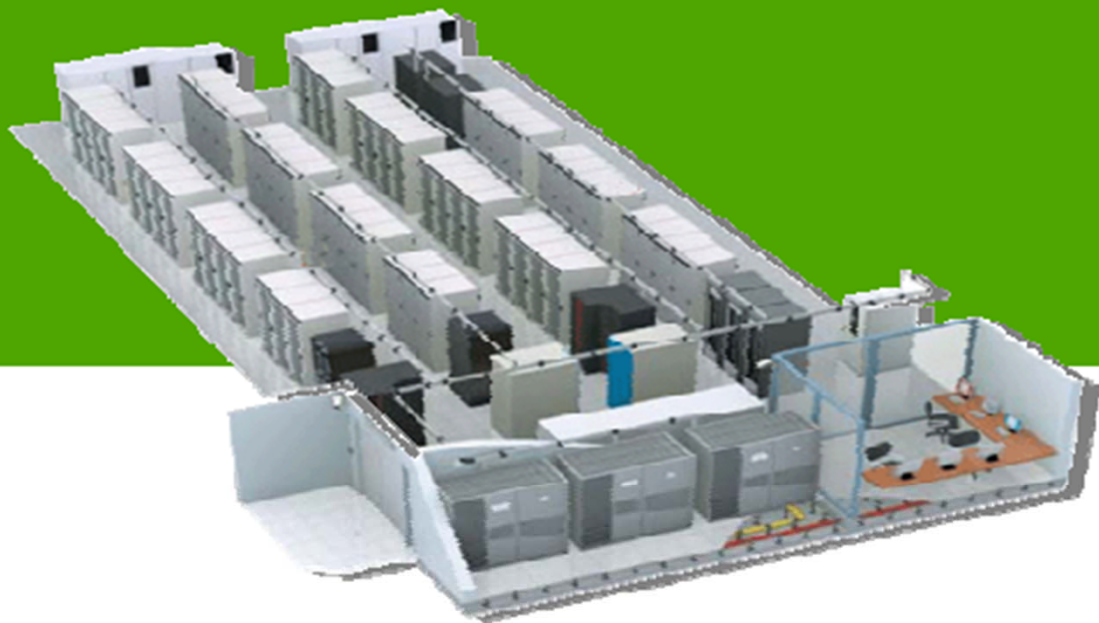


# Data Center Efficiency from the Plant to the Plug

Overview of the largest gains in electrical and mechanical efficiency being incorporated into today's data center designs



**APC**  
by Schneider Electric

# Agenda

- Schneider Electric - The Global Energy Management Specialist
- LV Distribution architectures
- Transformerless UPS technologies
- Close-coupled cooling
- Branch Current monitoring and metering
- Real time PUE metering

# Schneider Electric

An international and sustainable growth

**18.3**

billion sales in 2008 (in €)



**32**

% of sales in new economies



**114 000**

people in 100+ countries



**330**

Rank in *Fortune 500* ranking



**5%**

Revenue devoted to R&D



## Sales by business

Electrical distribution	57%
Automation	29%
Critical power	14%

## Sales by geography

Europe	44%
North America	27%
Asia-Pacific	19%
RoW	10%

## Sales by end market

Energy & Infrastructure	16%
Industry	26%
Data centres & Networks	17%
Buildings	31%
Residential	10%

## People by geography

Europe	42%
North America	25%
Asia-Pacific	25%
RoW	8%



Listed on the Paris  
stock exchange

**Schneider**  
Electric

# Customer-focused experts leveraging teamwork to drive solutions

## Worldwide teams of experts...

- 6,000 service experts
- 6,500 research and development experts
- 5,000 partners
- Plus thousands of
  - Engineers
  - Technicians
  - Program managers
  - Support staff

## ...dedicated to resolving your issues in:

- Energy and infrastructure
- Industrial automation
- Data centers and networks
- Commercial buildings
- Residential homes



# You can find most of the Schneider portfolio in a typical data center today

<b>Switchgear and power distribution</b>	<b>Building automation</b>	<b>Data center power, cooling, racks, and management</b>	<b>Energy management</b>	<b>Data center services</b>
   <small>by Schneider Electric</small>	 <small>by Schneider Electric</small>	  <small>by Schneider Electric</small>  <small>DATA CENTERS ON DEMAND</small>   		   <small>by Schneider Electric</small>

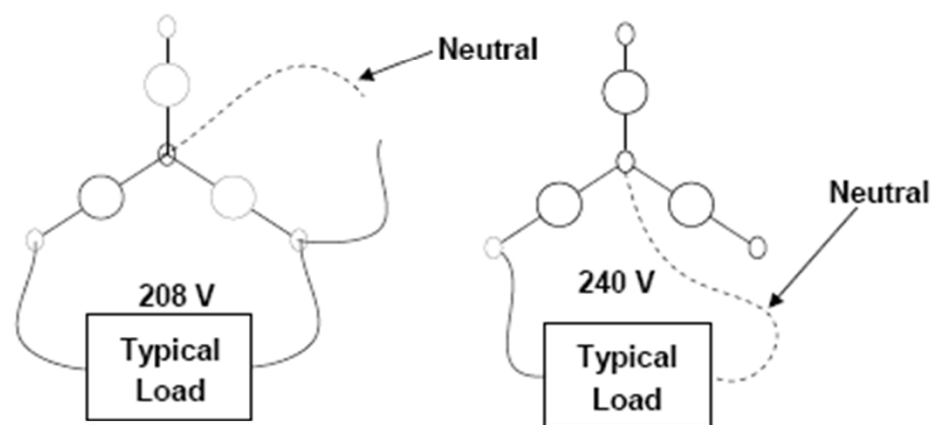
# Green Data Centers by the Numbers

## *Understanding the Motivations and Impacts*

- The average data center is **10 years old**
  - *45% of data centers are more than 10 years old*
- **65%** of data centers have power & cooling issues
- **30%** expect major DC facilities upgrade in next 3-5 years
- **70%** operate data center at 65-75 degrees Fahrenheit
- **90%** report energy efficient servers are important in selection

