

Lawrence Livermore National Laboratory (LLNL)
High Performance Computing (HPC)
Sustainability Master Plan
Power Management

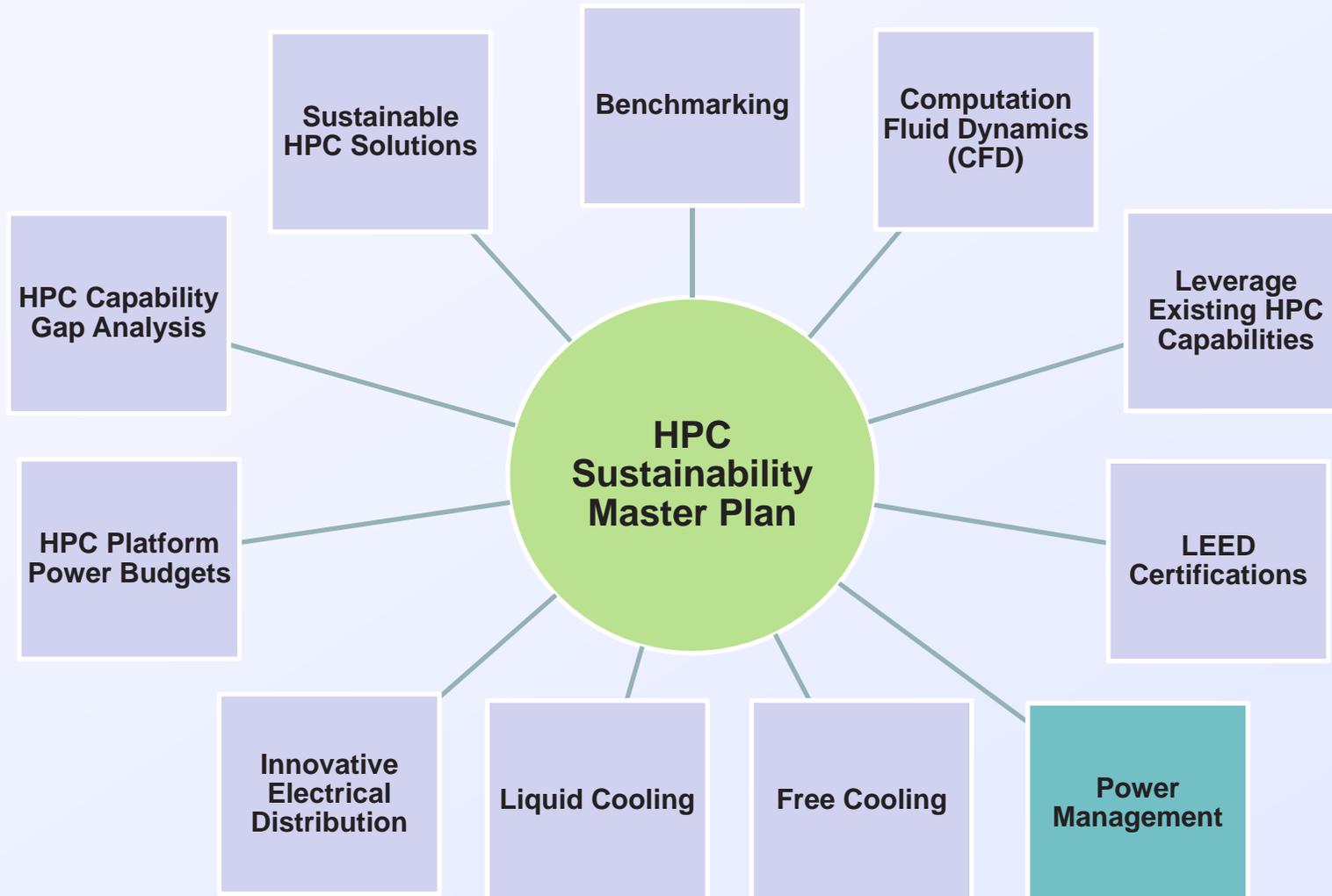


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Computation Directorate

Lawrence Livermore National Laboratory

HPC Sustainability Master Plan Core Competencies



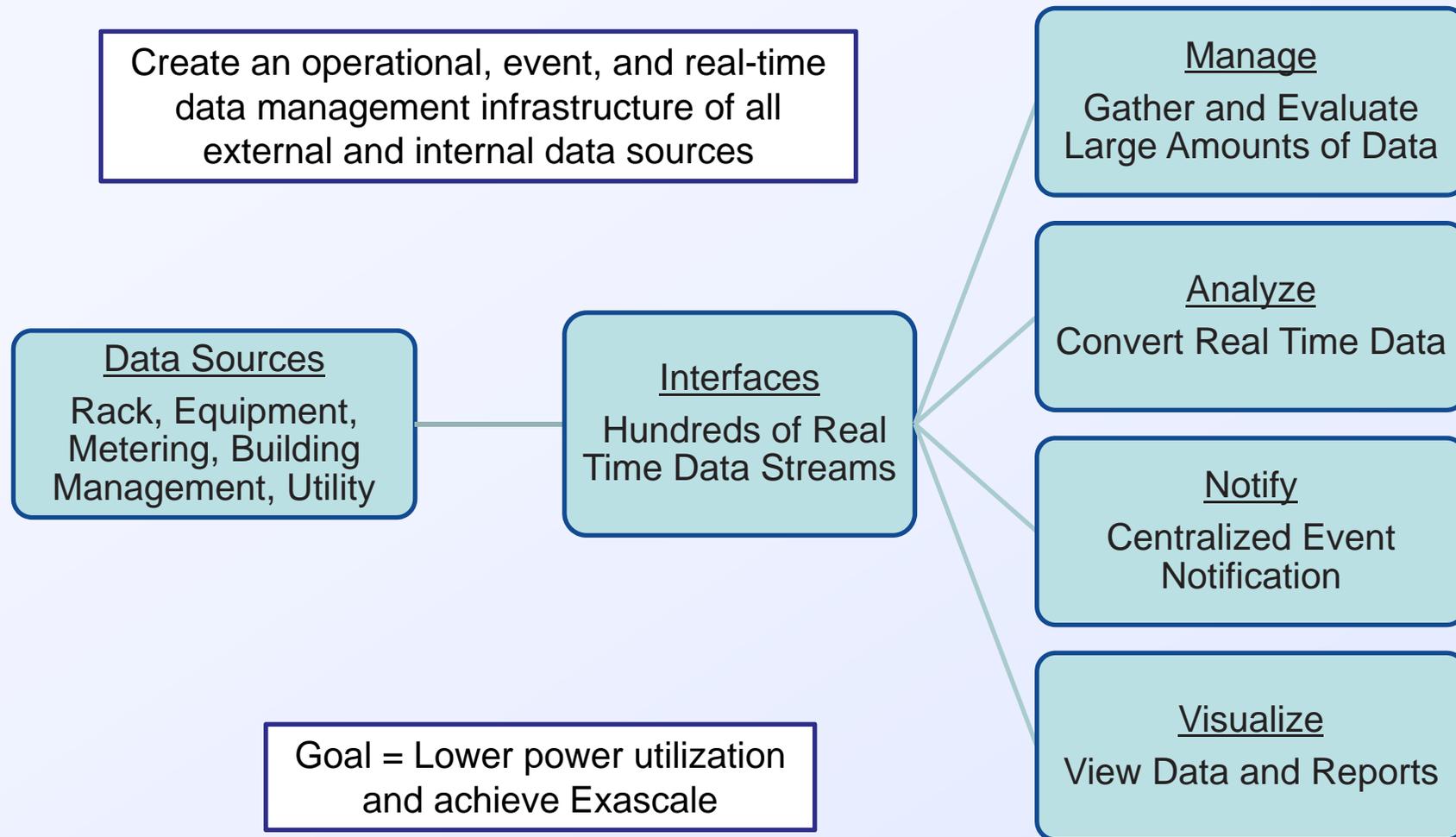
Power Management: Critical to success of energy management of HPC at LLNL and achieving Exascale



