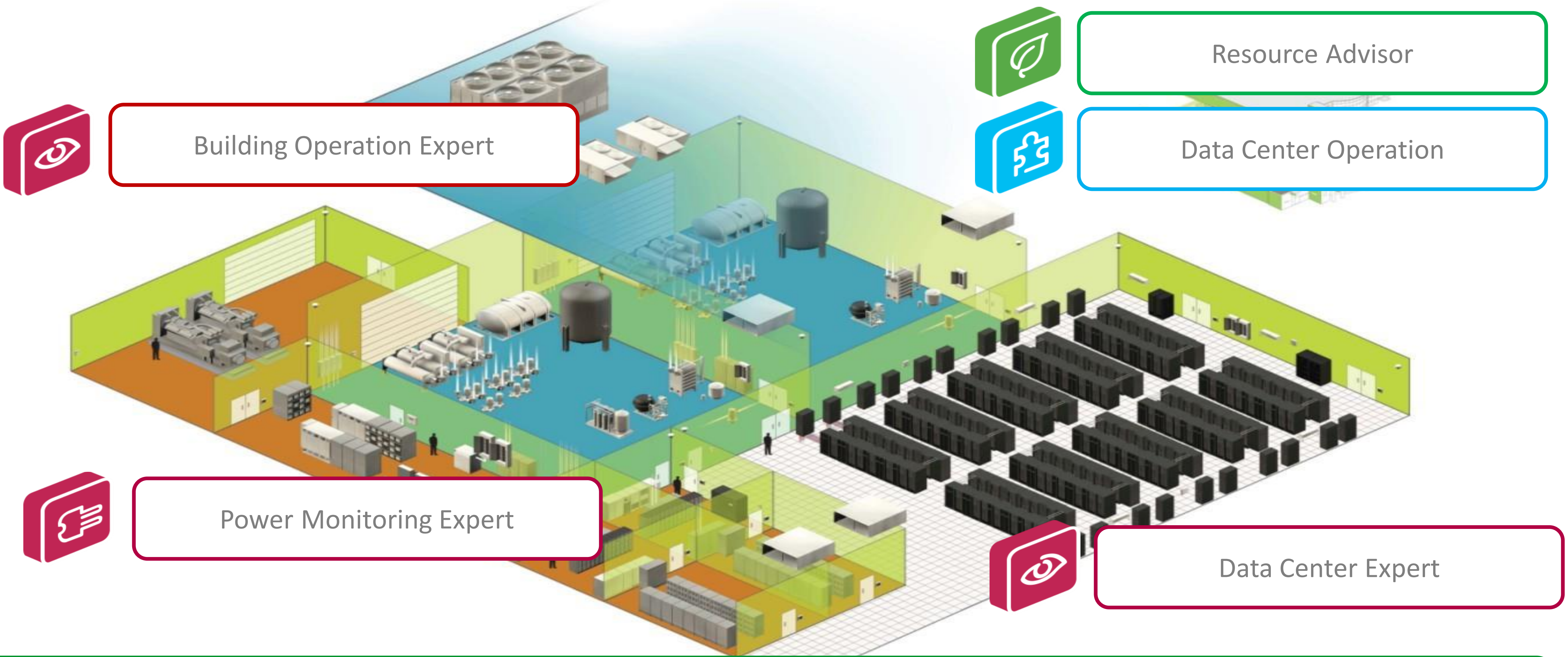
> Continued Transformation through 2014
  - > 124 kW of IT Equipment and Facilities Infrastructure load reduced
  - > 1,086,240 kWhs / year
  - > ~ 2 million lbs of CO_2 saved annually **

**** CO_2 savings are calculated differently, depending upon the energy providers power generation mix,**

Calculating PUE



StruxureWare for Data Centers



Business-wise, future-driven™
From server, to rack, to row, to room, to building, to sites, to the enterprise.

