

Managing Energy & Water Use at NERSC: Multidisciplinary Teamwork



Norman Bourassa
Building Infrastructure Group
HPC User Fal Forum - Sept. 6 & 7, 2023

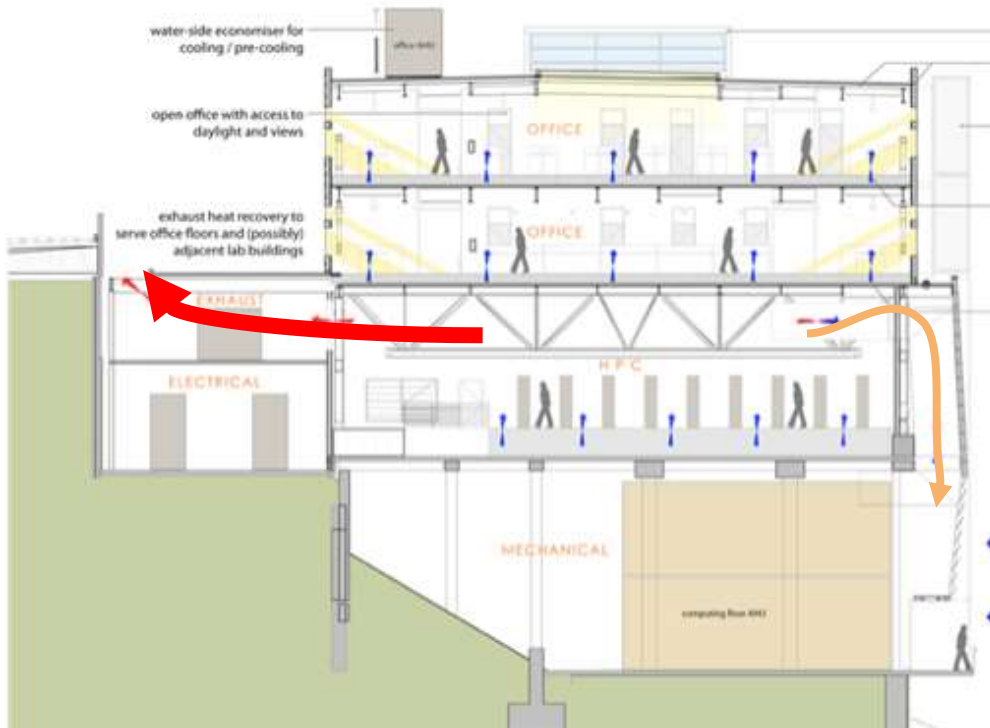
Suzy's Guiding Questions

- Brief background about your center
- Define sustainability for your HPC center
- Do you have Sustainability Goals, if yes then
- Sustainability Goal hurdles
- Utility provider challenges
- Any HPC Application Code power efficiency work