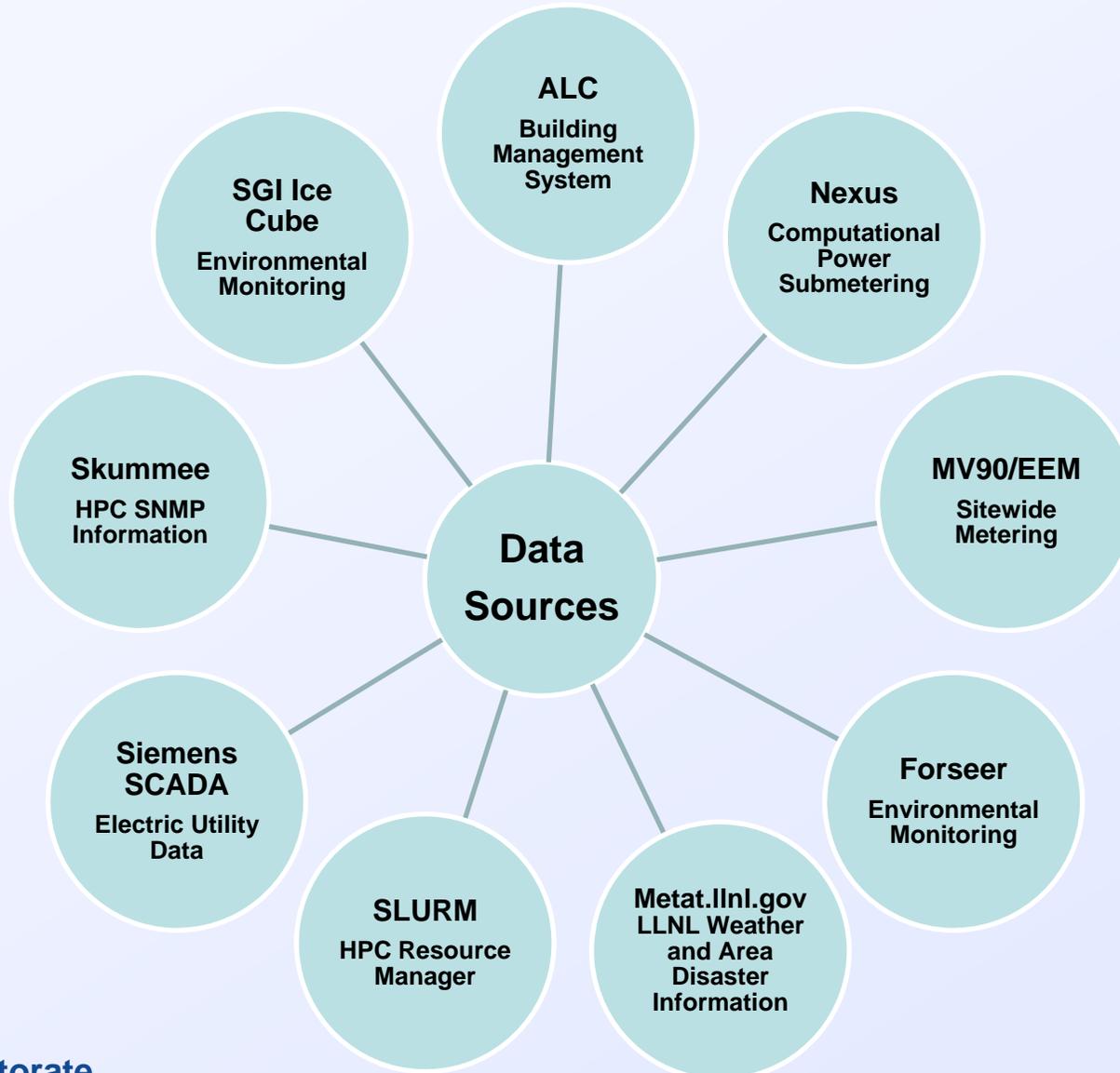
- Power management is critical but challenging to implement
 - Numerous data streams
 - Need to aggregate data into single source and view on common dashboard
 - Determining what data is significant
 - Unable to correlate events from various sources
 - Different timestamps and formats



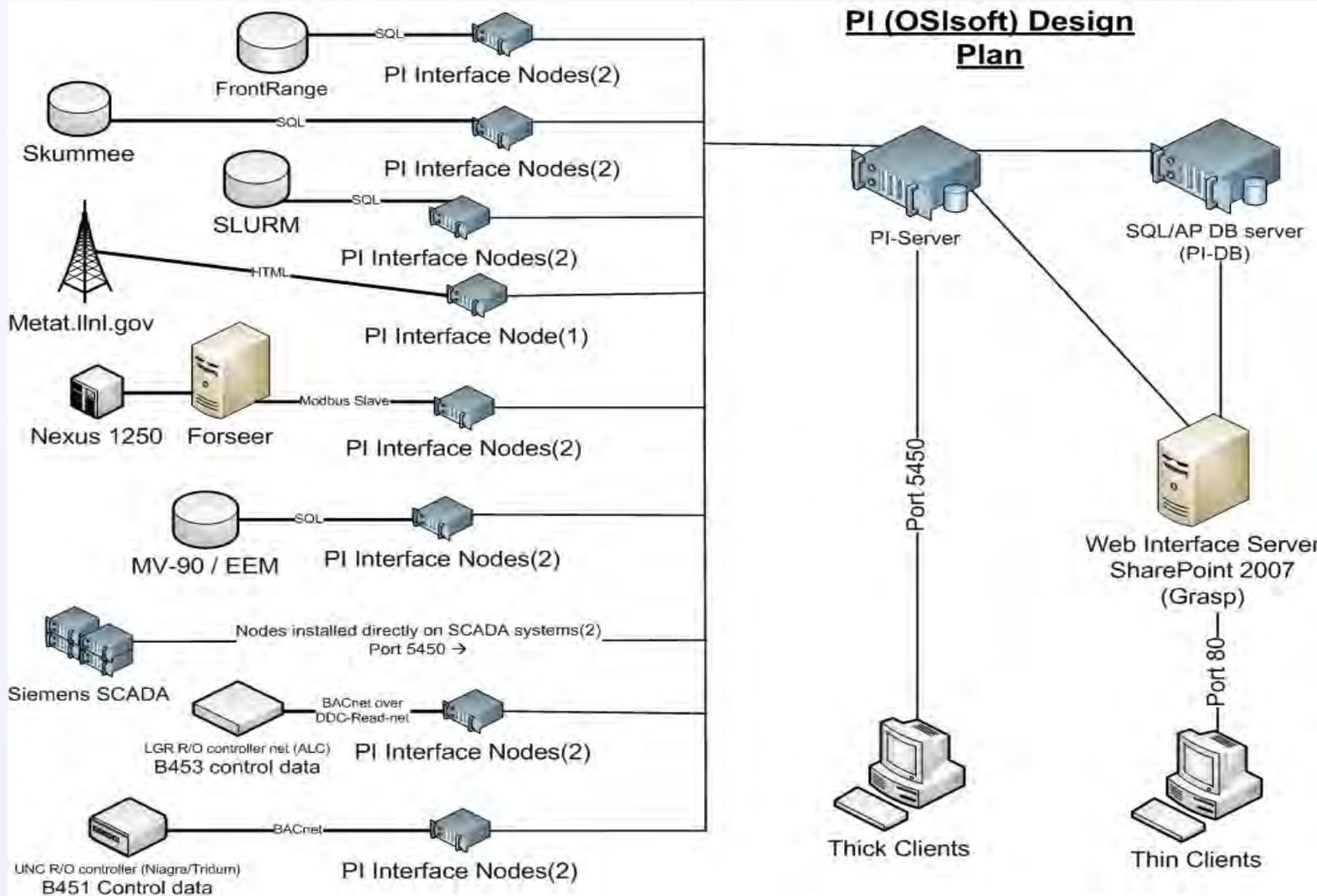
Power Management: Implement centralized system of real time data from the rack to the entire site



