HYPERION RESEARCH

HPC User Forum Update

Reflections on ALCF Sustainability Efforts at DOE/ANL

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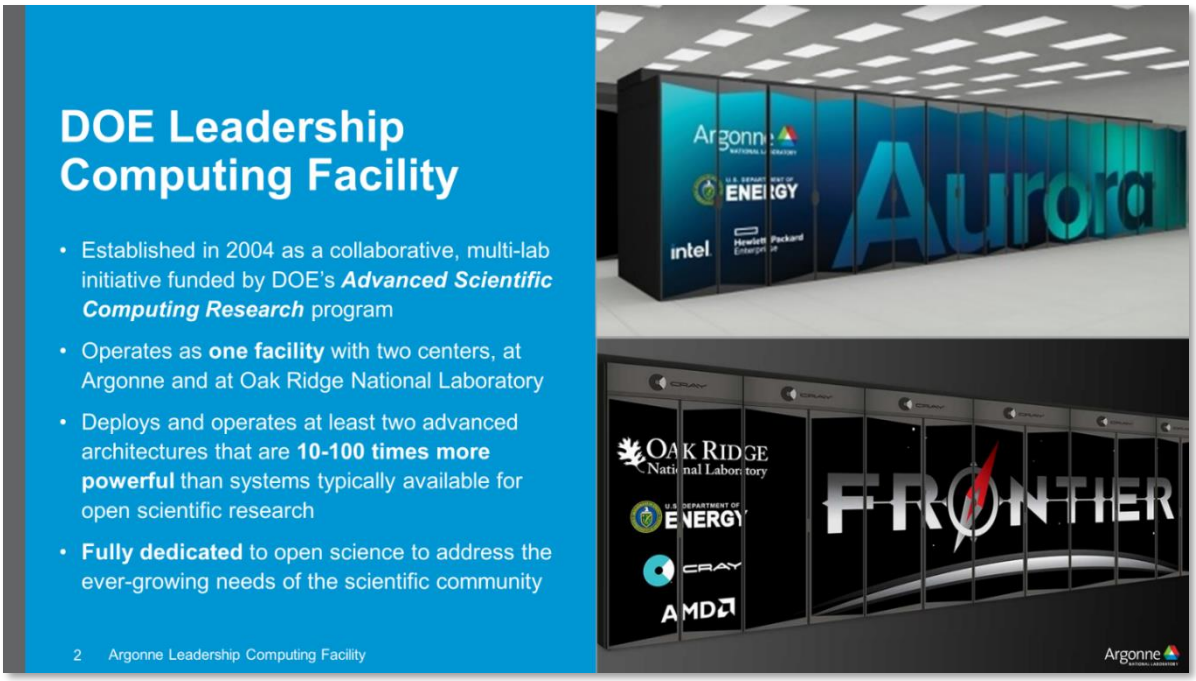
IN THIS UPDATE

The HPC User Forum was established in 1999 to promote the health of the global HPC industry and address issues of common concern to users. In September 2023, the 83rd HPC User Forum took place in Tucson, Arizona.

This update summarizes a presentation from that conference given by Ti Leggett, Deputy Project Director & Deputy Director of Operations at Argonne National Laboratory (ANL). Leggett presented the sustainability efforts of the Argonne Leadership Computing Facility (ALCF), including areas of success and challenges in the procurement, operations, and decommissioning processes.

FIGURE 1



Source: ALCF, 2023

PRESENTATION: ALCF SUSTAINABILITY, TI LEGGETT, ARGONNE LEADERSHIP COMPUTING FACILITY

Leggett began by providing an overview of the ALCF, which was established in 2004 under the DOE's Advanced Scientific Computing Research (ASCR) program. The DOE LCF operates as a single facility with two centers. ALCF, along with its partner organization, the Oak Ridge Leadership Computing Facility, provides leadership computing capabilities to open science projects that require hardware ten to one hundred times more powerful than what is typically available at other research institutions. Due to the devotion to open science, much of the work done at ALCF is published as scientific research.