StruxureWare for Data Centers

	Function	Capability
Enterprise Energy and Sustainability	Resource Advisor	Track and manage enterprise energy and carbon costs
Data Center Business Process	Data Center Operation	Manage Data Center assets, operational and capital costs
Data Center Monitoring and Control	Data Center Expert	Monitor and control Data Center power, cooling and security
	Power Monitoring Expert	Advanced power monitoring, analysis and power quality
	Building Operation Expert	Advanced cooling monitoring and automation

Steve Hammond, National Renewable Renewable Laboratory

U.S. DEPARTMENT OF ENERGY

Energy Efficiency – Multi-Use Facilities

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Steve Hammond May 2015

NREL ESIF Data Center

Showcase Facility

- ESIF 182,000 s.f. research facility
- Includes 10MW, 10,000 s.f. data center
- LEED Platinum Facility, PUE 1.06
- NO mechanical cooling (*eliminates expensive and inefficient chillers*).
- Use evaporative cooling only.

Utilize the bytes and the BTUs!

Data Center Features

- Direct, component-level liquid cooling (75F cooling water).
- 95-110F return water (waste heat), captured and used to heat offices and lab space.
- Pumps more efficient than fans.
- High voltage 480VAC power distribution directly to compute racks (*improves efficiency, eliminates conversions*).

Compared to a typical data center:

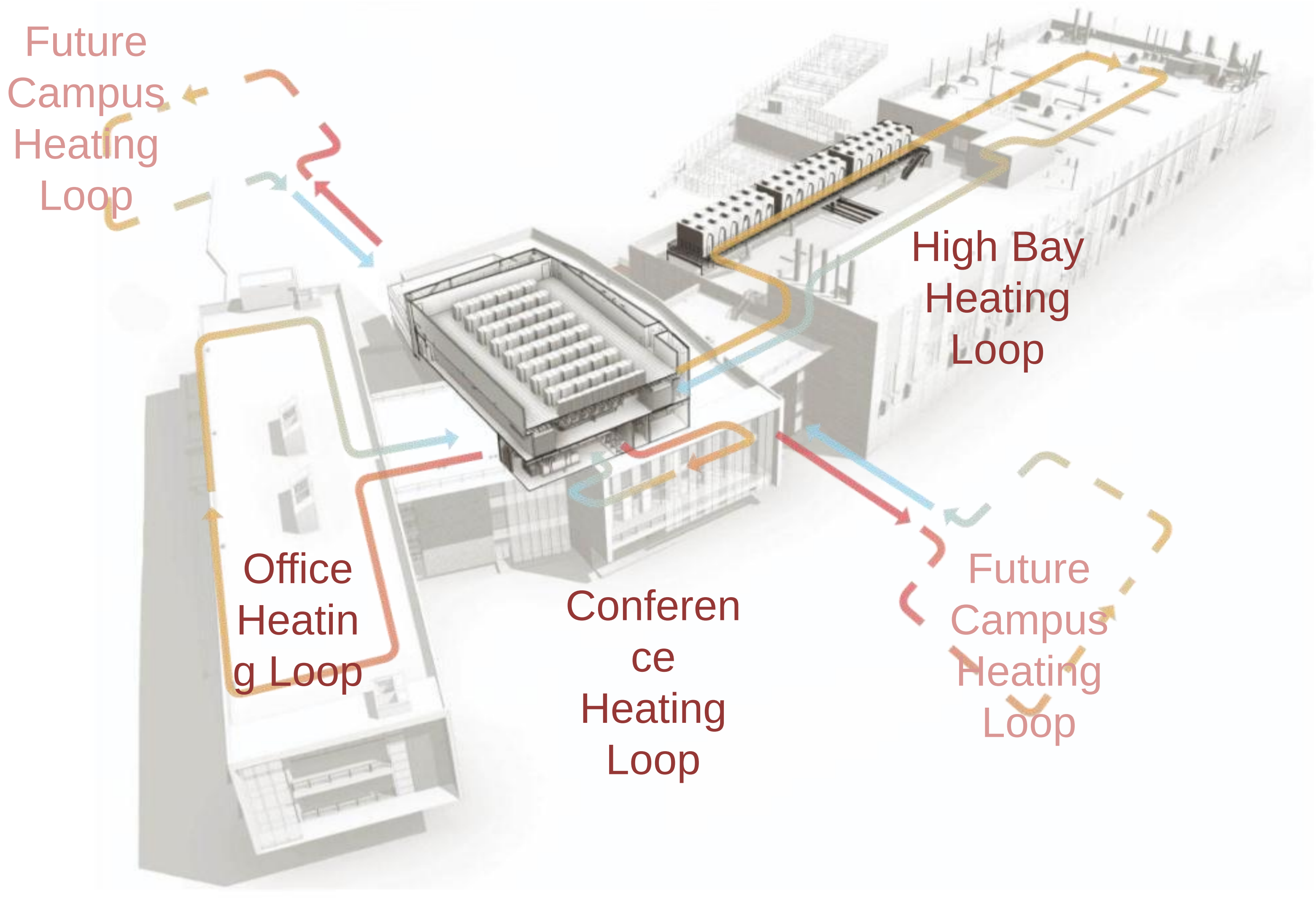
- *Lower CapEx – cost less to build*
- *Lower OpEx – efficiencies save ~$1M per year in operational expenses.*