Power Management: Current data sources are spread across LLNL



Overall Management Architecture

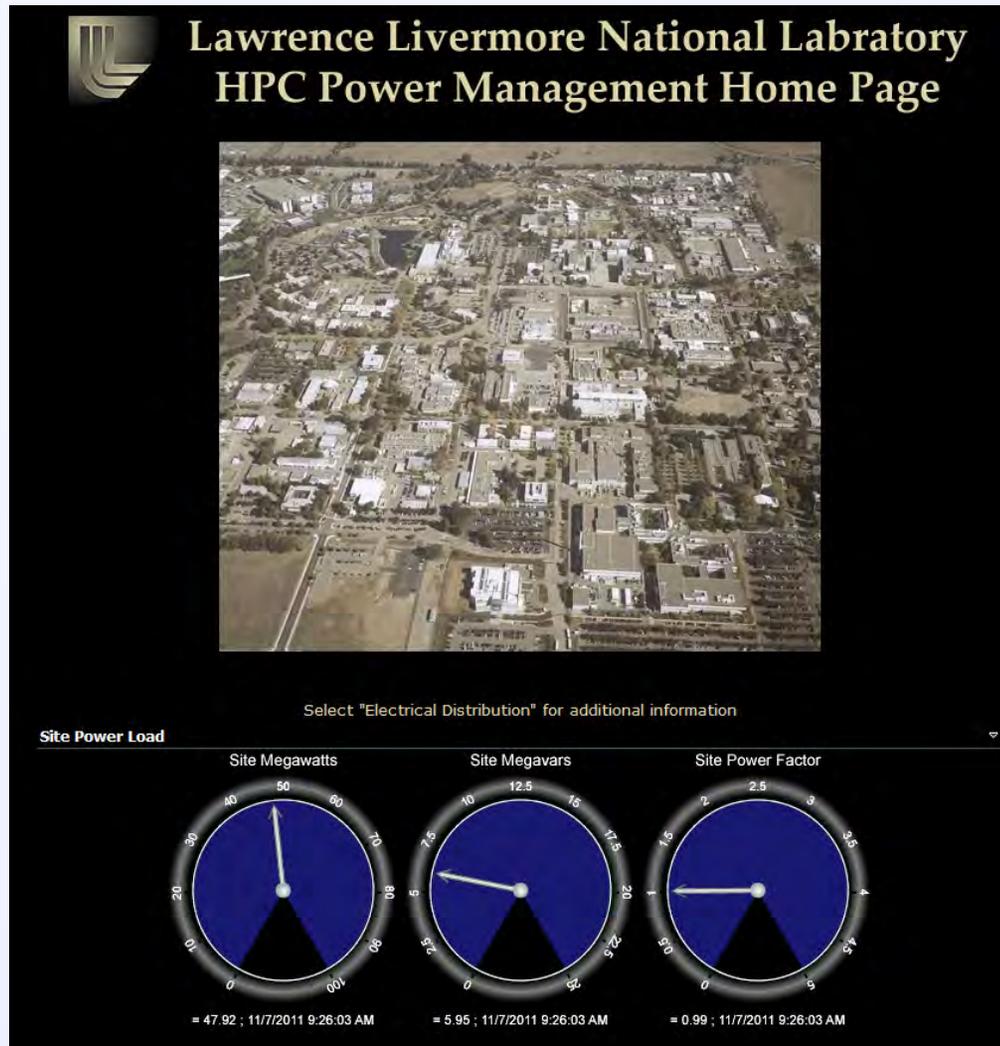


Power Management: Challenges

- Understanding how different types of hardware and software impact power utilization
- Correlating multiple types of data sources
- Coordinating with multiple owners of the data
- Accessing the data
- Selecting the best interface
- Comparing and viewing the data on a common platform
- Creating various dashboards

HPC Power Management System

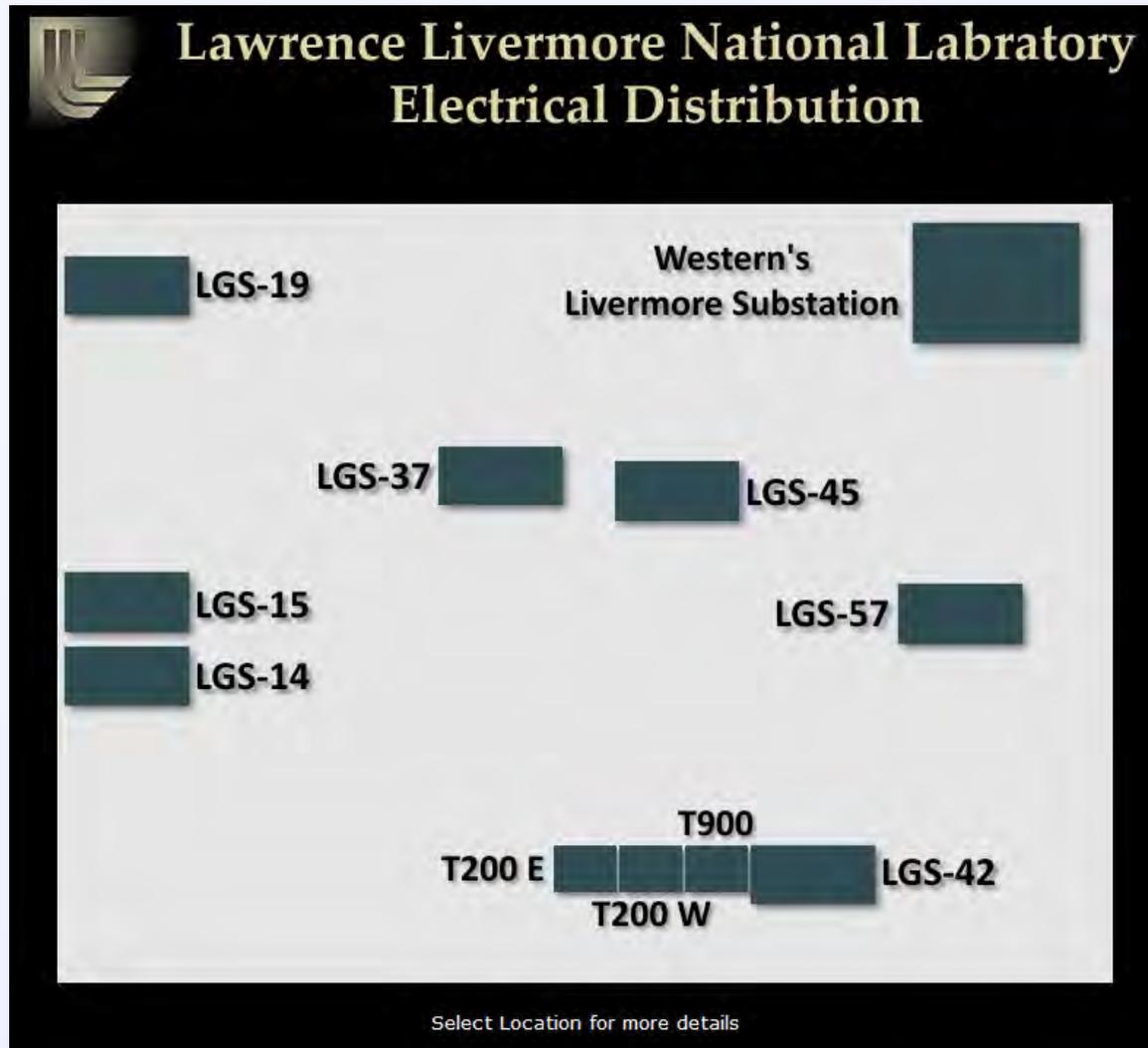
LLNL Electrical Distribution Home Page



- Instantaneous electrical site information
 - MW
 - MVAR
 - Power Factor



HPC Power Management System - LLNL Electrical Distribution



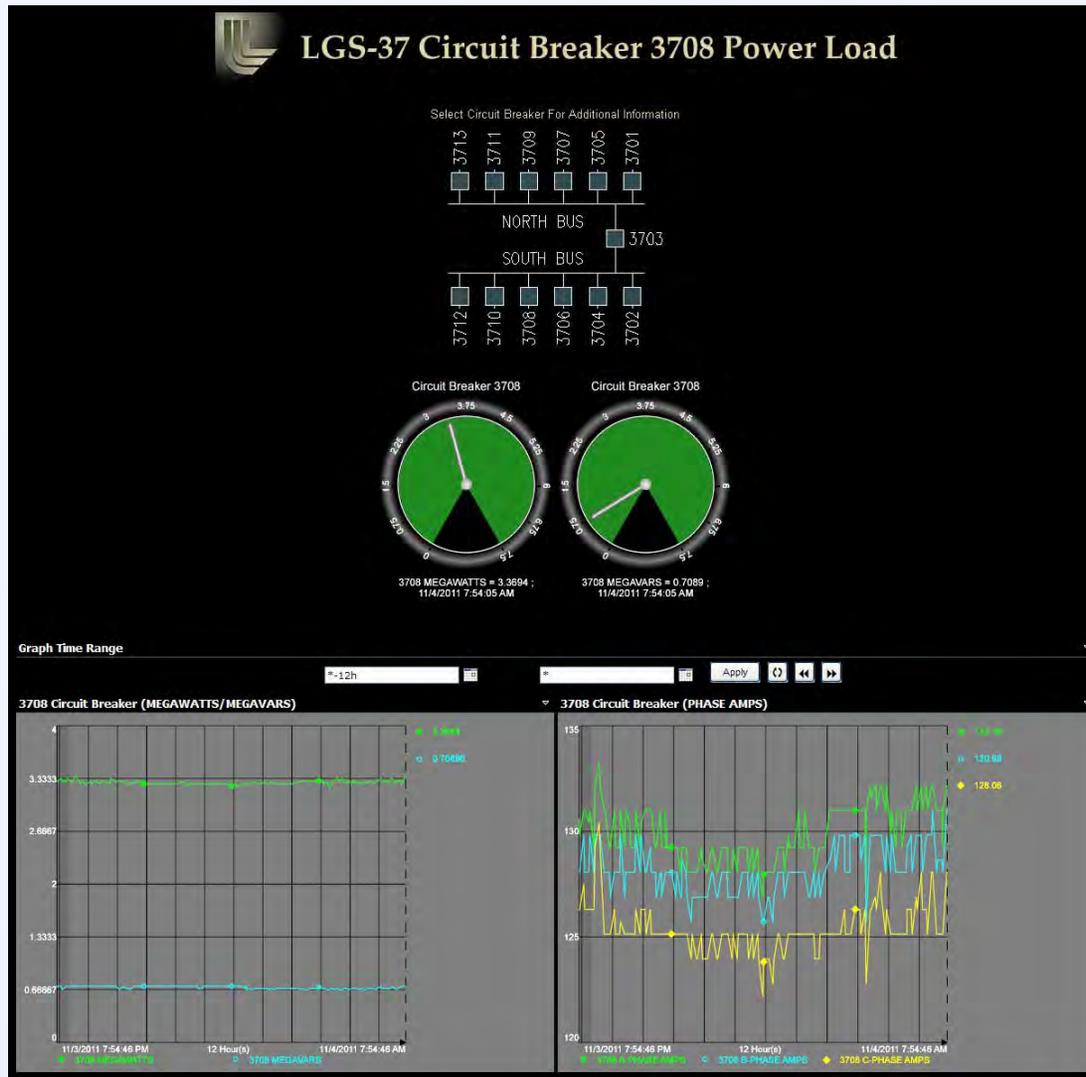
- 115kV Distribution
 - WAPA and PG&E Load Flow
- 13.8kV Distribution Load Flow at Load Grid Switchgear (LGS)
 - LGS-14
 - LGS-15
 - LGS-19
 - LGS-37
 - LGS-42
 - LGS-45
 - LGS-57