# LV Distribution architectures

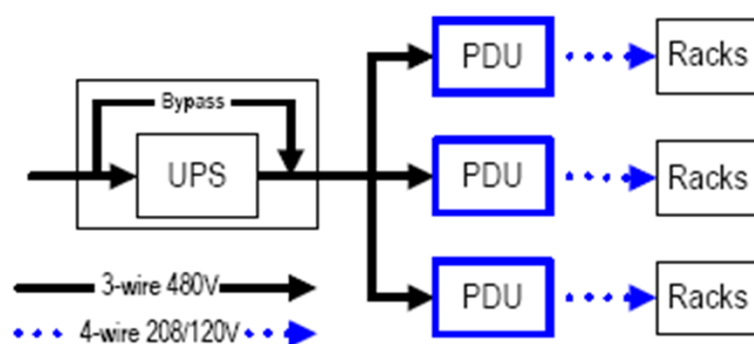
How does 415V drive gains in both usage and capacity?



- Servers draw their power from the 208 V high voltage (line to line) connection in North America
  - They draw their power from the 230 V low voltage (line to neutral) connection in almost every other country
  - comparison should be between 120 V and 240 V and NOT between 208 V and 240 V.
- Assume 20 amp circuits are provided to the load in either case.
  - 120 V “line to neutral” distribution method is calculated as  $(20 \text{ amps} \times 120 \text{ V} \times 3 = 7.2 \text{ kW})$
  - 240 V “line to neutral” distribution method is calculated as  $(20 \text{ amps} \times 240 \text{ V} \times 3 = 14.4 \text{ kW})$ .
  - 240 V distribution provides 100% more power than the 120 V distribution.

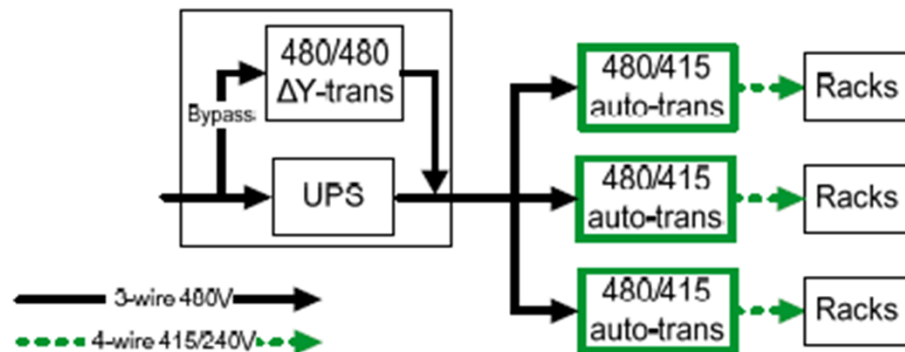
# Comparative LV Distribution in North America

480:208V



One-line diagram showing standard power distribution system for North American data centers

480:415V



One-line diagram showing alternative power distribution system for North American data centers

*Why 415V, why not 480V and use 277Y at the rack?*

*When can we expect 277Y servers in North America?*

# Data center power distribution

- 415/240V distribution throughout the data center

- UPS runs @ 415V 3 phase with RPPs downstream optimizing
  - Floor space - eliminating PDUs
  - $I^2R$  losses - cable sizes are reduced
  - Elimination of 480:208V PDU transformers and their losses

- Traditional & Modular Power Distribution

- Modular Power Distribution used for distribution to rows of racks
- Hot swap modules allow for safe & reliable future expansion and changes.
- Overhead cabling



# Transformerless UPS technologies

## What are the tradeoffs?

- **Lower Capital Expenditure**
  - No internal isolation transformer reduces purchase and shipping costs
  - Generally have a higher power factor
- **Lower Operating Expenditure**
  - No transformer means less loss
  - Non-modular UPS can take longer to realize efficiency payback
- **Distortion?**
  - Input harmonic distortion is usually less as IGBT's have become the standard of design
  - They are classified as VFI systems per EN/IEC 62040-3
- **Galvanic Isolation to the batteries**
  - There is a ground potential on the battery
- **Systems without transformers rely on an electronic monitoring, which will switch off the Inverter if a critical fault occurs in the Inverter**

**PRO**

**CON**



# Transformerless UPS

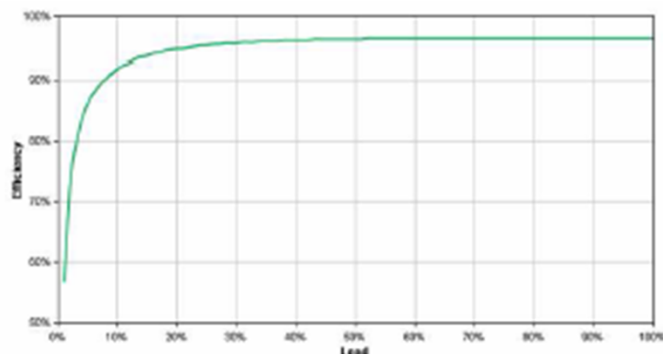
- Result is very high efficiency UPS

- Very flat curve
  - 91.5% at 10% load.
  - 96% at 35% load
- Especially important in 2N configuration

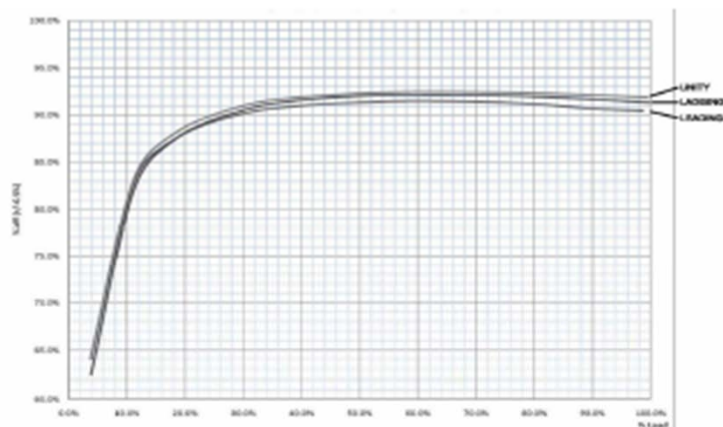
- UPS right sizing, and efficient components are key to optimizing efficiency in IT equipment power path.