Leggett outlined the evolution of resources deployed at ALCF, mentioning past systems like IBM Blue Gene/L, Intrepid, Mira, and Theta, with a focus on the upcoming Aurora system. Additionally, he discussed auxiliary systems such as ThetaGPU and Crux, highlighting their roles in supporting research, including COVID-related studies during the pandemic.

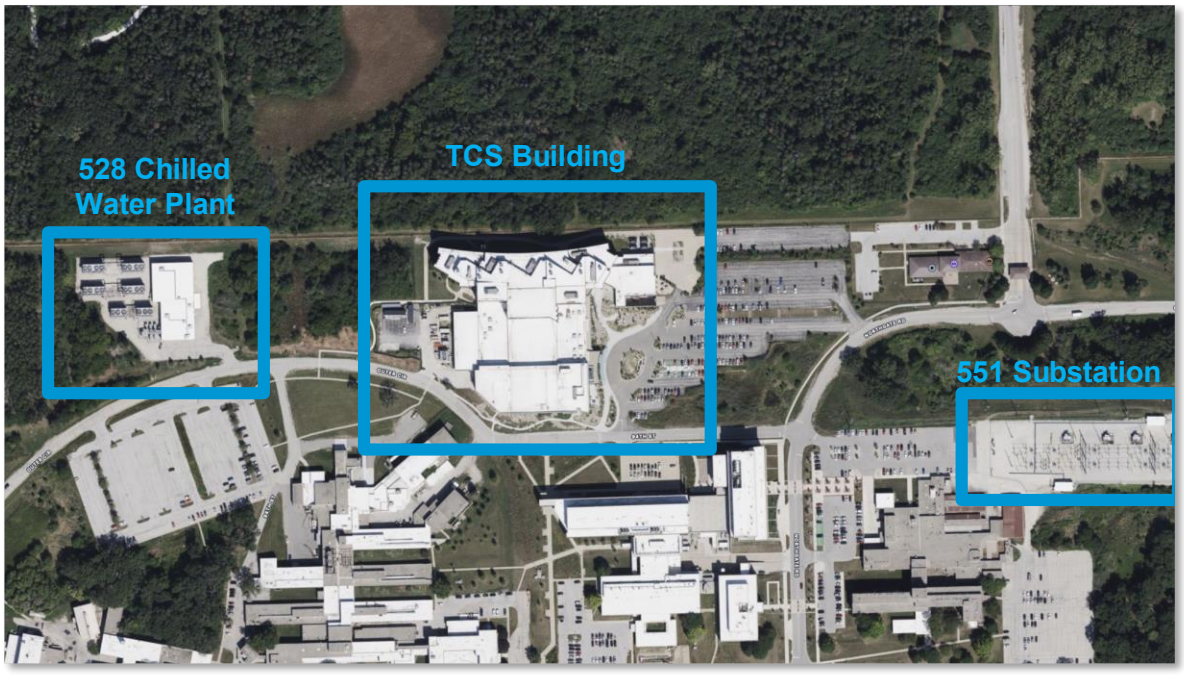
The discussion extended to Polaris, a system introduced to bridge the gap between traditional and GPU-based computing, in preparation for Aurora's deployment. Other testbeds and evaluation resources were also mentioned, emphasizing the progression towards Aurora, expected to deliver over 2 exaflops of performance.

The physical infrastructure of the Argonne campus, particularly the Technical Computing Services Building (Building 240) which houses the data ALCF systems, was described during Leggett's presentation. Building 240 is distinctive in that it is owned and operated by a third-party trust under a lease agreement with the DOE. While this arrangement has its benefits it also presents challenges, particularly regarding sustainability considerations.

One notable aspect of the infrastructure is its reliance on external resources for essential services. The cooling system, for instance, primarily draws water from a nearby plant, which supplies chilled water to Building 240 and various other facilities within the Argonne campus. Additionally, the power supply is predominantly sourced from a substation operated by ComEd, the utility provider, further highlighting the complex network of dependencies that support Argonne's operations.