HPC Power Management System – LGS-37



- LGS-37 Example of Load Flow in MWs for the entire switchgear and each feeder
- 12 hour window illustrated
 - Window can be modified for different bandwidths

HPC Power Management System – LGS-37 Feeder 3708

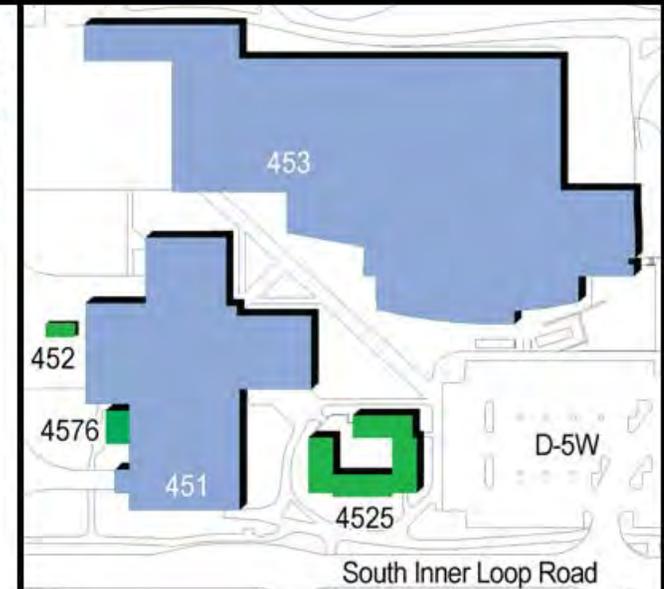
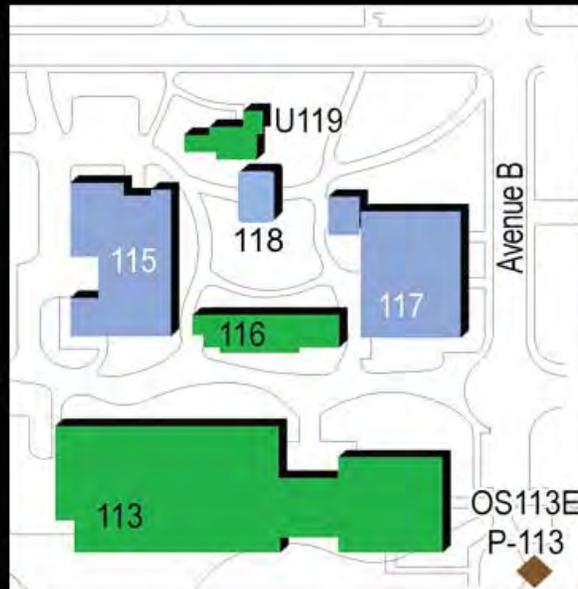


- LGS-37 Feeder 3708 Example of Load Flow
 - MW
 - MVAR
 - Phase Amps

HPC Power Management System - Livermore Computing



Lawrence Livermore National Laboratory Computation Facilities



Select building 453 for more information



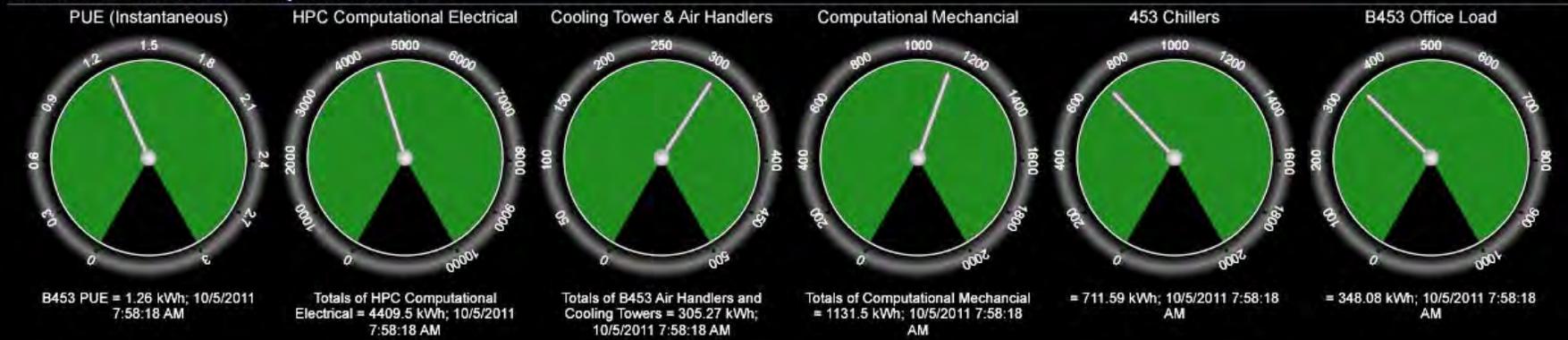
HPC Power Management System - B453 TSF Overview



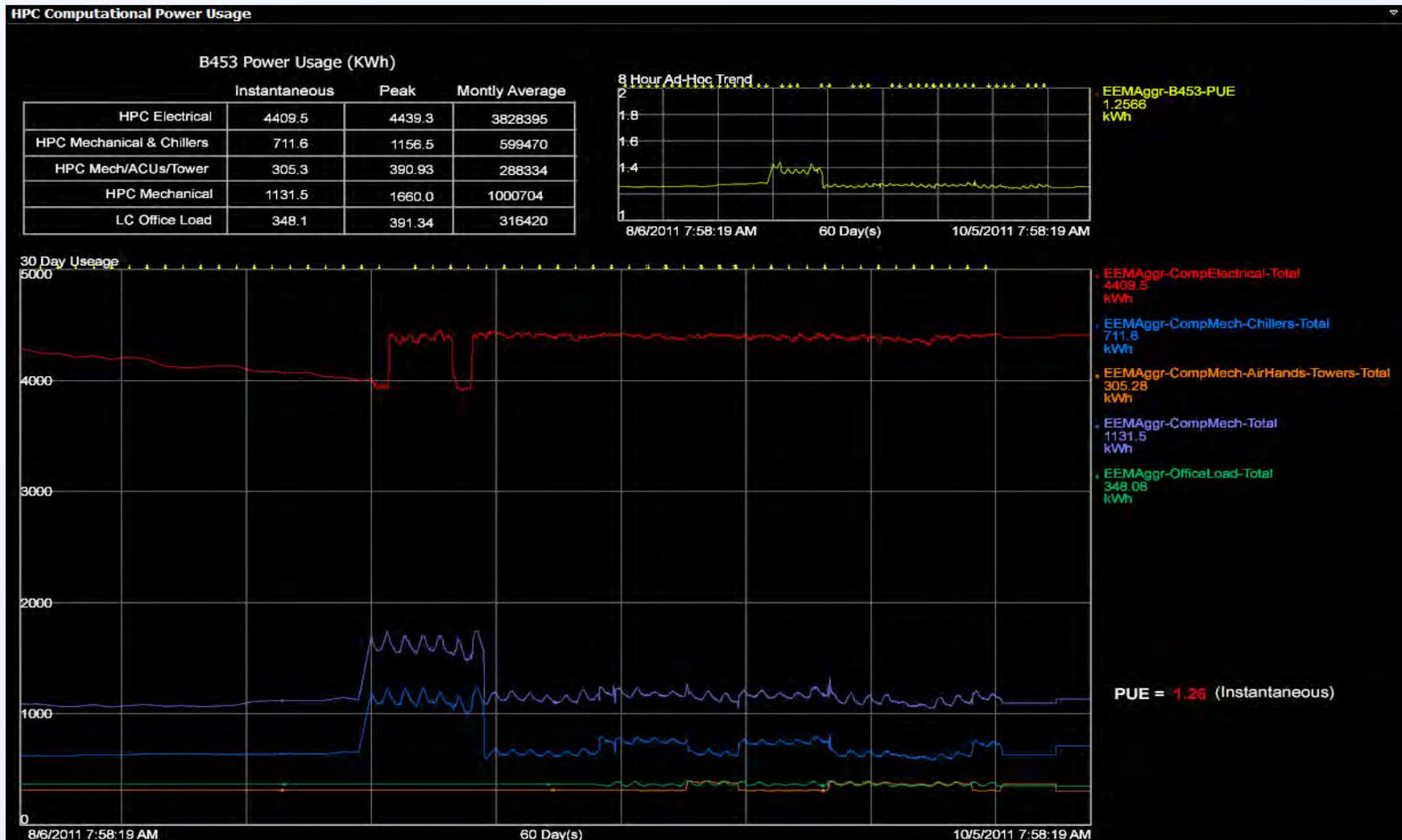
Lawrence Livermore National Laboratory Building 453