- CAPEX limitations can be met through an ability to scale the capacity with the load.
- OPEX limitations can be met through hot-swap capabilities.

## Transformerless UPS >96% at 35% load



## Transformer UPS <92% at 35% load



# Close-coupled cooling

Can the efficiency gains and the density supported be afforded?

- Moving the cold air a shorter distance will buy a much quicker return on investment
  - Smaller fans, reduced HP, less mixing - all drives more effective usage
  - Removing the HP required to pressurize a raised floor has instantaneous effect on usage effectiveness
- Hot aisle containment allows higher inlet air temperatures
  - Get the most of the installed cooling system capacity by running "hotter" increasing return temperatures
  - Increased chilled water temperature delta T increases air handler capacity and improves chiller efficiency
- Do containment strategies work with Perimeter cooling?
  - A conventional data center layout with one vented tile per rack simply cannot cool racks of over approximately 6 kW per rack over a sustained area.
  - This value could increase to as much as 10kW per rack over a sustained area when used with a hot or cold aisle containment system.



# Cooling System design considerations

- **Row Based cooling with Hot-Aisle Containment**

- Allows for high cooling efficiency, while providing flexibility on densities.
- Variable speed fans provide significant energy savings.
- Data center ambient temperature, same as server inlet temperature, can be better controlled for comfort or increased for improved efficiency.
- Key when employing water side economizer.



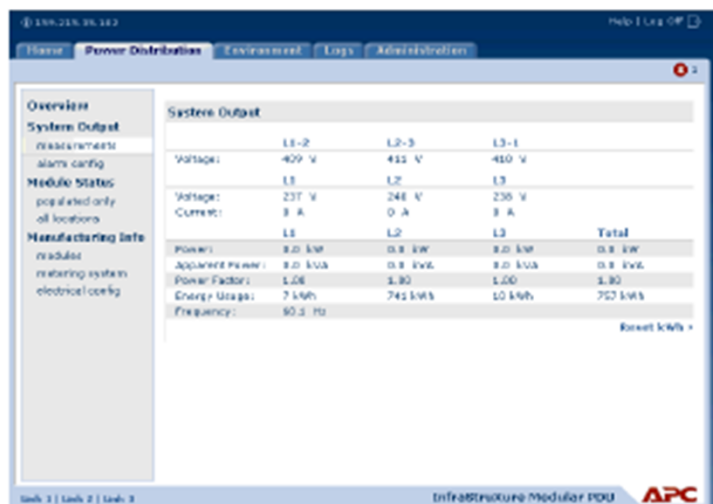
- **Perimeter cooling**

- For low density applications, perimeter cooling and a properly managed raised floor plenum can offer more flexibility and good TCO.
- Many installations, especially retrofit, are optimized by a mix of perimeter and Row Based for higher density zones.



# Branch Current monitoring and metering

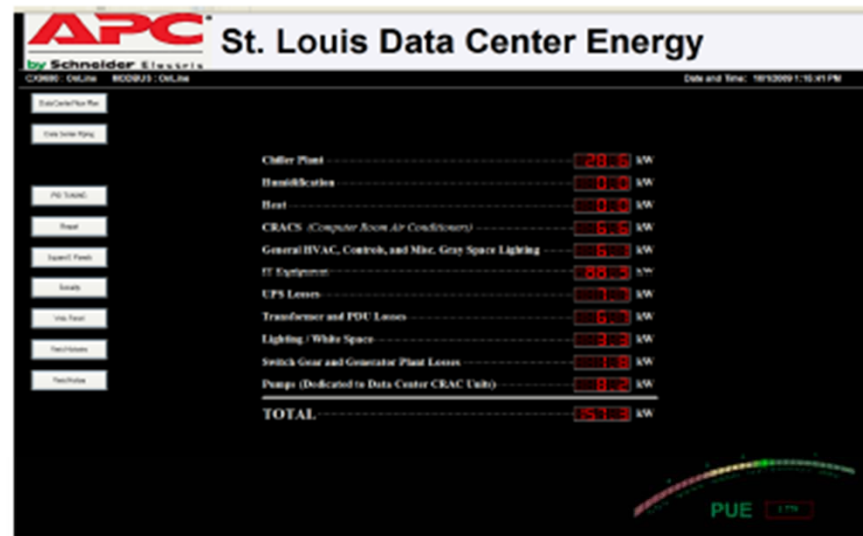
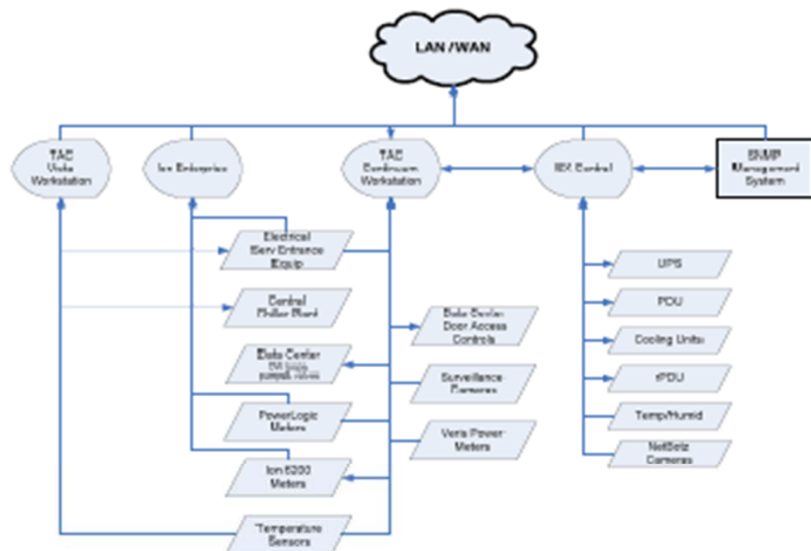
- Performance realization is in the enablement of knowing not just the max draw, but the usage
- Many Datacenter operations, passed to building automation and monitoring systems cannot predict or trend the usage
- Metering for charge-backs will become the standard in the next few years, as usage effectiveness becomes more important than design efficiency.
  - Virtualized loads are driving these needs as more operators look to optimizing their electricity buy through statistically driven models
  - “Follow-the-moon”