Building 240 houses systems other than the ALCF systems, many utilizing a range of cooling systems to support their computational activities. Mira and Aurora are the first fully direct water-cooled systems. While some equipment operates on existing infrastructure inherited from decommissioned systems, others are part of a central information system designed for reliability rather than efficiency. This diversity in cooling mechanisms and equipment underscores the laboratory's commitment to optimizing performance while ensuring operational resilience across its various computational endeavors.

FIGURE 2

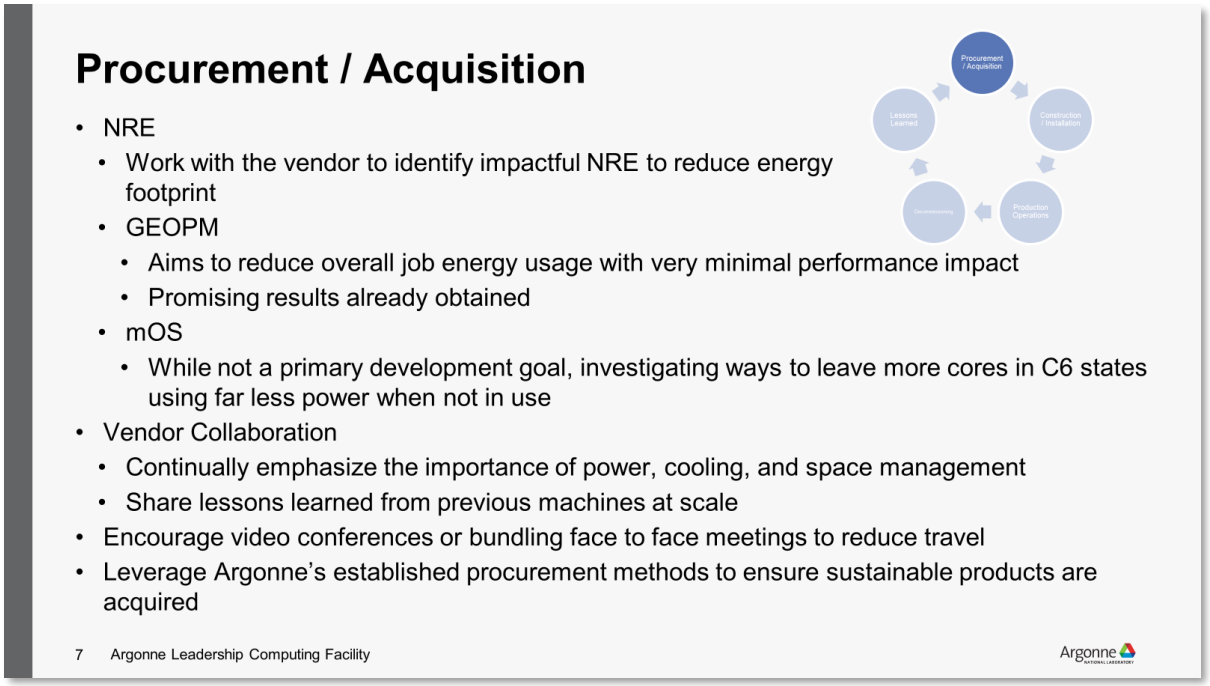


Source: ALCF, 2023

Leggett pointed out that sustainability considerations at ALCF always come second to the laboratory's mission of running large-scale computational jobs for its open science clients. While sustainability is not explicitly outlined in ALCF's mission, efforts are made to integrate it into procurement decisions without compromising the core objectives.

Innovative approaches such as the Global Extensible Open Power Manager (GEOPM) and Management Operating System (mOS) highlight ALCF's commitment to sustainability within its computational infrastructure. GEOPM optimizes performance and power consumption by dynamically adjusting clock frequencies of CPUs and GPUs based on workload characteristics, minimizing energy consumption without significantly impacting overall run time. Similarly, mOS serves as an orchestrator for CPU resources, enabling efficient allocation and utilization of computing cores based on workload demands, thereby reducing unnecessary power consumption during periods of low computational intensity. By integrating sustainability considerations into software development and resource allocation strategies, ALCF strives to maximize energy efficiency and minimize environmental impact without compromising computational performance.