Background: Shyh Wang Hall - Building 59



Background: Building 59 Section View

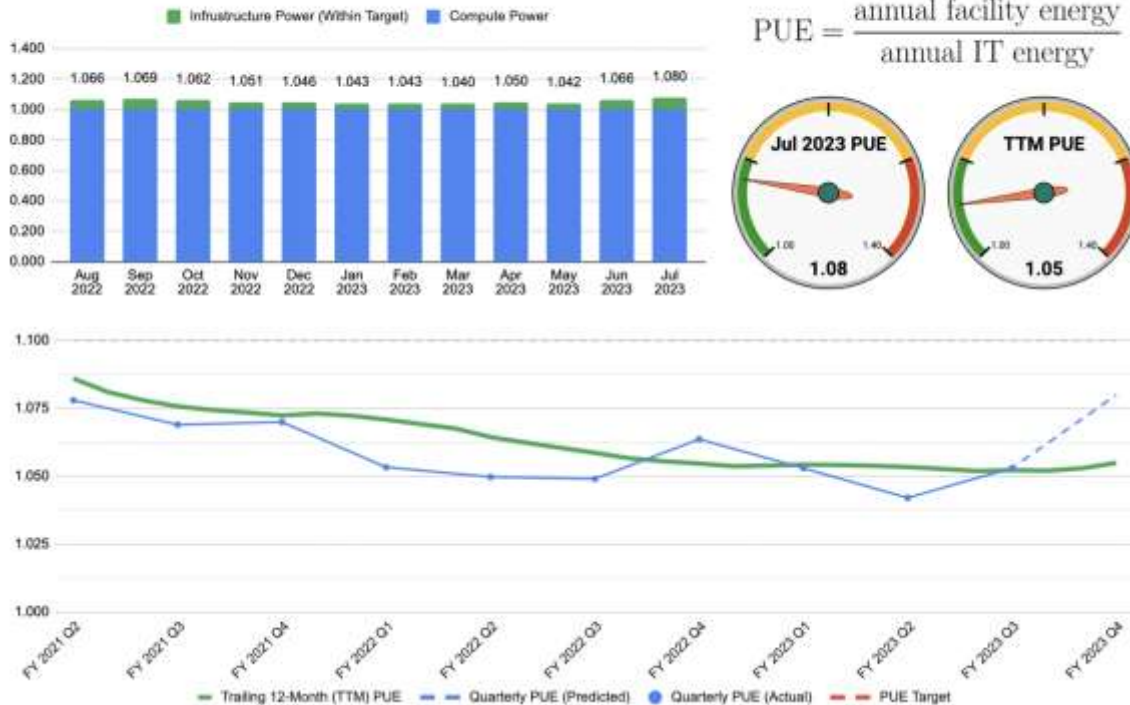


- Four-Story 150,000 GSF (13,935 M²)
 - Two 20k sf office floors, 300 offices
 - 28k sf HPC floor
 - 21.5 MW HPC Electrical Service
 - Current peak demand ~6 MW (Cori Retired)
- Energy Efficient
 - Year-round compressor-free air and water cooling
 - LEED Gold Rated Building
 - High resolution monitoring (OMNI system)
 - **TTM PUE 1.05**
- Room Air & Cooling Water
 - ~70% annual hours, single pass air
 - Full year, wet cooling towers provide 75°F (24°C) or colder Cooling Water (CW) for HPC loads

Background: Trailing 12-Month (TTM) PUE

NERSC PUE Dashboard (Jul 2023)

LBNL Energy Management Power Usage Effectiveness (PUE) Target < 1.10



Background: HPC Average Power History

Perlmutter: 3x Cori Flops, ~4.5 MW, ~50% MUS *



Cori: 5x Edison Flops, ~4 MW, 70% MUS (Retired)



Edison: ~2 MW , 70% MUS (Retired 2018)



* Machine Unit Specification: Vendor provided peak power rating

Define Sustainability: Three Guiding Categories

- Compute Job & Application QA/QC
 - A failed Job is pure energy waste
 - Opportunities:
 - Job code “Tuned Approximation” for the science need
 - Typically 10% of active Jobs, responsible for 70% of power demand
- Site Specific Facility Design
 - Dissipate waste heat directly to outside environment or other end-uses
 - Avoid vapor-compression based cooling systems
- High Resolution Instrumentation for Operational Data Analytics (ODA)
 - Supporting all operational activities
 - Core tool for Ongoing Commissioning (OCx) of Building 59 systems

Sustainability Goals: NERSC Dominates Campus Energy

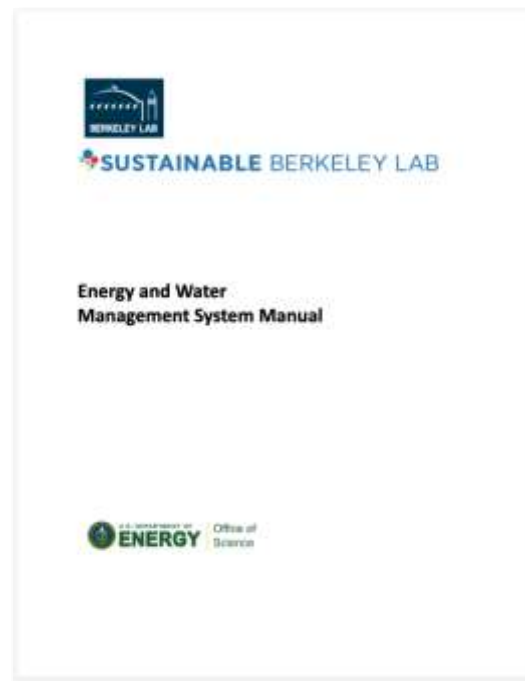
At ~35% of campus energy demand, NERSC is the Significant Energy User (SEU) in the LBNL Energy & Water Management Program