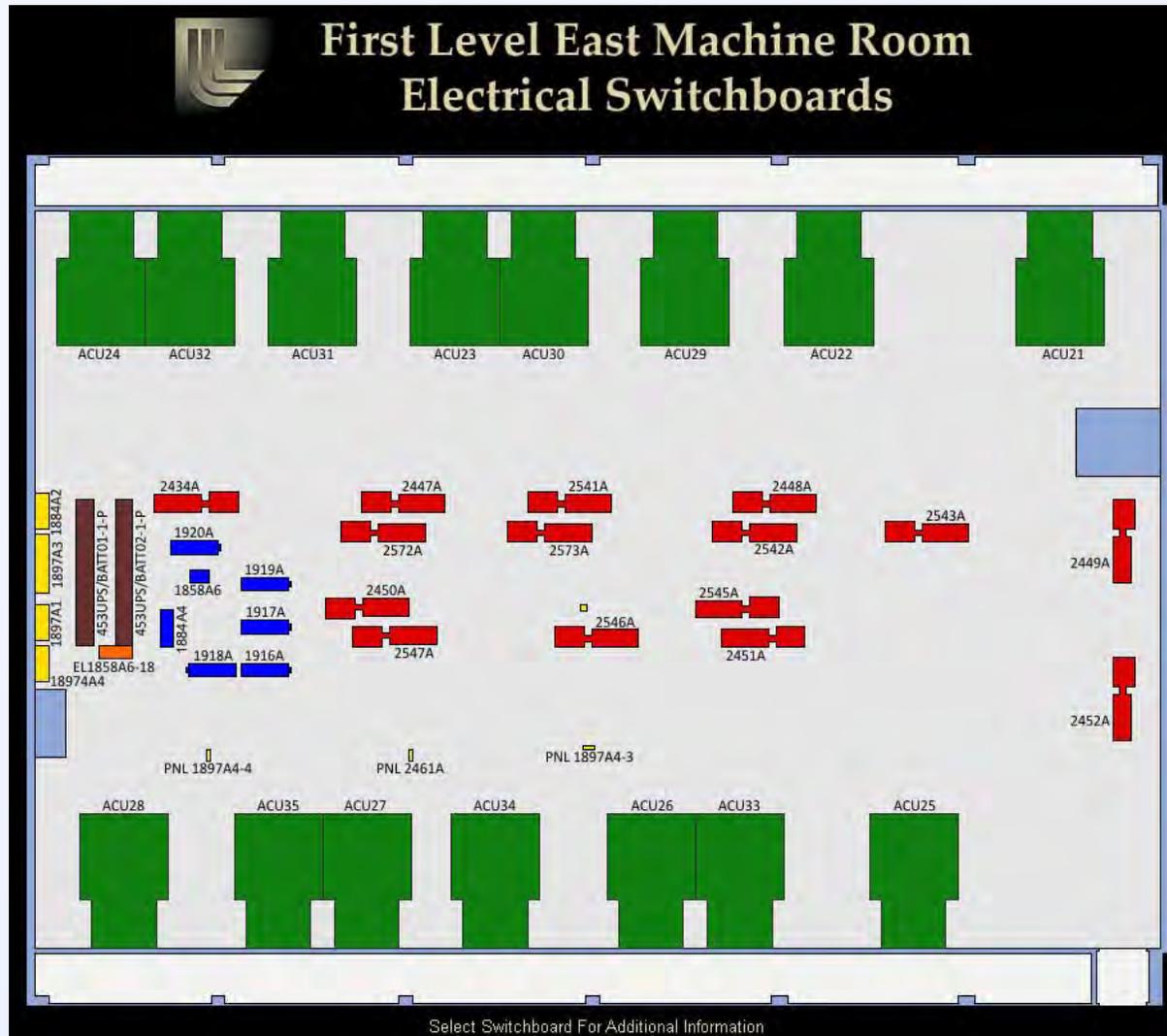
Instantaneous Totals of HPC Computational Electrical