# Real Time PUE

## The integration of Management Systems

- To properly monitor and manage a data center which is a tenant in a larger building, management tools are required to measure performance & efficiency



# Data Center Case Study

- In 2006 APC by Schneider Electric was facing a datacenter problem that many companies face
  - Existing computer rooms in West Kingston, Rhode Island were out of physical space & out of power capacity.
  - Rapid growth began to compromise availability
- The decision was made to build a new 6500 Square foot data center within the 100,000 square foot Schneider Electric Technology Center (SETC) near St Louis, Missouri. The goals of the data center included:
  - High efficiency, high reliability, affordable
  - APC and Schneider North American production IT
  - Data center suitable for marketing - must show cross-Schneider products working together
  - Mixed use, multi-tenant building



# Drinking your own Kool-Aide™

Impact of the economy on design requirements

## **Original Design Goals**

- 1.3 MW total IT capacity, 6500 ft<sup>2</sup>
- Efficiency top priority. PUE 1.34 @ 100% load
- High availability 2N design everywhere possible
  - 2N chiller plants, piping and air handlers
  - 2N power path (from 1 onsite substation)
  - 2N standby generators
- Real-time efficiency and energy usage measurement

## **Redesigned Goals**

- 750kW total IT capacity, 4300 ft<sup>2</sup>
  - Currently built to 450kW
- Efficiency still top priority. PUE ~1.4-1.5 @ 100% load
- Redundancy where possible
  - Existing N+1 building chiller plant, N piping, N+1 air handlers
  - 2N power path (from 1 onsite substation)
  - Existing N standby building generator
- Real-time efficiency and energy usage measurement



