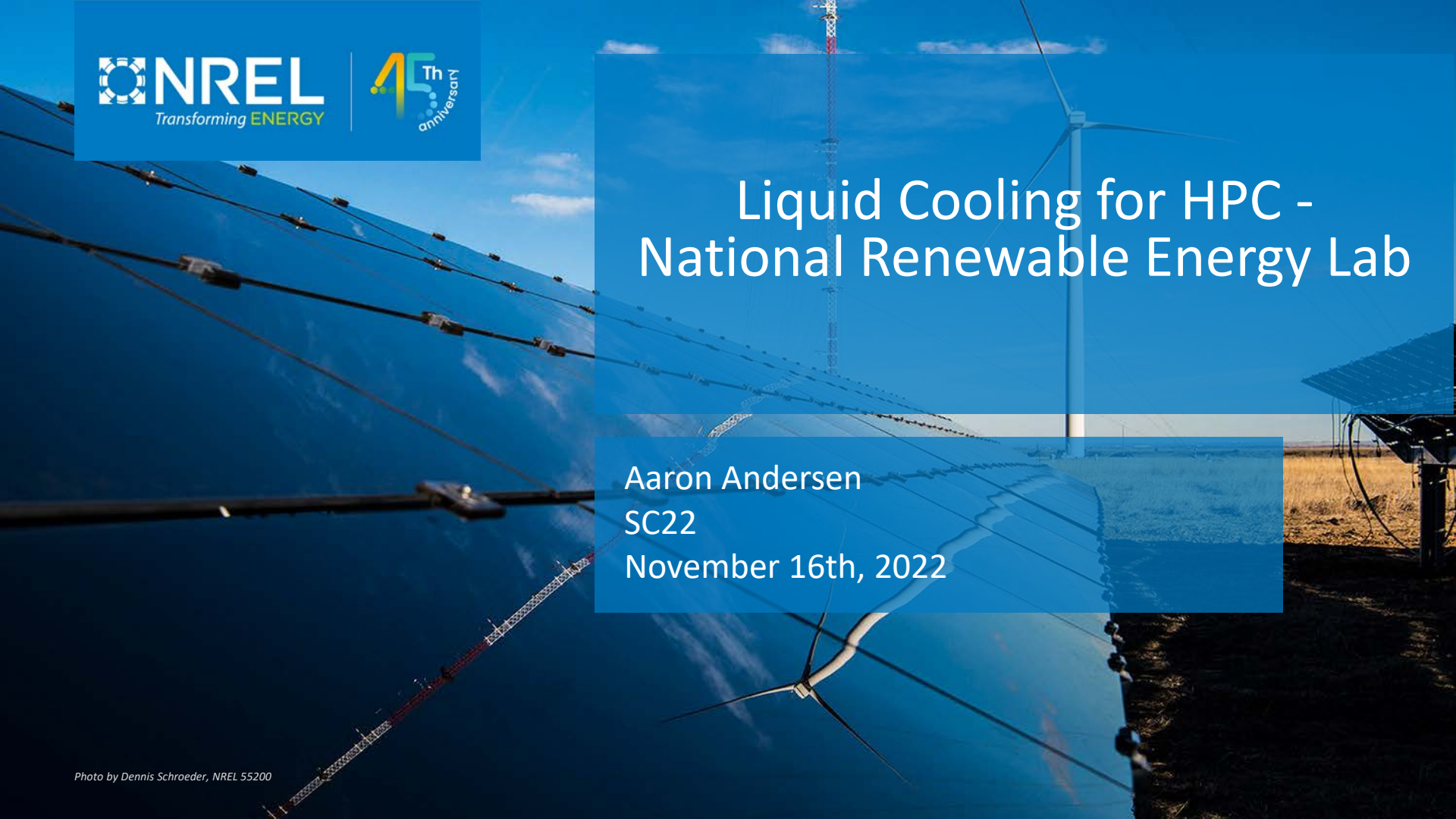


Liquid Cooling for HPC - National Renewable Energy Lab

Aaron Andersen

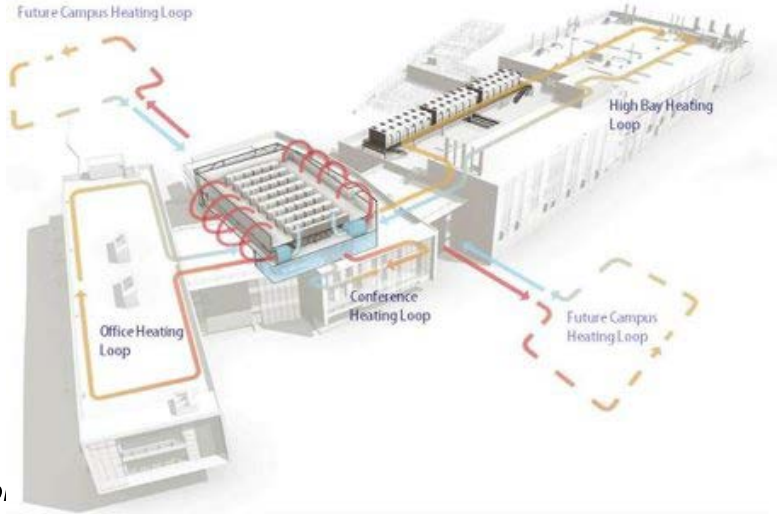
SC22

November 16th, 2022

Photo by Dennis Schroeder, NREL 55200

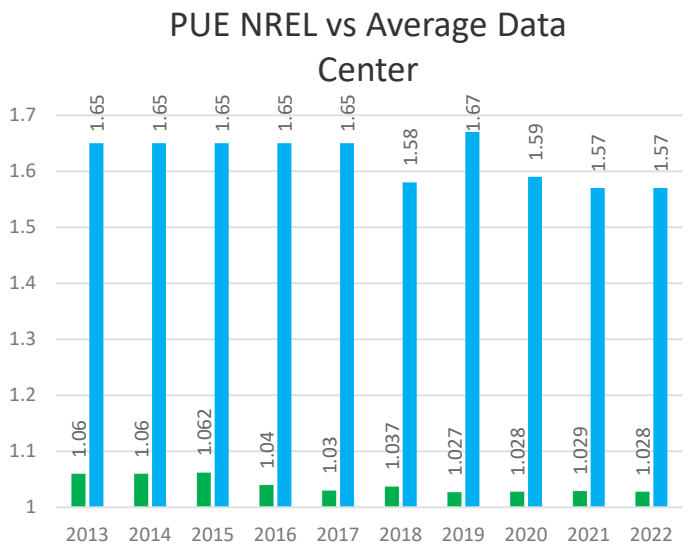
NREL HPC Data Center

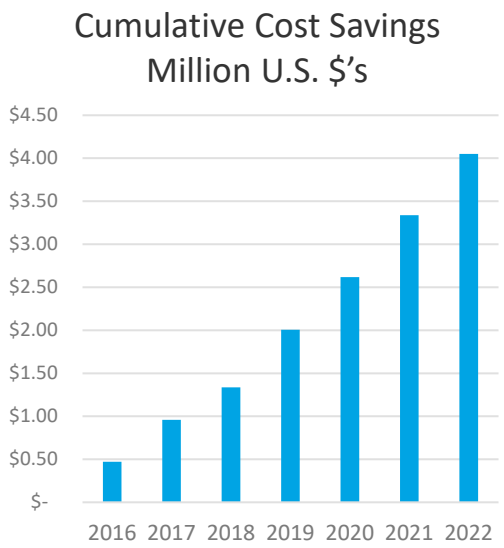
- **Showcase Facility**
  - ESIF 182,000 ft.^{2} research facility
  - 10,000 ft.^{2} data center
  - 10 MW at full buildout
  - LEED Platinum facility, PUE ≤ 1.04
  - No mechanical cooling (eliminates expensive and inefficient chillers)