FIGURE 3



Source: ALCF, 2023

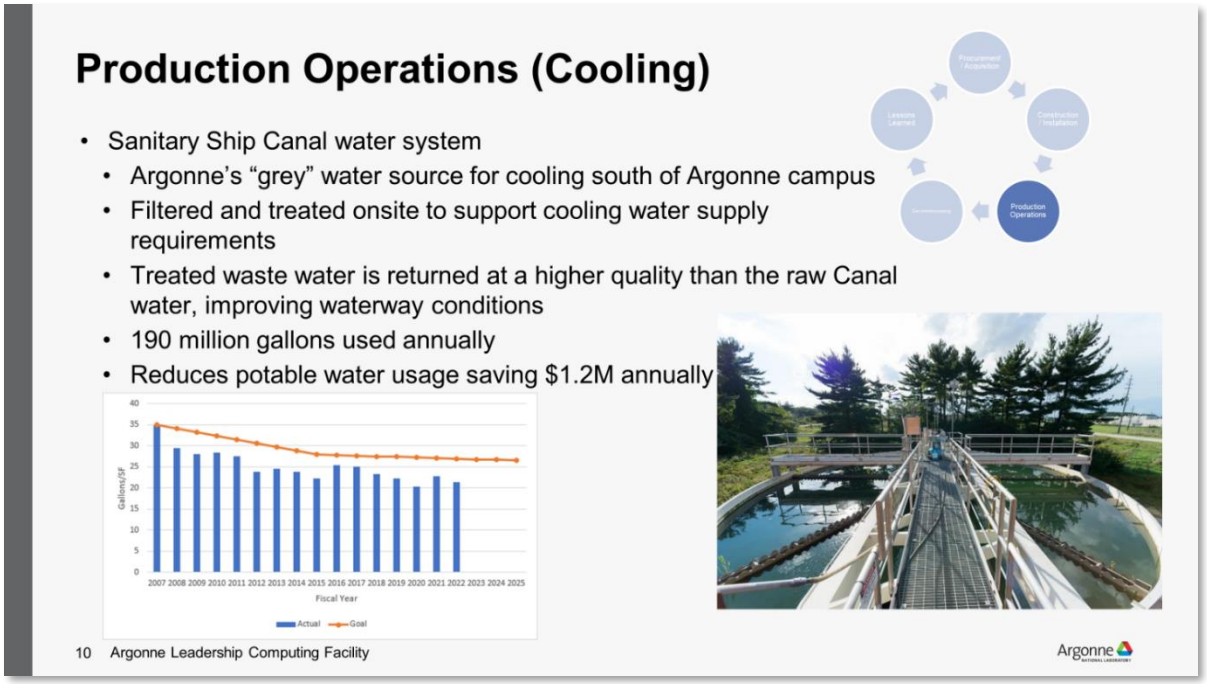
Leggett discussed the relationship between the TCS (Technical Computing Services) support facilities and the entities responsible for constructing and managing these facilities. ALCF provides its statement of requirements to these entities but does not dictate the specific implementation details. This relationship can be challenging to manage, however often can result in some positive sustainability outcomes. For instance, the construction company involved in the Aurora project emphasized recycling construction waste, showcasing a commitment to sustainability in the building process.

Another highlighted area of sustainability was ongoing retrofitting efforts across the Argonne campus. Despite the historical nature of the Argonne laboratory, which dates back to the 1940s, efforts are continuously made to retrofit existing facilities and incorporate sustainable technologies into new projects. Many of these facilities were constructed several decades ago and may not meet modern standards for energy efficiency and sustainability. Retrofitting involves upgrading or modifying existing buildings to improve their performance, reduce energy consumption, and minimize environmental impact.