**2008/2009  
economic crisis**

**More use of existing building systems rather than dedicated data center equipment**

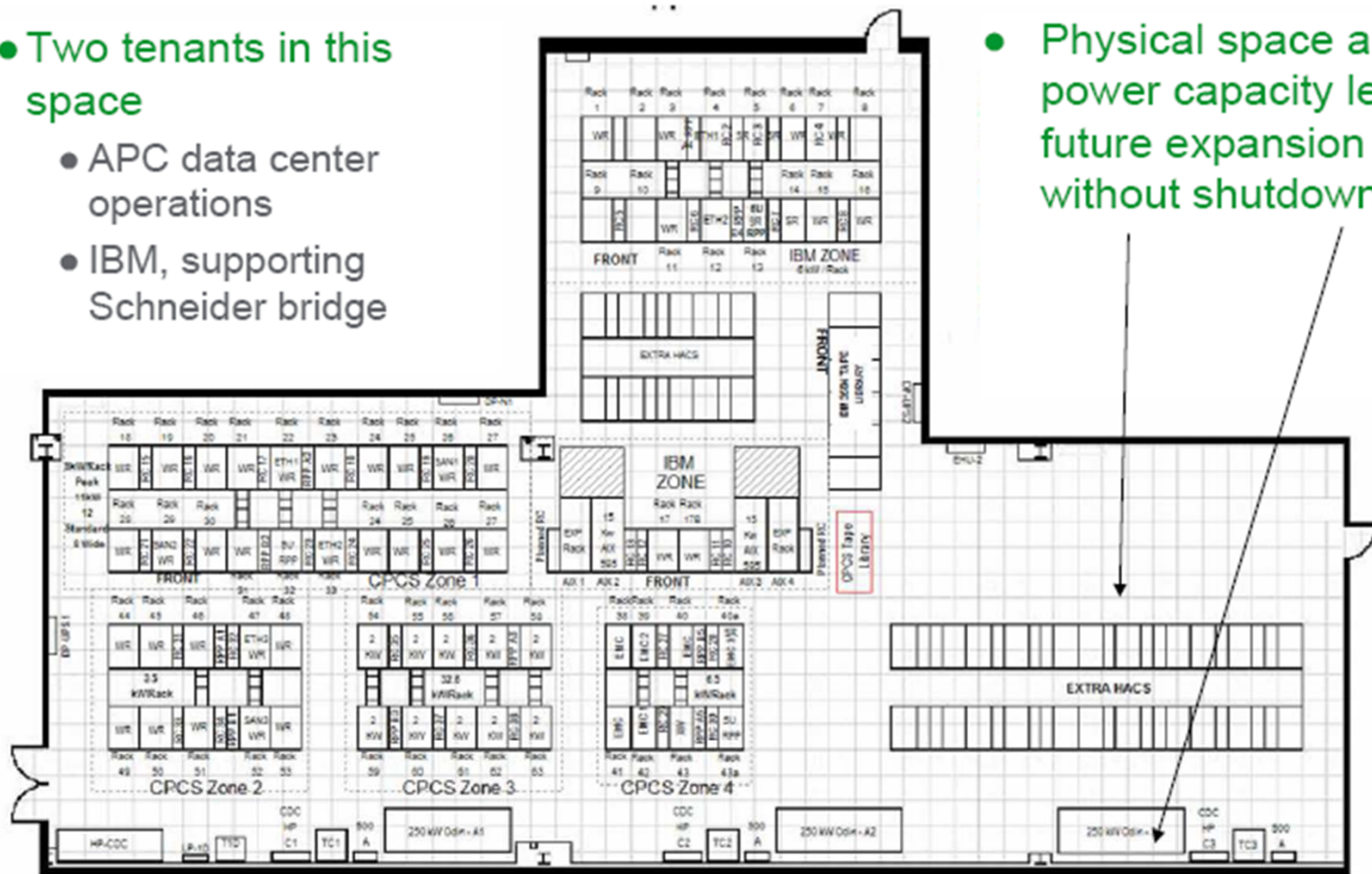
# Design highlights

- Although individual technologies deployed might not seem noteworthy, there are several key highlights with this project
- **Management integration**
  - Visibility across all facility equipment
  - PUE measurement, allowing for continuous improvement / experimentation
  - Ability to meter & accurately bill departments
  - IT & facilities cross-over with appropriate visibility & control
- **415V distribution**
  - Save space, materials and is the most efficient readily available solution today for distributing power to IT equipment
- **High efficiency & availability as a tenant in an existing building - on a budget**
  - VFD controls & software monitoring allowed the data center to make the most efficient use of existing building systems, while ensuring high availability

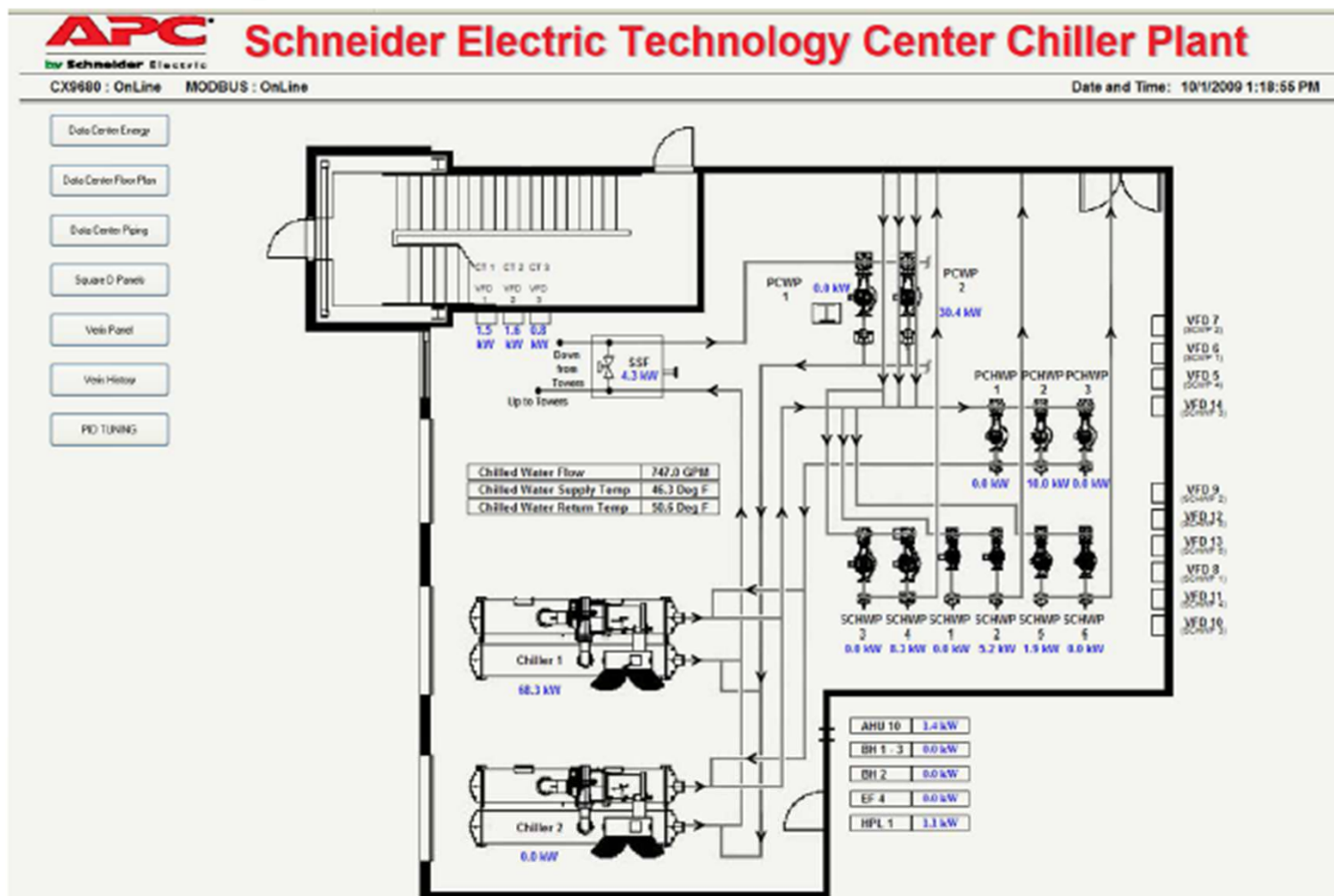
# Data center layout

- Two tenants in this space
  - APC data center operations
  - IBM, supporting Schneider bridge