HPC Power Management System - B453 TSF Load Graphs

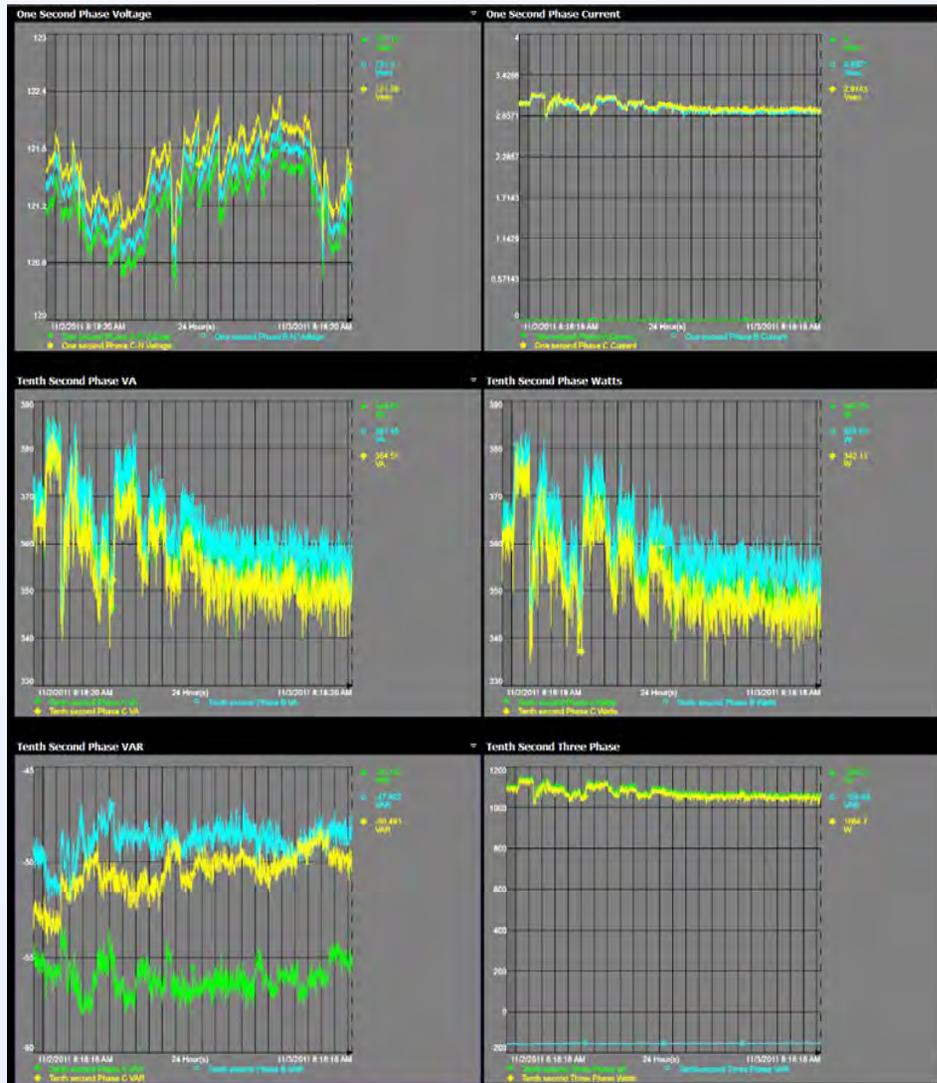


HPC Power Management System - B453 1st Level Machine Room



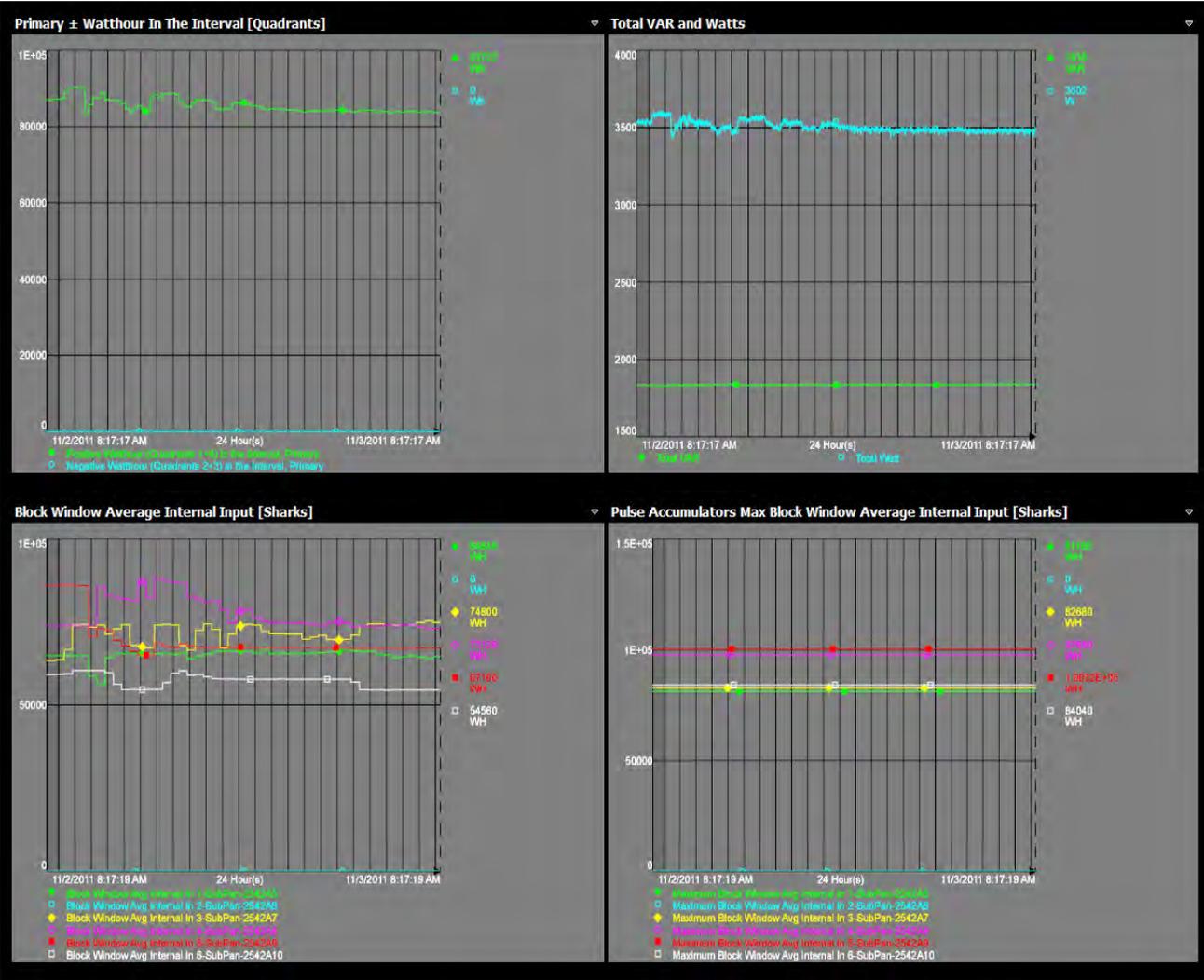
- Switchgear interface for computational load
- Select #2541A

HPC Power Management System - B453 Switchboard 2541A



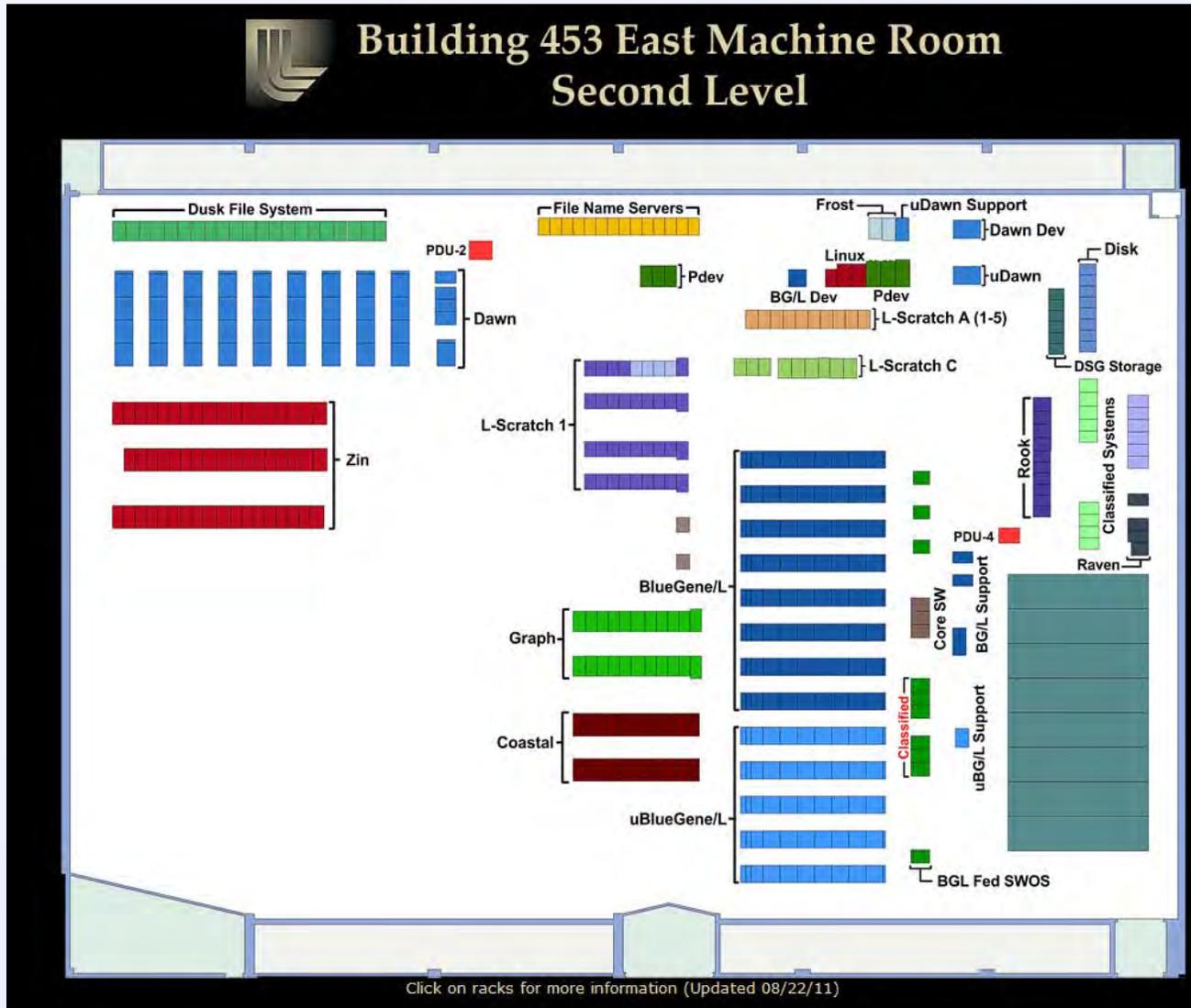
- Phase Data
 - Voltage
 - Current
 - VA
 - Watts
 - VAR
- Total Instantaneous Watts, VARs and VA