Integrated "chips to bricks" approach.

Key NREL Data Center Specs

- Warm water cooling, 24C (75F)
  - ASHRAE “W2” category
  - Water much better working fluid than air - pumps trump fans.
  - Utilize high quality waste heat, +35C (95F).
  - +95% IT heat load to liquid.
- Racks of legacy equipment
  - Up to 10% IT heat load to air.
- High power distribution
  - 480VAC, Eliminate conversions.
- Think outside the box
  - Don’t be satisfied with an energy efficient data center nestled on campus surrounded by

Facility Planning for Energy Reuse, Now & In the Future



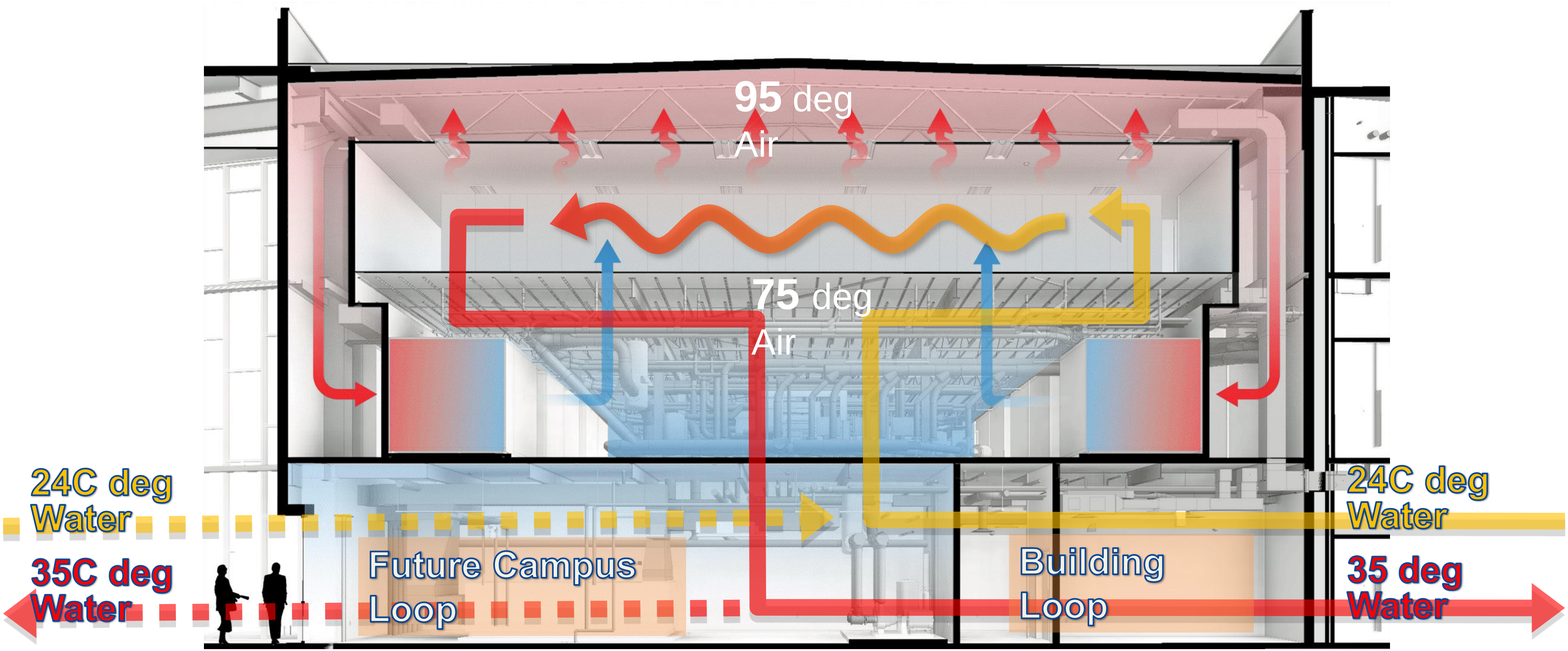