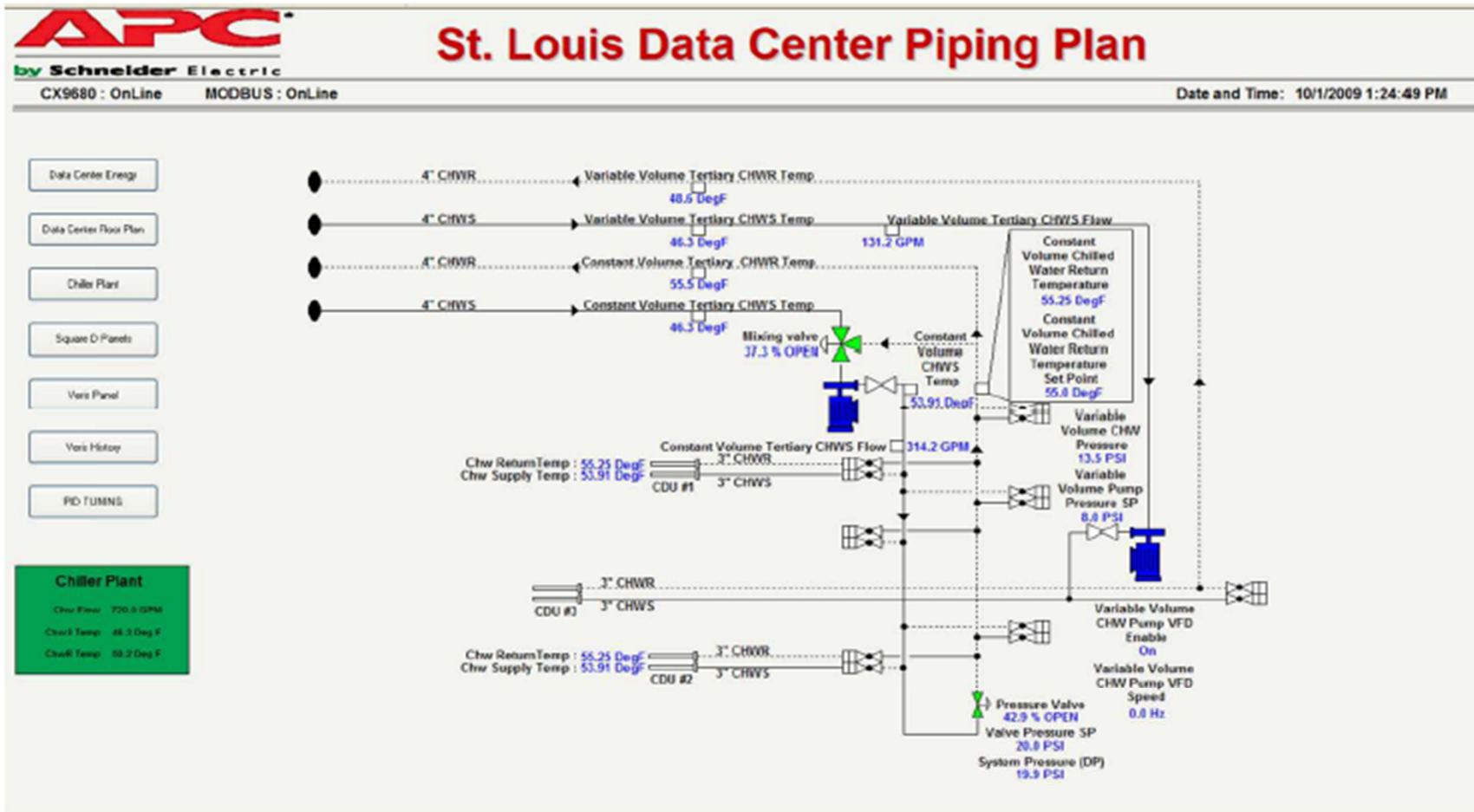
- Physical space and power capacity left for future expansion without shutdown



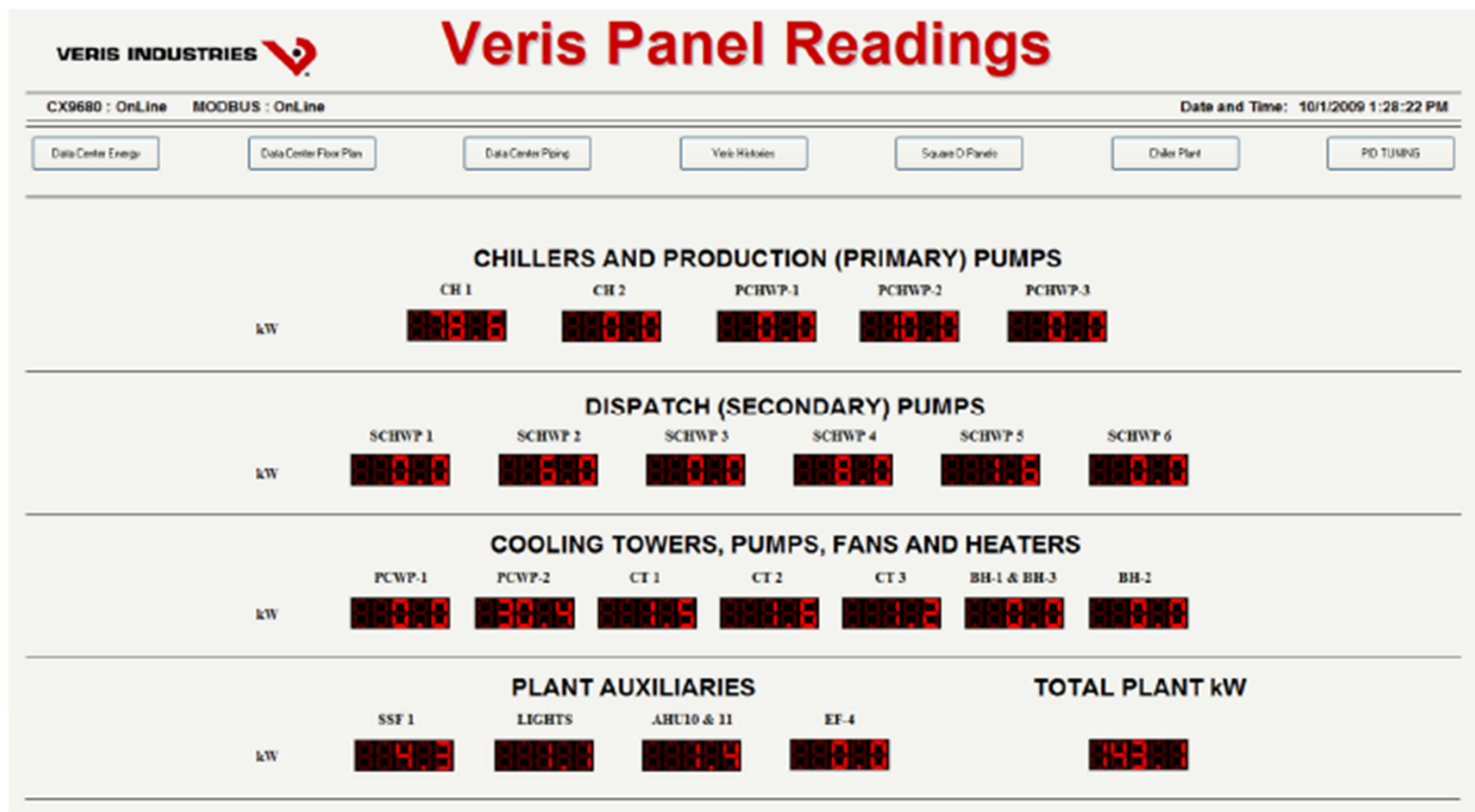
# Existing Main Chiller Plant & Controls