LBNL Receives DOE's 50001 Ready & ISO 50001

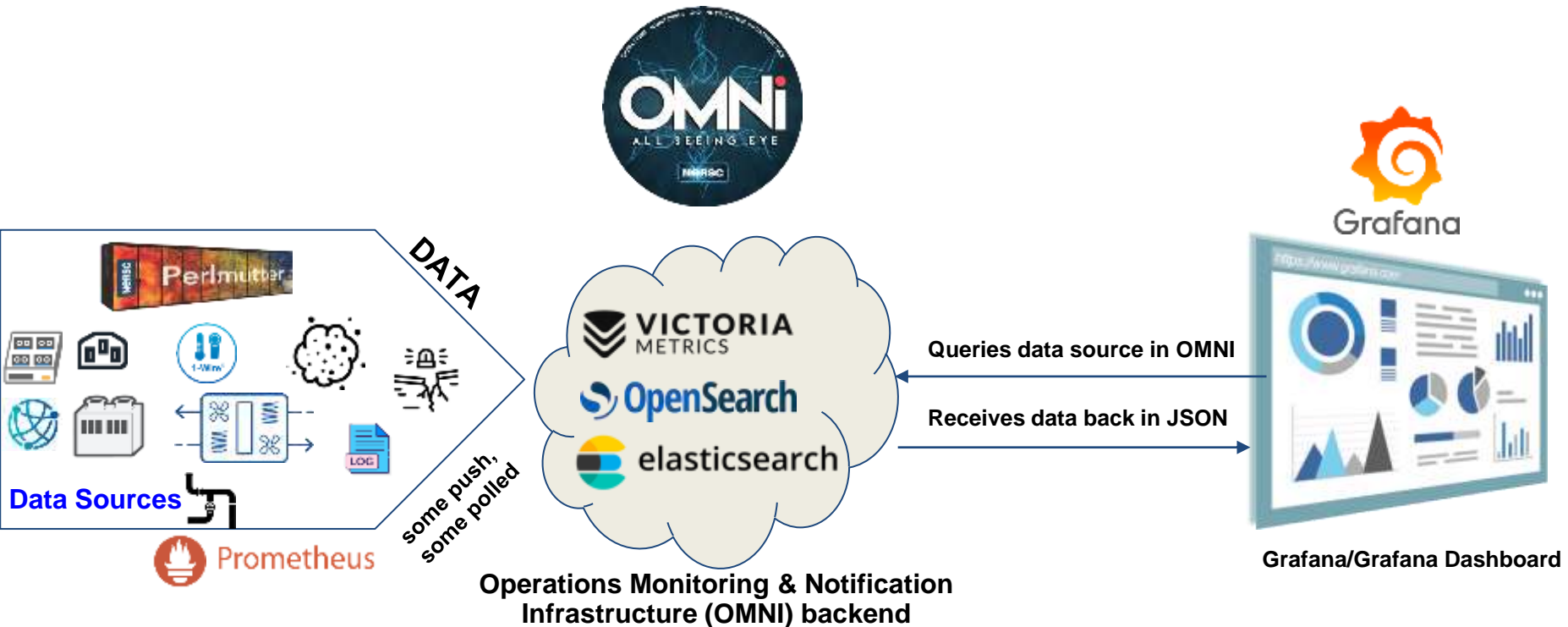


Photo Credit: LBNL. Shyh Wang Hall, home of NERSC, the Lab's high performance computing center.

After nearly three years of development and implementation, Lawrence Berkeley National Laboratory (LBNL) received DOE's 50001 Ready recognition in June 2020, and was subsequently ISO 50001 certified in September 2020 with zero non-conformities. ISO 50001 is an international standard for managing and improving energy management and DOE's 50001 Ready Program is a free, self-guided approach based on the principles of the ISO guidance. LBNL pursued 50001 as a way to ensure both its energy and water management activities and efficiency savings were strategic, effective, and persistent.



Sustainability Goals: NERSC OMNI Data Infrastructure




Sustainability Goals: Inter-Division Collaboration



BERKELEY LAB Bringing Science Solutions to the World

31 Elements
News for Employees at Berkeley Lab

Monday, Feb. 24



Groundbreaking Step Toward Efficient Data Centers

Berkeley Lab's decades of expertise in energy-efficient data centers is now being applied to NERSC resources via the Efficiency Optimization Project, a partnership between NERSC, ETA, and Sustainable Berkeley Lab that uses operational data analytics to optimize cooling systems and save electricity.



HPC NEWS

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Berkeley Lab Team Improves HPC Datacenter Efficiency with Analytics
By Claire Nacham

February 25, 2020

As HPC datacenters scale up, improving efficiency is crucial to avoiding correspondingly large energy use (and the ensuing high costs and large carbon footprints). Now, a team at Lawrence Berkeley National Scientific Research Cor...