ERE – ENERGY REUSE EFFICIENCY

- Measure of How Efficiently We are Using Data Center "Waste" Heat to Heat the Facility & Future Campus
- Goal is to Minimize Cooling Energy in the Data Center While Reducing Heating Loads in Other Areas

NREL ESIF, ERE = 0.7

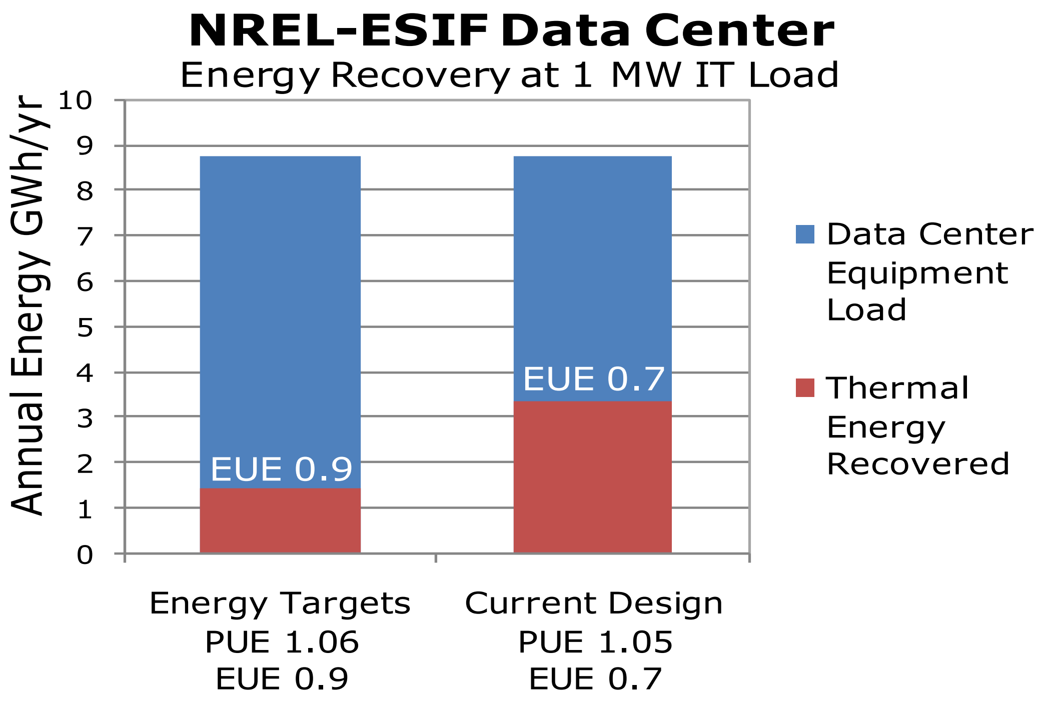
- ESIF Utilizes 30% of the Data Center "Waste" Heat on an Annual Basis
- Utilization to Increase with the Addition of Future Campus Heating Loops

Optimized Data Center Configuration for Maximum Performance



Direct Liquid Cooling & Energy Recovery On Display

"We want the bytes AND the BTU's!"