Leggett's sustainability discussion moved to a cooling innovation unique to Argonne. The use of water from an industrial canal for cooling purposes is an innovative and sustainable approach employed by the ALCF to address its cooling needs while reducing environmental impact and conserving resources. Located near an industrial canal, ALCF leverages this water source for its cooling requirements, particularly for systems like Aurora. Instead of relying on potable water sources, which are limited and valuable, ALCF taps into the industrial canal's water. This water, although typically considered unsuitable for consumption due to its potential contamination, serves a valuable purpose in the

facility's cooling infrastructure. ALCF implements a treatment process to clean and purify the canal water before it is utilized for cooling. This treatment process not only renders the water safe for use but also contributes to improving the overall quality of the water returned to the canal, effectively reducing pollution, and enhancing environmental sustainability. Using this canal water instead of potable water amounts to $1.2M in annual savings for ALCF.

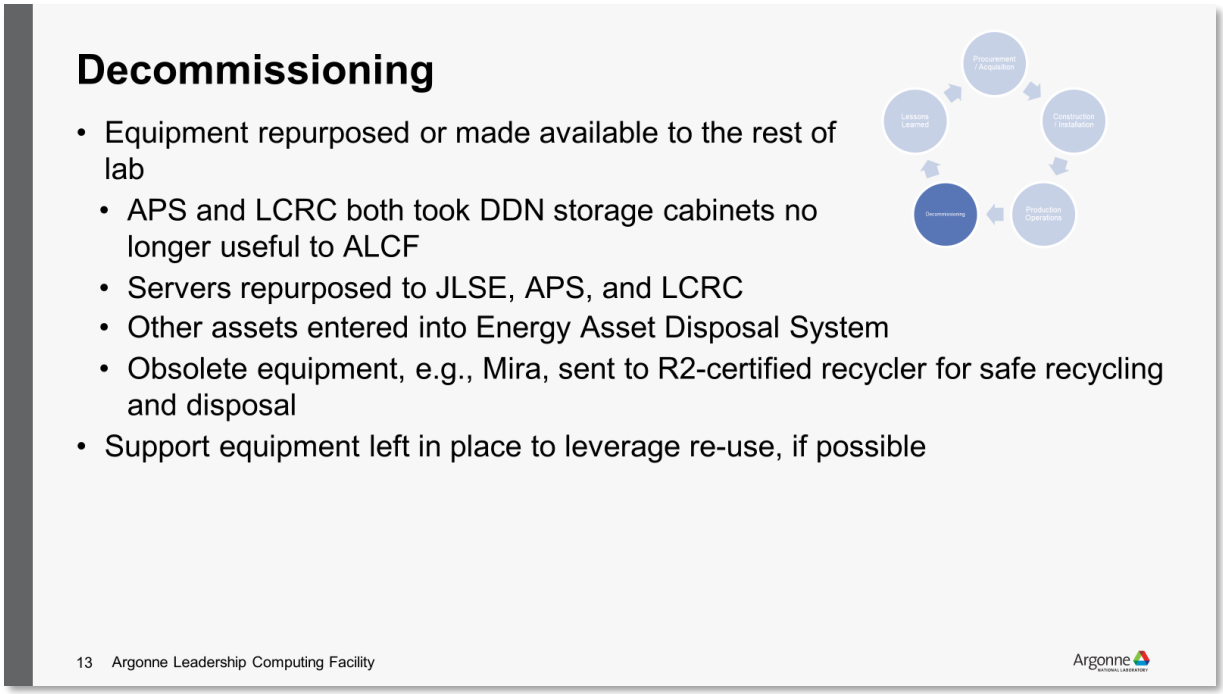
FIGURE 4



Source: ALCF, 2023

Leggett's final thoughts surrounded the decommissioning process for various systems at ALCF. As these systems reach the end of their operational lifespans, they need to be disposed of responsibly. He brought up the example of Mira, a Blue Gene/Q machine. Finding a new home for Mira was challenging due to its unique specifications. However, ALCF collaborated with a recycling company to responsibly dispose of Mira's components. Materials such as aluminum, steel, copper, and gold were recovered through recycling, and ALCF received payment for these materials. This approach ensures that decommissioned systems are not simply discarded but are instead recycled, minimizing waste and environmental impact.

FIGURE 5



Source: ALCF, 2023

For more information or to view this and other presentations given at HPC User Forums dating back to 2008, visit www.hpcuserforum.com.

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