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LESS IS MORE: LBNL BREAKS NEW GROUND IN DATA CENTER OPTIMIZATION
NERSC efficiency metrics project leverages Lab's decades-long expertise in energy management

FEBRUARY 16, 2020
COURTESY: TONY WILSON, BERKELEYLAB.GOV / LBNL LAB PRESS

Energy users to improve energy efficiency at high performance computing (HPC) data centers is a real challenge and it is an ongoing one. Energy-intensive data centers, storage in the service of data, and pressure to reduce energy consumption and carbon footprint. Together these factors ultimately influence the design and maintenance of HPC facilities and the hardware and software ecosystem which runs them.

Following up on Berkeley Lab's decades-long National Laboratories (NERSC) lab mission of the forefront of efforts to design, build, and optimize energy-efficient systems and services. The Energy Technologies Area (ETA) has supported the National Energy Research Scientific Computing Center (NERSC) and other Berkeley Lab facilities on energy issues for some 20 years, according to Rich Brown, a research scientist at ETA's Building Technologies and Urban Systems Division. In 2017, for example, Berkeley Lab was lead author on a U.S. Environmental Protection Agency (EPA) study of the overall impact of data center energy use and on the resulting CO2 output. In addition, EPA has been involved in EPA Energy Wise program for more than 20 years, developing specifications for servers, data storage, and network equipment.

"Berkeley Lab has been the most contributor to the U.S. on data center energy use research," Brown says. "It's an ongoing energy mission, and the center has a tradition of the environmental impacts of energy use." Much of the work that Brown leads through the National Energy Research Scientific Computing Center is focused on



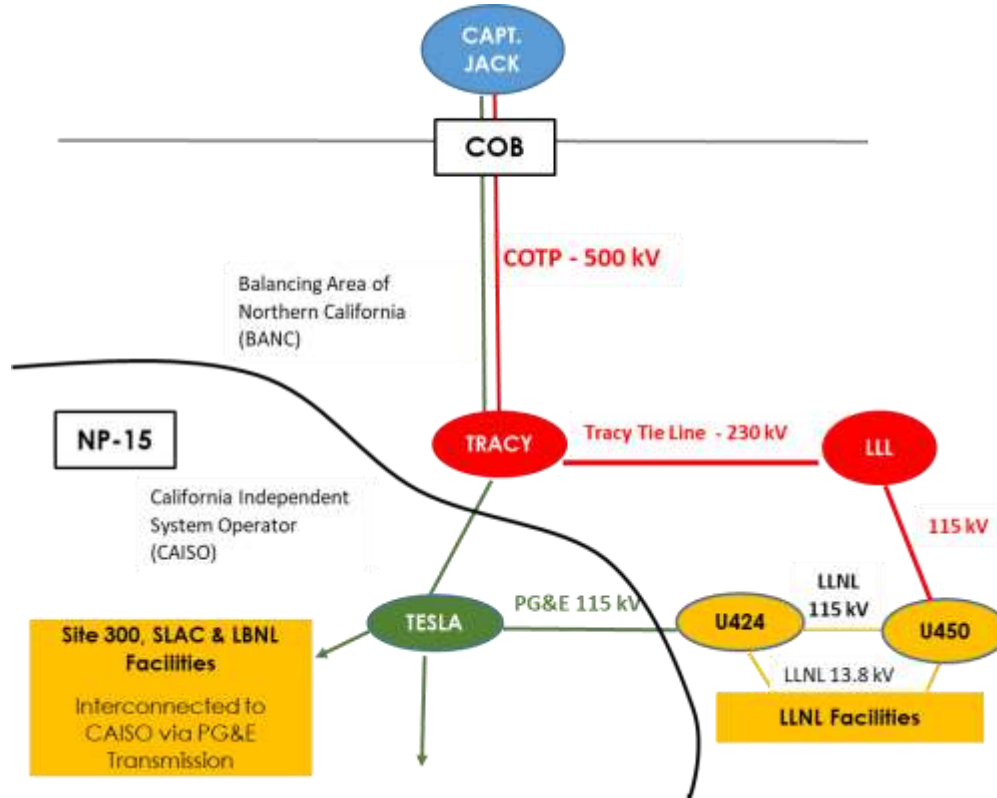
"The cooling system at NERSC, part of what makes the Berkeley Lab..."