Energy Reuse Effectiveness (ERE) =

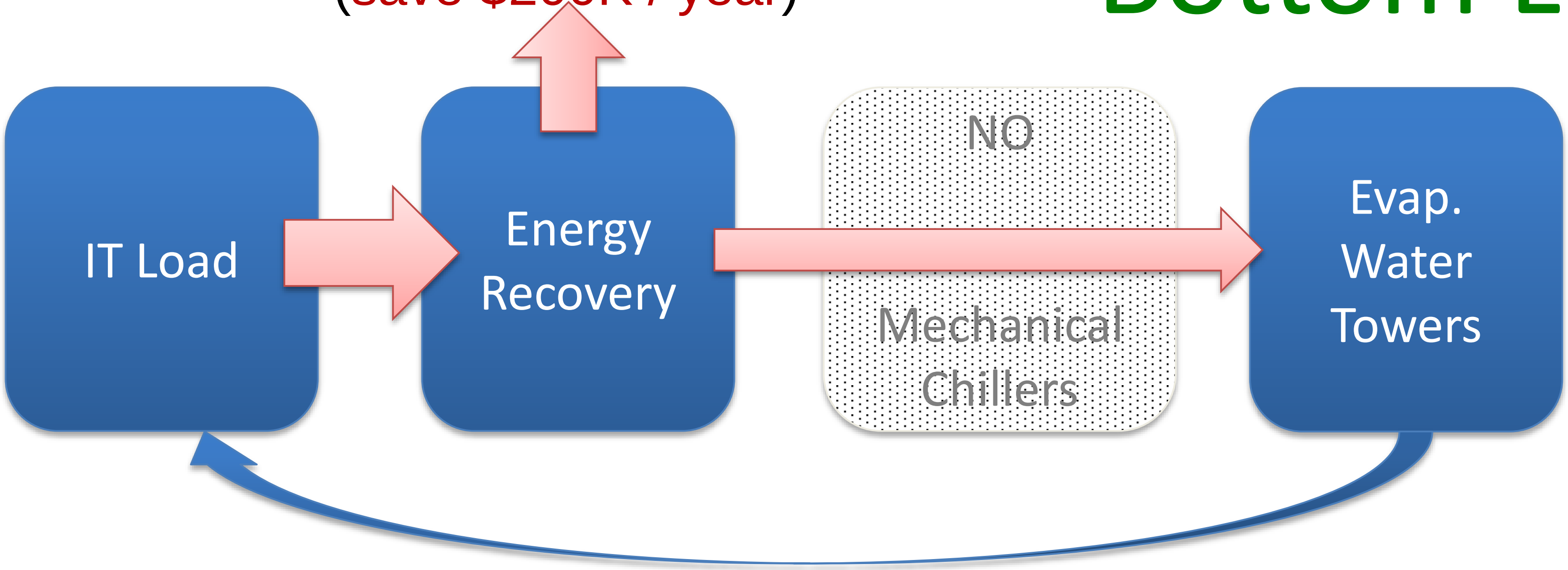
$$\frac{\text{Total Data Center Annual Energy} - \text{Total Energy Recovered}}{\text{Total IT Equipment Annual Energy}}$$

Significant Energy and Resource Efficiencies Demonstrated

- Innovative, holistic data center design implemented with readily available components.
- Design concepts readily applicable to other locations.
  - Optimal site-specific solutions may vary, but …
  - Fundamentals of NREL approach widely applicable.
- Showcase facility, best in class engineering:
  - VFD motors used throughout using only as much energy as is necessary to dissipate thermal load.
  - Hydronic system with "smooth piping" to reduce pressure drops and pump energy.
    - First of a kind demonstration of warm-water liquid cooling.
    - Total waste heat capture and re-use.

Green Data Center Bottom Line

Heat ESIF Offices,
Labs, ventilation
(save $200K / year)



Cost less to build
Cost less to operate

Comparison of ESIF PUE 1.06 vs efficient 1.3 data center.

CapEx	**Savings**
No Chillers	No Chillers
Initial Build: 600 tons	$.9M
10 Yr. growth: 2400 tons	$3.6M
10-year Savings:	**$4.5M**
($1.5K / ton)	

OpEx (10MW IT Load)	**Utilities**
PUE of 1.3	$13M
PUE of 1.06	$10.6M
Annual Savings	$2.4M
10-year Savings	**$24M**
($1M / MW year)	*(excludes heat recovery benefit)*

Biggest challenge is <u>not</u> technical

- Data Center best practices are well documented.
- However, the total cost of ownership (TCO) rests on three legs:
  - Facilities – “owns” the building and infrastructure.
  - IT – “owns” the compute systems.
  - CFO – “owns” the capital investments and utility costs.