# Data Center Chiller Loop



# Chiller plant power consumption



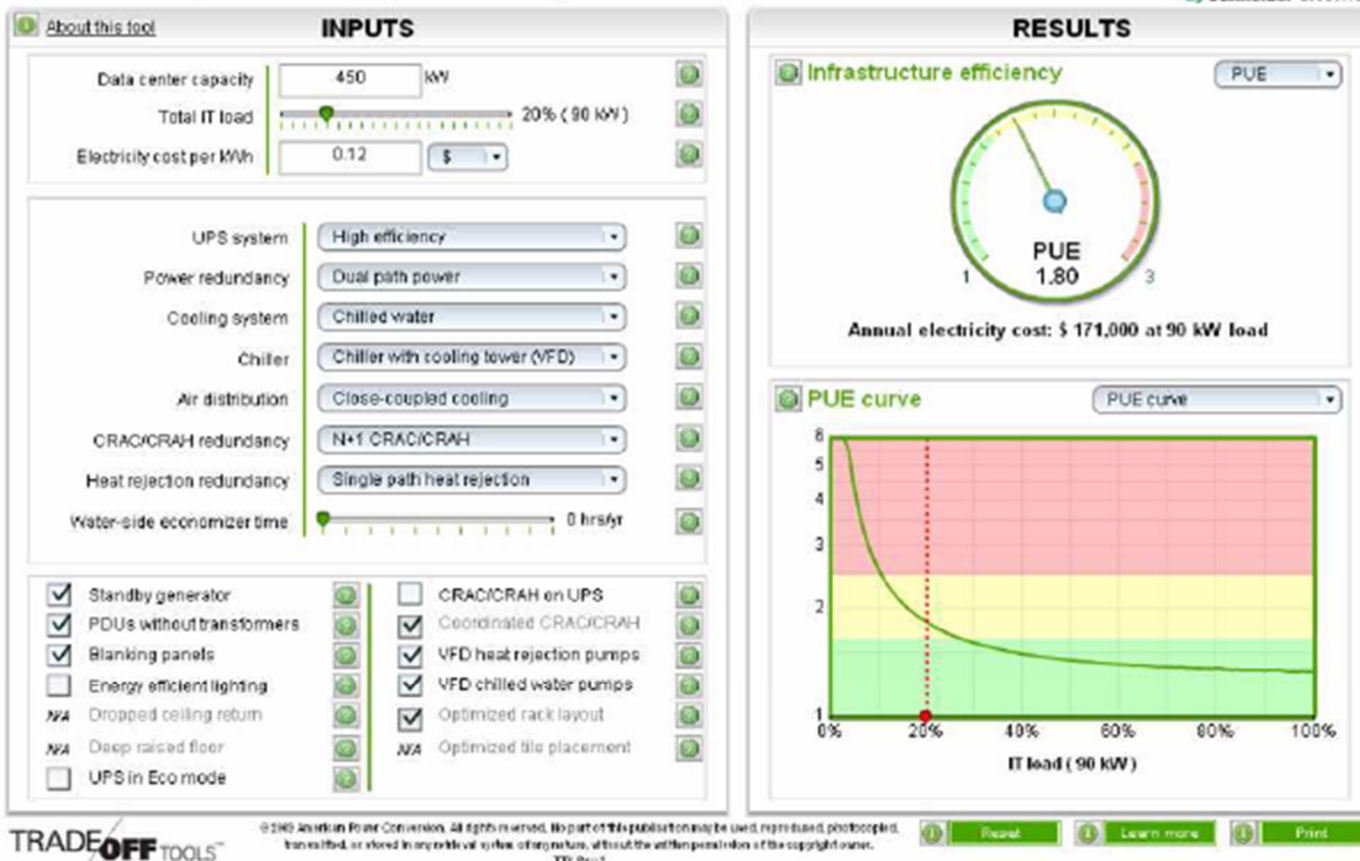
# Predicting performance

## Data Center Efficiency Calculator

Impact of alternative power and cooling approaches on energy costs

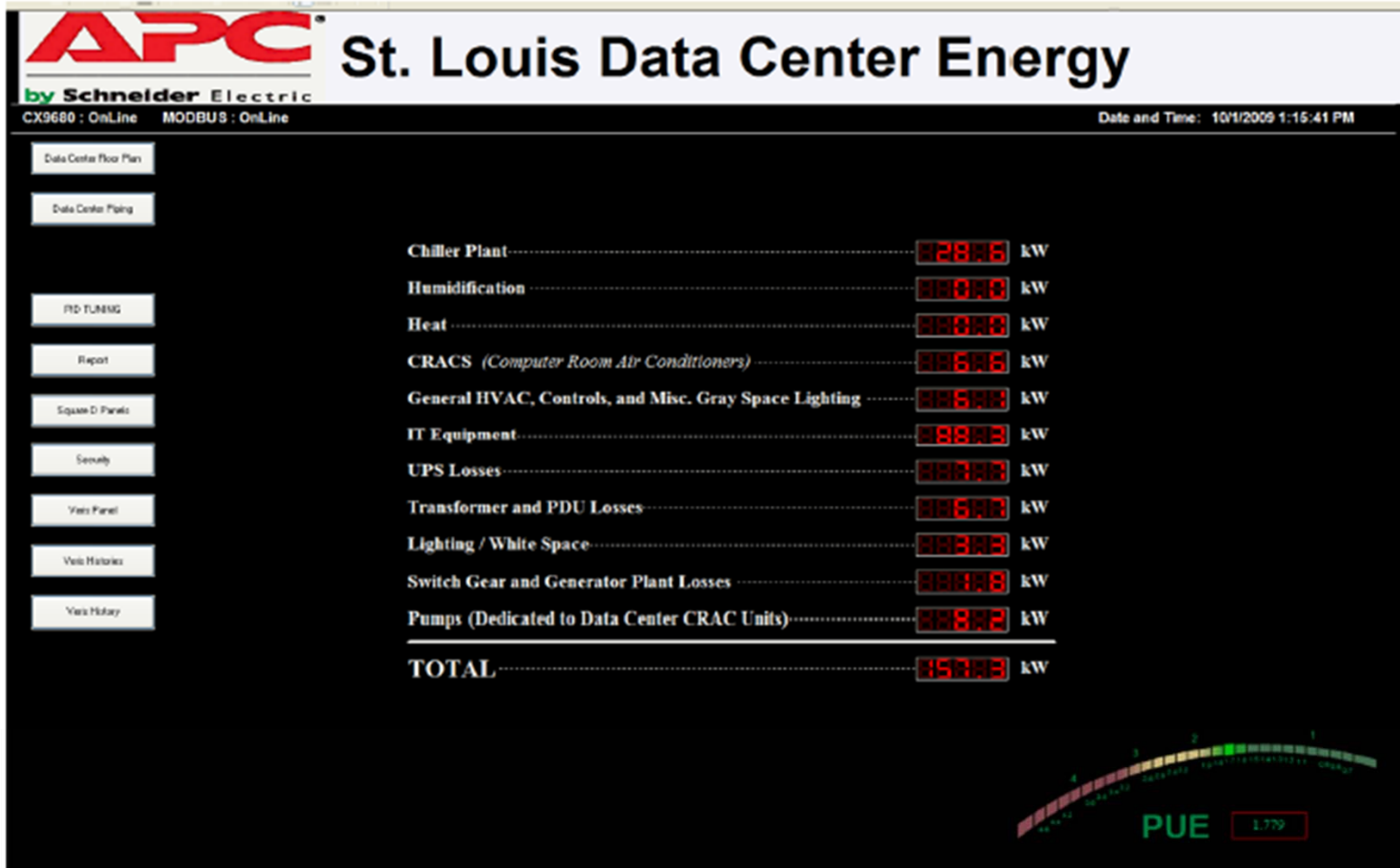
**APC**

by Schneider Electric



TRADEOFFTOOLS™

# Where we are today



# Summary



***Plans change – be ready with modular designs***

***Basing designs on modular systems & solutions allows for easier redesign when requirements change. Allows you to stay on track & on budget.***

***Right sized & efficient solutions are key to data center efficiency***

***Efficient components with flat efficiency curves are important, but integrated solutions & right sized designs are key to efficiency over its lifespan.***

***High availability and efficiency cannot be achieved without integrated monitoring & management systems***

***Integrated monitoring and management systems offer an unparalleled visibility & control. Efficiency monitoring can be achieved in tenant data centers.***

# Backup Slides



# IT Equipment at a glance

	APC	IBM managed SAP Bridge