Utility Providers: DOE Lab Power Consortium

- A collaboration between three divisions of the U.S. Department of Energy (DOE):
 - Western Area Power Administration (WAPA)
 - Office of Science, Berkeley Site Office (BSO)
 - National Nuclear Security Administration (NNSA)
- Made possible by the federal government's investment in hydropower and transmission in California's Central Valley region
- An important component of advancing science by helping to keep research costs lower

Utility Providers: CA DOE Lab Locations & Interconnections



Combined Load = ~100 MW

Key

- = WAPA Facilities
- = BPA Facilities
- = PG&E Facilities
- = DOE Facilities

App Power Codes: Jobs & Application Code Energy Efficiency



HPC EE studies at NERSC

- Detailed Job & App power profiling
- CPU vs GPU energy studies *
- Frequency tuning & energy-to-solution optimization



* Paper: *VASP Performance on HPE Cray EX Based on NVIDIA A100 GPUs and AMD Milan CPUs*, Zhengji Zhao (NERSC) et al, 2023.



Thank You

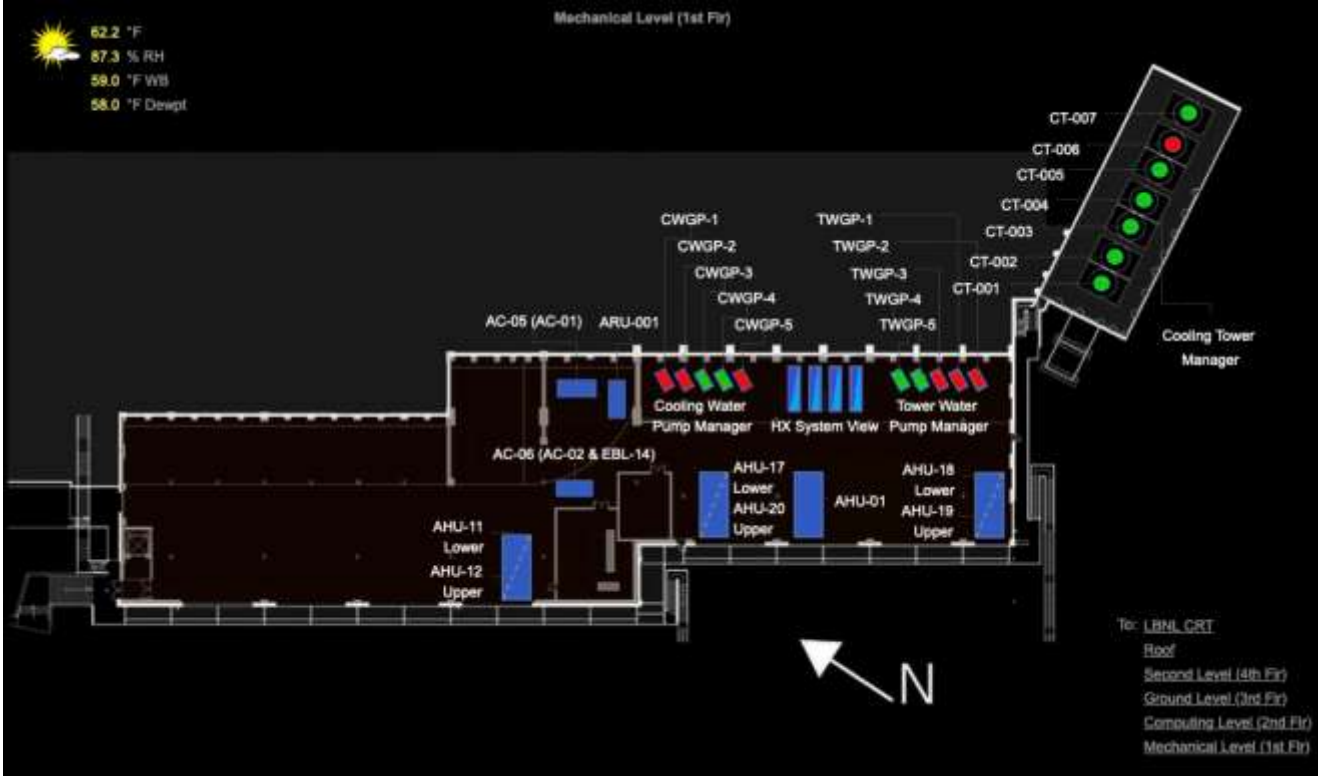
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Perlmutter (N-9) System