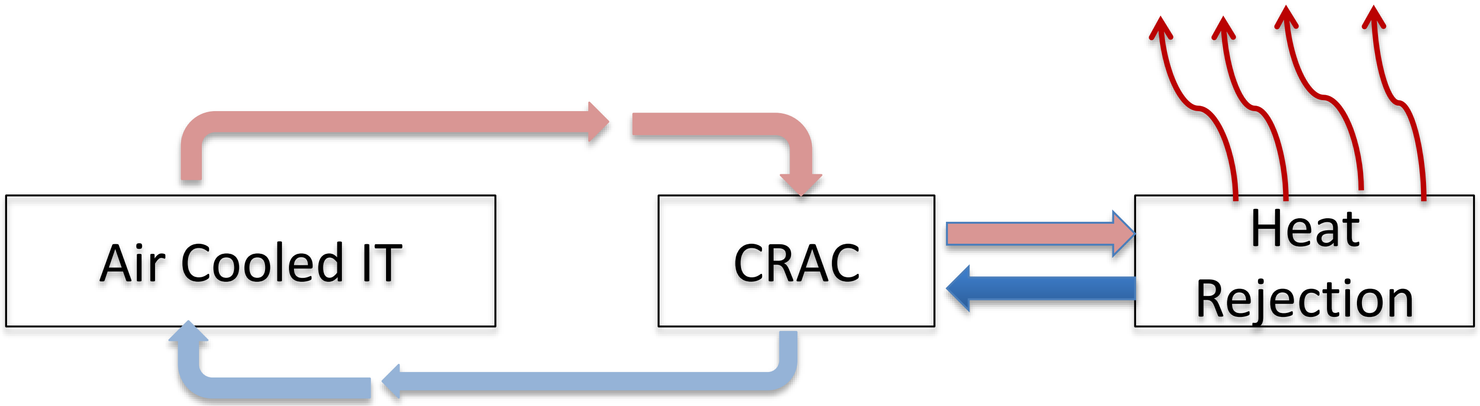
- Why should “Facilities” invest in efficient infrastructure if the “CFO” pays the utility bills and reaps the benefit?
- Why should “IT” buy anything different if “CFO” benefits from reduced utility costs?

- *Efficiency ROI is real and <u>all</u> stakeholders must benefit for it to work.*

Questions?

Air to Liquid Transition Path

- **NREL started with a new data center, how do I use liquid cooling in my traditional data center?**
  - If you have traditional CRAC units, you already have liquid into your data center.
  - Intercept the CRAC return water that would go to your heat rejection (chiller?) and route it to the liquid cooled racks first and take the warmer return water to your chiller.



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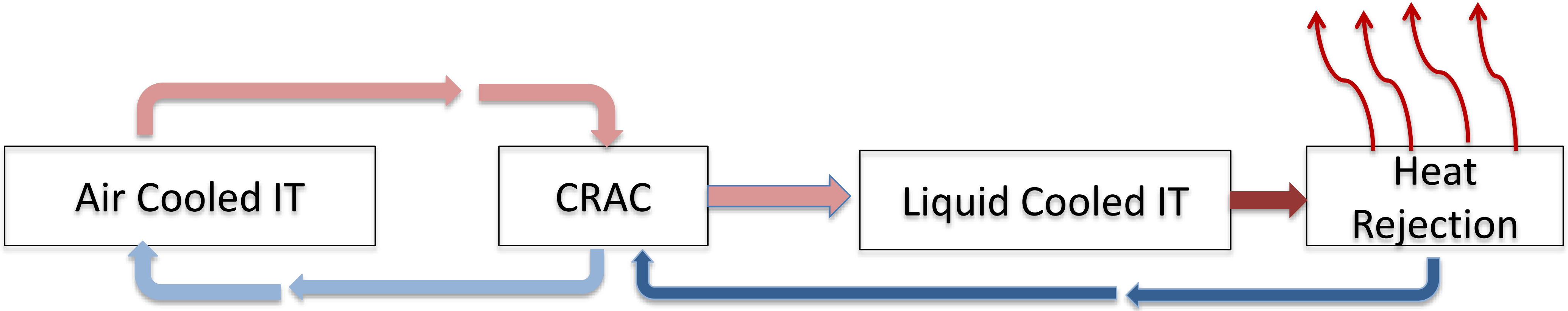


Bill (William) Lakos, Michigan State University

U.S. DEPARTMENT OF ENERGY

Managing Data Centers in Multi-Use Environments

Bill Lakos

Energy Analyst

MSU IPF Energy and Environment

May 28, 2015

Background Information

Michigan State University – East Lansing, MI

Mission:

Michigan State University Spartans work every day to advance the common good in uncommon ways. Together we tackle some of the world's toughest problems to find solutions that make life better.