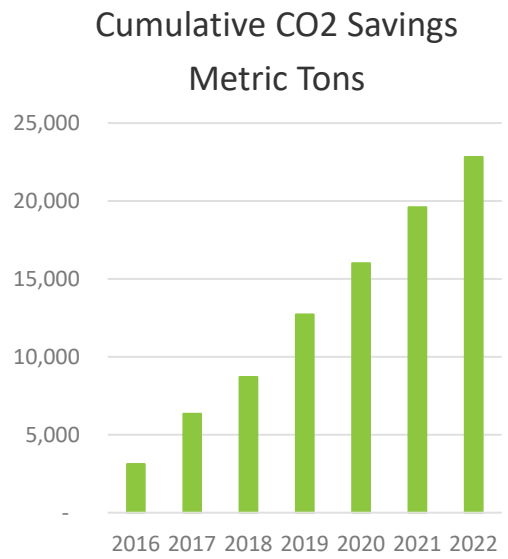


- **Data Center Features**
  - Direct, component-level liquid cooling, 24ºC (75ºF) cooling water supply
  - 35ºC–40ºC (95ºF–104ºF) return water (waste heat), captured and used to heat offices and lab space
  - Pumps more efficient than fans
  - High voltage 480 VAC power distribution directly to high power density 60kW–80 kW compute racks
- **Compared to a Typical Data Center**
  - Lower CapEx—costs less to build
  - Lower OpEx—costs less to operate
- **Data Centers often largest load on campuses**
  - NREL current and projected in the 30-50% range

Success Story - PUE, Cost and Emission Savings





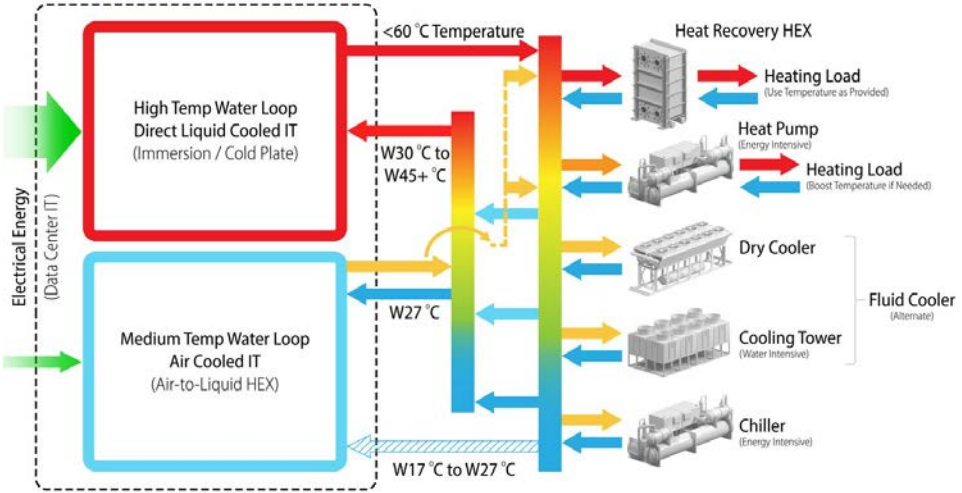


Data center average annual power usage effectiveness (PUE) worldwide 2007-2021
https://www.statista.com/statistics/1229367/data-center-average-annual-pue-worldwide/

Emissions & Power Cost Data from
https://www.eia.gov/electricity/state/colorado/

Lessons Learned

- Lessons Learned
  - Invest in expertise translate facilities and computing operations
  - Preventative maintenance is key
    - Water quality testing
    - CDU maintenance
  - Clear roles and responsibilities
  - Consider process cooling loop design



Thank You

www.nrel.gov

NREL/PR-2C00-84492

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

Transforming **ENERGY** through computational excellence