HPC Power Management System - B453 Switchboard 2541A



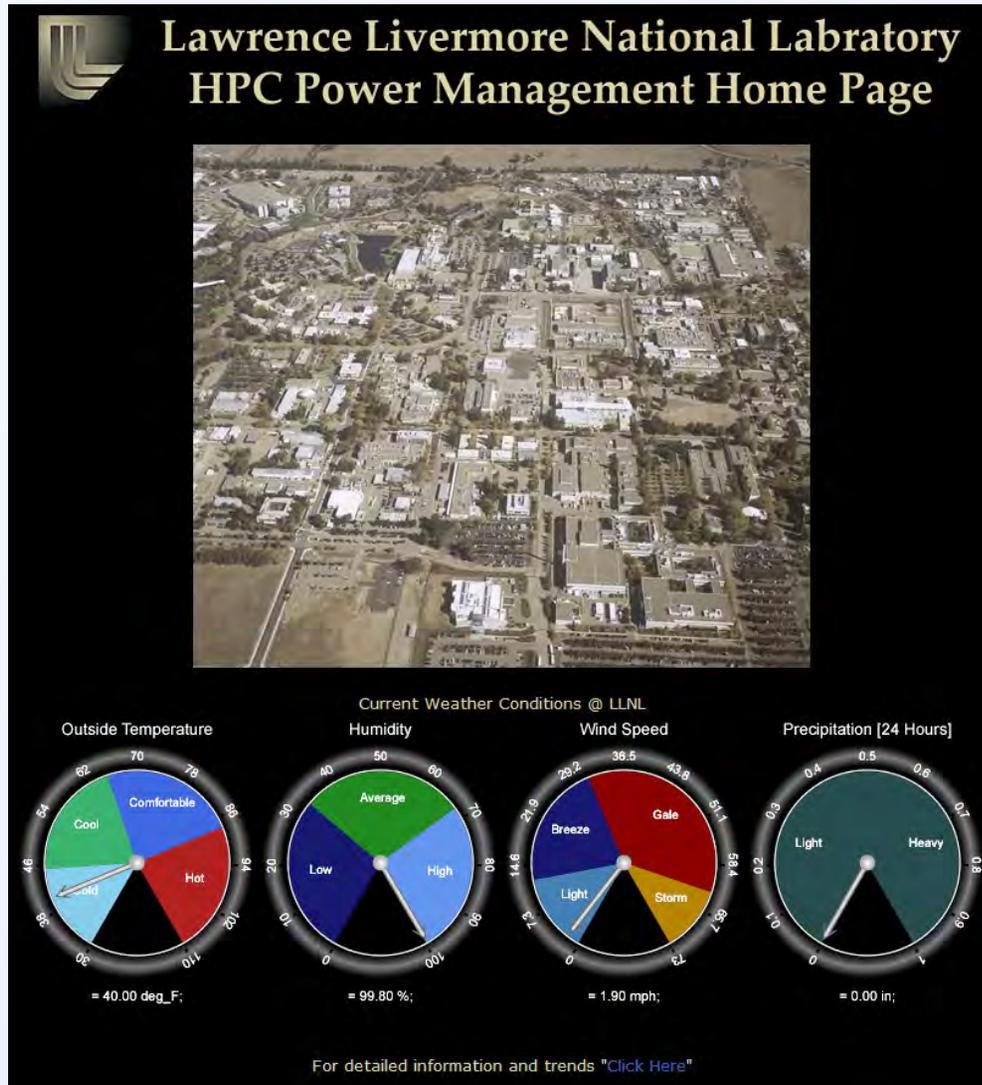
HPC Power Management System

B453 2nd Level East Machine Room



HPC Power Management System

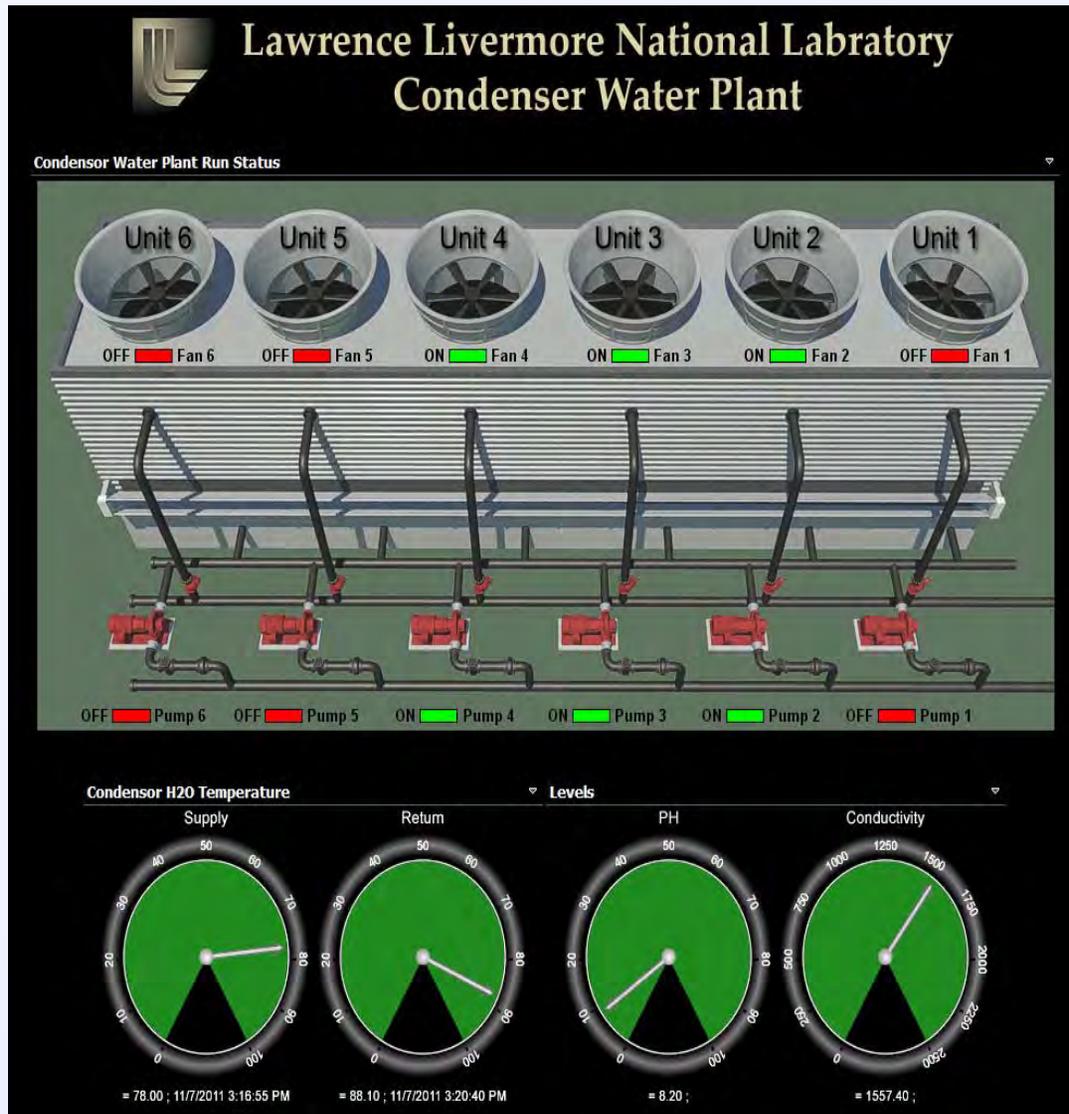
LLNL Mechanical Distribution Home Page



- Instantaneous Environmental Conditions
 - Outside Temperature
 - Humidity
 - Wind Speed
 - Precipitation