Background Information

Michigan State University – East Lansing, MI

Statistics:

- 49,350 Students
- 11,110 Faculty & Staff
- 5,200 acre campus with 2,100 acres in existing or planned development
- 538 buildings, including 95 academic buildings
- Own and operate 100MW co-generating power plant (steam and electricity)

Background Information

Michigan State University – East Lansing, MI

Better Buildings Challenge Data Center Commitment:

- Two major facilities
- 5,900 Sq. Ft.-700kW Total Load
- Campus Administration
- High Performance Computing Center
- Back Up Facility

Existing Landscape:

MICHIGAN STATE UNIVERSITY

Top 10 MSU Data Cent.	[sqft]
1) Computer Cent.	[5900]
2) Admin	[3800]
3) NSCL/FRIB	[1900]
4) Comm. Arts	[1500]
5) HPCC	[1300]
6) Social Science	[1100]
7) Engineering	[1000]
8) Library	[800]
9) Clinical Center	[800]
10) Advancement	[800]

out of more than 66 total

MSU Campus (consumes 28-61 MW electricity, total annual energy input: ~ 6 BCF gas)

What's the problem with having many server rooms?

- Server Utilization
- Energy Efficiency (PUE)
- Cooling Systems
- Staffing
- Consistent Standards
- Backup of Data
- Backup Systems/Continuity of Operations

How does this impact energy?

- More servers = more energy
- More server rooms = more energy
- Servers in spaces not designed for them =

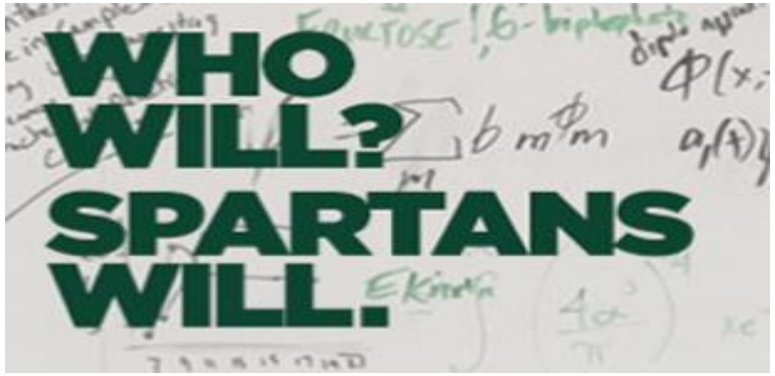
MORE ENERGY!

What does it mean?

Given the need to support the:

- Academic mission of the university
- Operational needs of the university
- Research needs of the university

Spartans need to find a solution.



MSU Data Center Census

Over 1000 square feet:

- 7 facilities

Under 1000 square feet:

- 45+ facilities

Under 100 square feet (server closets):