<b>Servers</b>	Dell: Poweredge (rack and blade) HP - Integrity (RISC and Itanium) - 9000 IBM: Bladecenter L & H	IBM - p595 Power 6 servers / AIX HACMP - p520 TSM servers - HS21 blade servers / Novell SUSE Linux - Intel standalone servers
<b>Storage</b>	EMC IBM Quantum tape library	IBM - 3584 LTO tape backup - DS8300 SAN
<b>Network</b>	Cisco Catalyst 6500 series switches	Cisco Catalyst 6500 series switches
<b>Overall</b>	<b>6500 square foot data center with 500 + servers, 50% of which are virtualized</b>	



# Power System design & considerations

- The decision was made to deploy 415/240V in NAM to eliminate PDUs on the data center floor
- UPS systems and downstream distribution is zoned, rather than parallel redundant configuration
  - Allows for separate power zones in this data center where we have two tenants.
  - This saved money on paralleling switchboards
  - 3<sup>rd</sup> UPS power zone can be added at lower risk/complexity
- The facility has an onsite 34kV → 12.5kV substation
  - 12.5K → 415V transformers were in the design, but budget cuts changed the design to 480V → 400V transformers upstream of the UPS systems
- Dedicated 2N standby generators in the original design were eliminated, opting for use of the existing 2.5 MVA building generator
  - Concrete pad already poured for future second generator