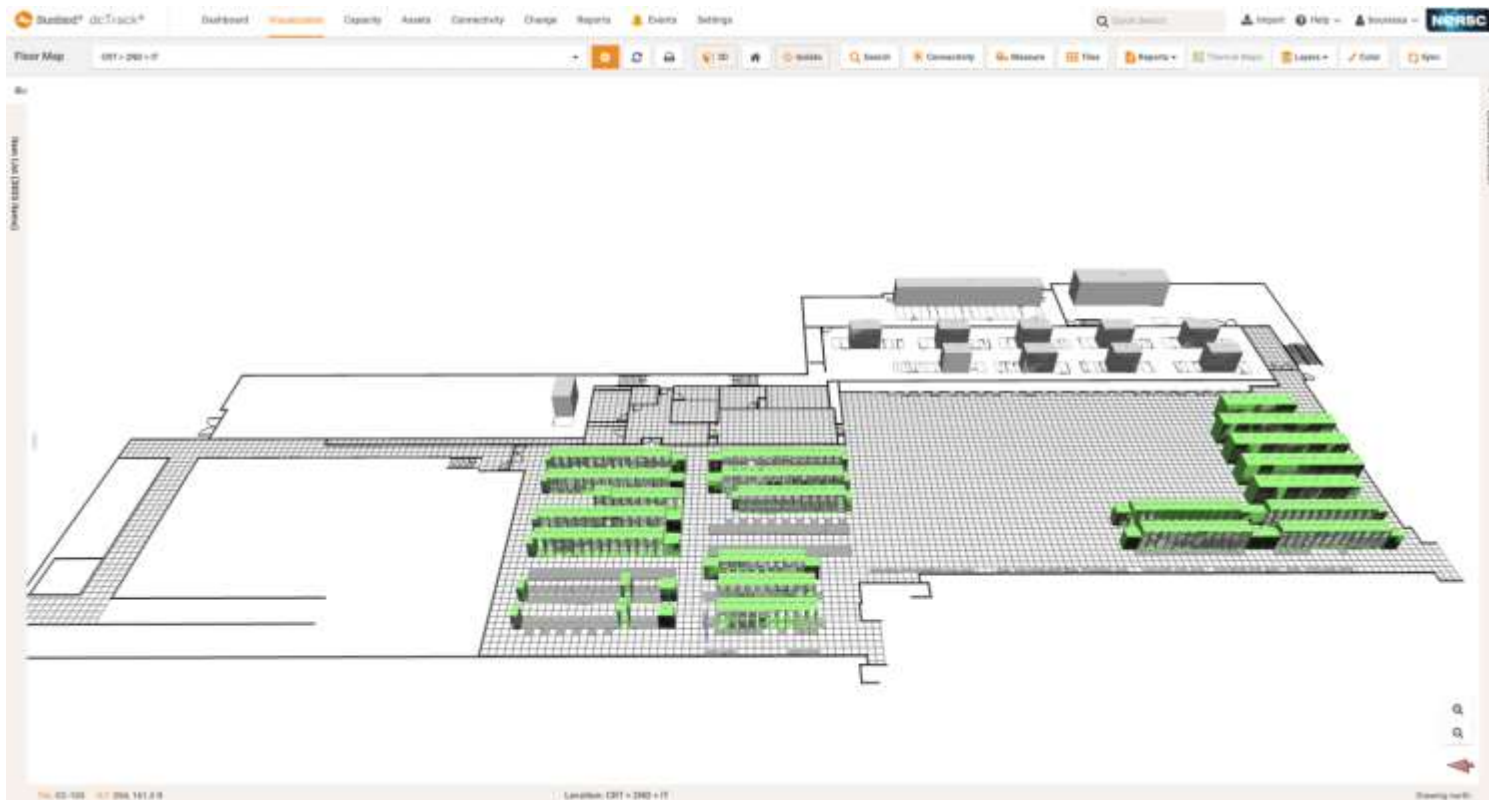


- Phase 1 delivered December 2021 to January 2022
 - 12 GPU cabinets (3 CDUs)
- Phase 2 delivered March 2022 to May 2022
 - 12 CPU cabinets (4 CDUs)
 - Development system rack + CDU
 - (Sandbox) Alvarez system rack + CDU
- Infrastructure in place to support another 9 racks and 2 CDUs
 - Expansion and POD systems installed (4 GPU cabinets + 2 CDUs)

NERSC - Mechanical Level



NERSC - Computer Level



ODA SkySpark - Cooling Tower Staging Data