- 12+ facilities

Department creates a space for servers

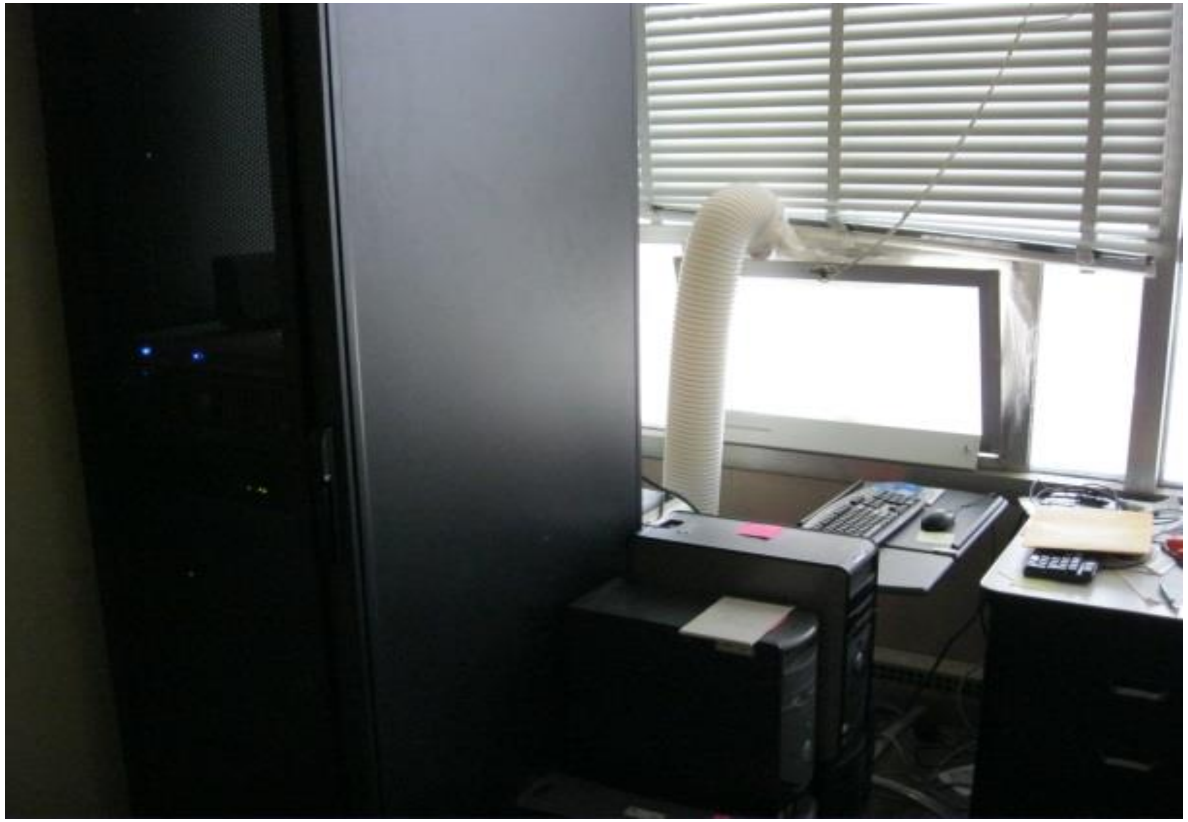
Unintended Consequences

- Without adequate ventilation, server room heats up
- Signals thermostat to turn off heat
- Office neighbor is cold because there is no heat
- Neighbor requests space heater

Multi-use space (office and server room)

Clever (?) “free cooling” option

Multi-use space (office and server room)



Clever (?) solution for heat rejection

A real server room

A real server room mess

University Goal

Centralized Solution (first step):

Combine two major data centers in single facility

Status:

- Board approved Energy Transition Plan
- Pending RFP for project development

Challenges/Barriers

- Balance future operation cost savings with need for initial investment
- Create trust relationships between Administration, Facilities, Academia, and IT

Anticipated Outcome

- Target PUE < 1.2 from current > 2.2
- Reduction of energy use by 40%
- Avoided consumption of 10,000 MWh per year
- Utility savings of approximately $1 million
- Avoid outages due to failures
- Future integration opportunities with additional data centers on and off campus (other universities, State of Michigan, etc.)

University Goal

Centralized Solution (second step) ? :

- Replicate first step using other major data centers in a separate location to create backup facility
- Contingent on successful first step

Challenges

- Server Utilization
  - Centralized operations vs. Decentralized
- Energy Efficiency (PUE)
  - Purpose built space vs. Space designed for other use
- Cooling Systems
  - Reclaim waste heat vs. Reject to atmosphere
- Staffing
  - Shared resources vs. Single point of risk

MICHIGAN STATE UNIVERSITY

Challenges (continued)

- Consistent Standards
  - Replicable framework vs. “one-off” solutions
- Backup of Data
  - Manage centrally vs. Unmanaged
  - Stored off-site vs. Local Storage
- Backup Systems/Continuity of Operations
  - Resilient vs. Single point of failure
  - Recoverable vs. Irreplaceable

Discussion

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