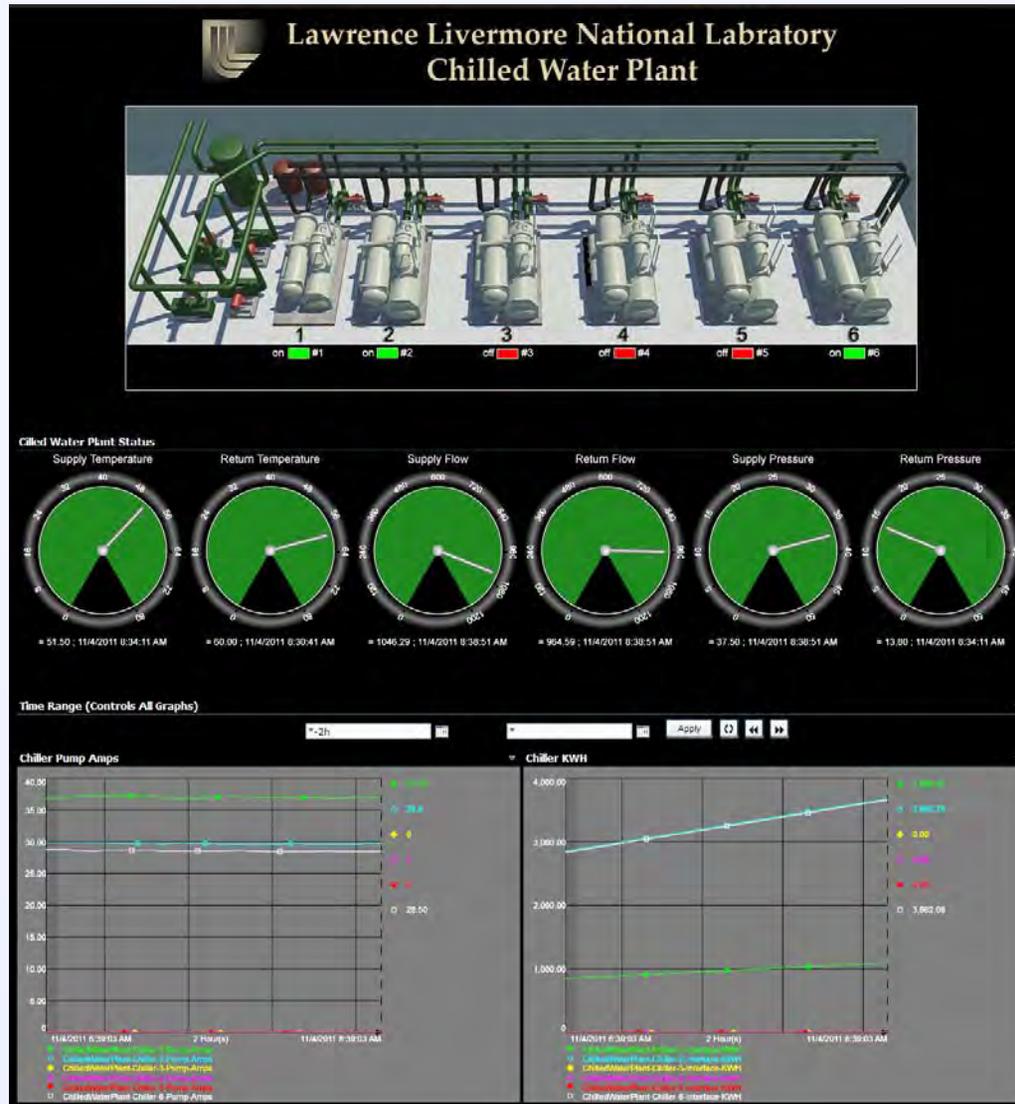


HPC Power Management System - Condenser Water Plant



- Equipment Status
- Environmental Conditions
 - Supply Temperature
 - Return Temperature
 - PH
 - Conductivity

HPC Power Management System - Chilled Water Plant



- Equipment Status
- Environmental Conditions
 - Supply Temperature
 - Return Temperature
 - Supply Flow
 - Return Flow
 - Supply Pressure
 - Return Pressure

Questions

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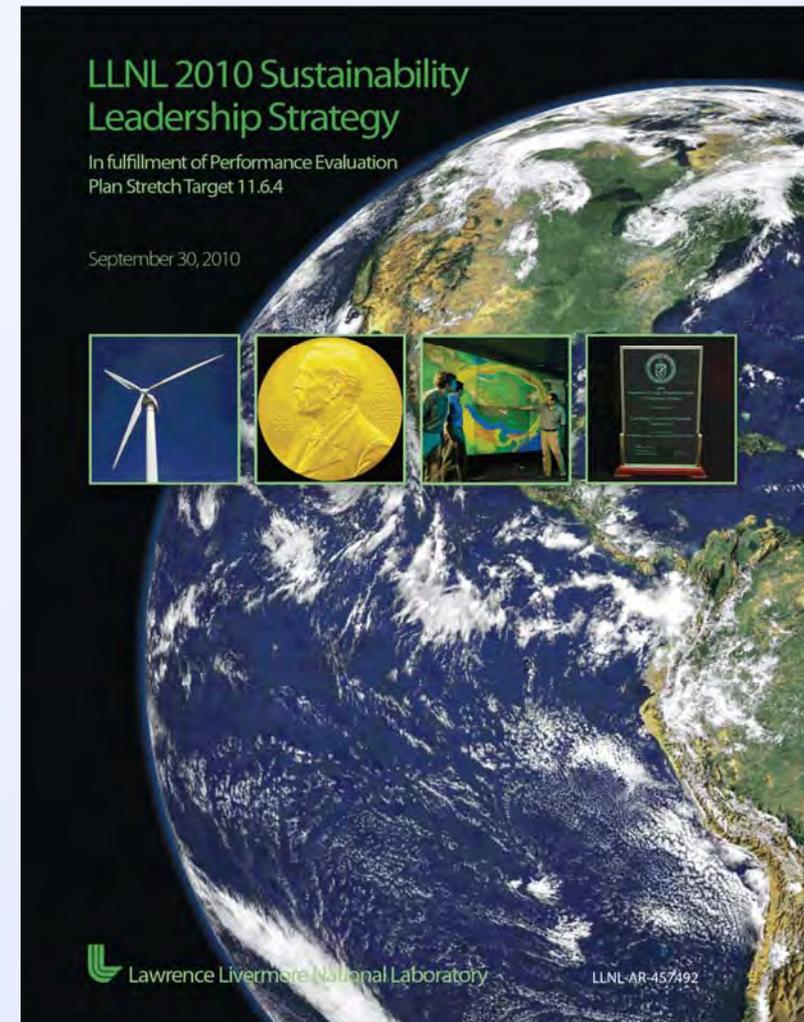
LLNL's Sustainability Leadership Strategy

- Developed a Strategic Plan
 - Sustainability is integral to the Laboratory's mission success
- Developed key points of integration
 - Facilities and infrastructure management
 - Mission and program engagement
 - Workforce involvement
 - External stakeholder relations.
- Creating synergy to foster sustainability and mission success
- Integrating a process for the entire organization



Sustainability Program Vision at LLNL

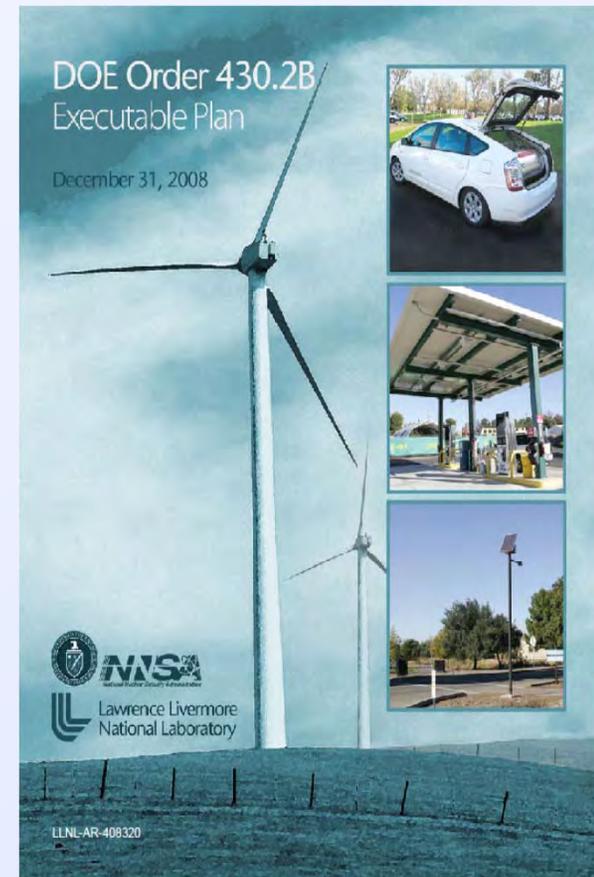
- Create governance process
 - Sustainability Advisory Board (SAB) and Sustainability Working Group (SWG)
- Leverage current successes
- Track metrics
- Communicate strategies and successes to employees
- Outreach programs to the community



HPC at LLNL strives to reduce energy consumption and ultimately reduce operating costs



- Energy conservation is critical to improve efficiencies and reduce operational costs
 - Operational efficiencies are vital to future of HPC - **Exascale Computing**
- Executive Order DOE 430.2B
 - Reduce energy intensity 30% by 2015 from baseline (FY03)
- Address High Performance Computing (HPC) capabilities and gaps as well as energy impacts site wide
- Developed HPC Sustainability Master Plan to feed into overall LLNL Sustainability Program



HPC's goal is to develop efficiencies across TSF complex "Turn Megawatts into PetaFLOPS and ExaFLOPS"



■ Highlights:

- Capitalized on flexible and scalable infrastructure of the facility and computational platforms
- Performed extensive benchmarking
- Prepared comprehensive computational fluid dynamics (CFD)
- Improved operational efficiencies
 - DOE FEMP 2009 Energy Award
 - B-453 LEED Gold Certified Awarded on December 2009 and B-451 LEED Silver April 2011

