INL/EXT-21-62368

Nuclear Science User Facilities High Performance Computing

FY 2021 Mid-Year HPC Utilization Report
M3UF-21IN0701018

Report Team:
Stephanie J. Parker, HPC Account & User Coordinator
Robert K. Podgorney, ASC Chief Computational Scientist
Eric T. Whiting, ASC Division Director

Idaho National Laboratory

INL is a U.S. Department of Energy National Laboratory
operated by Batelle Energy Alliance, LLC

INL/EXT-21-62368

Nuclear Science User Facilities High Performance Computing

FY 2021 Mid-Year HPC Utilization Report
M3UF-21IN0701018

March 2021

Idaho National Laboratory
High Performance Computing
Idaho Falls, Idaho 83415

http://www.inl.gov

Prepared for the
U.S. Department of Energy
Office of Nuclear Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

CONTENTS

Page intentionally left blank

ACRONYMS

CPU	Central Processing Unit
DOE-NE	Department of Energy Office of Nuclear Energy
GPU	Graphics Processing Unit
HPC	High Performance Computing
INL	Idaho National Laboratory

1. INTRODUCTION

Idaho National Laboratory (INL), supported by the Department of Energy Office of Nuclear Energy (DOE-NE) through the Nuclear Science User Facilities, provides access to supercomputer systems and data storage along with support staff for system management, software installation, cybersecurity and user support to the broader DOE-NE user community. Users include individuals at universities, industry, and government laboratories enabling a wide range of research and development and mission-supporting activities. The availability of high-performance computing (HPC) capabilities is a key foundation of collaboration and innovation in nuclear energy systems research. HPC resources and INL directly support the mission and objectives of DOE-NE.

From October 2020 through March 2021, INL HPC capabilities were utilized by a diverse set of computing and applied researchers, for a wide range of research and engineering activities. This report focuses on current INL HPC systems and utilization from October 1, 2020 through March 31, 2021.

2. CURRENT HPC SYSTEMS

INL currently houses four HPC systems in the Collaborative Computing Center, a facility that includes space for up to 197 computer equipment racks. These systems are: Sawtooth, Hoodoo, Lemhi, and Falcon; all are available for use by individuals at universities, industry, and government laboratories. Table 2.1 provides a description of each system.

INL also leverages visualization resources, such as a 3D immersive Computer Assisted Virtual Environment and various power-wall display systems, to help researchers understand their data and communicate complex science to stakeholders as well as to the general public.

All these systems have a positive impact on DOE NE's ability to deliver results at a much larger scale. Sawtooth, Lemhi, and Falcon systems combined delivered more than 630 million core hours of compute time in FY20. This is an increase of 304 million core hours from FY19, largely due to the deployment of the new Sawtooth system. Between October 1, 2020 and March 31, 2021, Sawtooth, Lemhi, and Falcon systems combined delivered more than 476.6 million core hours of compute time The compute time observed each year continues to exceed our operational goals.

Table 2.1: Current INL HPC systems.

System	Description
Sawtooth	A Hewlett Packard Enterprise SGI 8600 distributed-memory system: 99,792 cores, 395 TB of total memory, high-speed EDR interconnect network, high-speed storage, and 0.56 petaflops of graphics processing unit (GPU) capabilities. The current LINPACK rating for Sawtooth is more than 6 petaflops from both central processing units (CPU) and GPUs.
Hoodoo	Machine learning only system. Lambda Hyperplane deep learning distributed-memory system: 44 NVIDIA A100 tensor core GPUs and 7.2 TB of total memory. The system provides a maximum GPU performance of 429 teraflops double precision or 858 teraflops single precision.
Lemhi	Dell PowerEdge distributed-memory system: 20,160 cores, 94 TB of total memory, Omni-Path interconnect network, and high-speed storage. The LINPACK rating for Lemhi is 1.002 petaflops
Falcon	An SGI ICE X distributed-memory system: 34,992 cores, 121 TB of total memory, high-speed FDR interconnect network, and high-speed storage. The current LINPACK rating for Falcon is 1.087 petaflops

3. MID-YEAR UTILIZATION

Table 3.1. lists the organizations with the largest number of active HPC users as of March 31, 2021. The majority of users come from INL (358), with the second largest number being from the Naval Nuclear Laboratory (57). The remaining organizations include a mix of universities (152), industry partners (79) other national laboratories (126), and the Nuclear Regulatory Commission (14).

Table 3.1. Institution and active user count utilizing INL HPC systems as of March 31, 2021.

Institution	Active Users
Idaho National Laboratory	358
Naval Nuclear Laboratory	57
Argonne National Laboratory	32
Oak Ridge National Laboratory	27
Framatome	24
University of Idaho	22
Idaho State University	21
North Carolina State University	21
Westinghouse Electric Company	19
Boise State University	18
MPR Associates	18
Nuclear Regulatory Commission	14
Texas A&M University	13
Los Alamos National Laboratory	10
Massachusetts Institute of Technology	8
University of Michigan	8
University of Illinois at Urbana-Champaign	7
University of South Carolina	7
Radiant Industries Incorporated	6
Lehigh University	5
Pennsylvania State University	5
University of Utah	5
Analysis and Measurement Services Corporation	4
Analytical Mechanics Associates	4
TerraPower, LLC	4
University of Tennessee	4
University of Wisconsin	4
University of Wisconsin-Madison	4

Table 3.2. presents the system utilization in million core hours for the organizations using the largest amount of INL HPC systems from October 1, 2020, through March 31, 2021. The majority of utilization is coming from INL (176.2 million core hours), with the second largest coming from North Carolina State University (78.9 million core hours). The remaining top thirty organizations include a mix of universities (96.1 million core hours), industry partners (56.3 million core hours) other national laboratories (69.8 million core hours), and the Nuclear Regulatory Commission (2.9 million core hours).

Table 3.2. INL HPC systems utilization in million core hours from October 1, 2020, through March 31, 2021.

Institution	Million Core hours
Idaho National Laboratory	176.171
North Carolina State University	78.913
Oak Ridge National Laboratory	28.640
Itasca Consulting Group	21.622
University of Utah	15.872
Los Alamos National Laboratory	15.610
MPR Associates	14.101
Pennsylvania State University	13.652
Naval Nuclear Laboratory	13.498
Argonne National Laboratory	12.028
Massachusetts Institute of Technology	10.954
Westinghouse Electric Company	10.339
University of Tennessee Knoxville	9.480
Georgia Institute of Technology	8.186
Boise State University	7.697
Blue Wave A.I. Labs LLC	7.531
Oregon State University	7.015
University of Idaho	3.683
Clemson University	2.889
Nuclear Regulatory Commission	2.877
University of Colorado Boulder	2.664
University of South Carolina	2.584
Idaho State University	2.425
University of Tennessee	2.299
Purdue University	1.840
Analysis and Measurement Services Corporation	1.620
University of Michigan	1.550
University of Wyoming	1.239
Electric Power Research Institute	1.100
University of Wisconsin	1.085

The HPC job scheduler utilizes fair-share metrics along with other considerations for prioritizing work. Given a specific need, users may request higher priority. Every job submission requires a project to be specified from a current list of project names. Figure 3.1 shows compute utilization in million core hours for all project categories and systems from October 1, 2020, through March 31, 2021, for a total of 476.6 million core hours. The majority of utilization (72%, 341.9 million core hours) was from Nuclear Energy related projects.

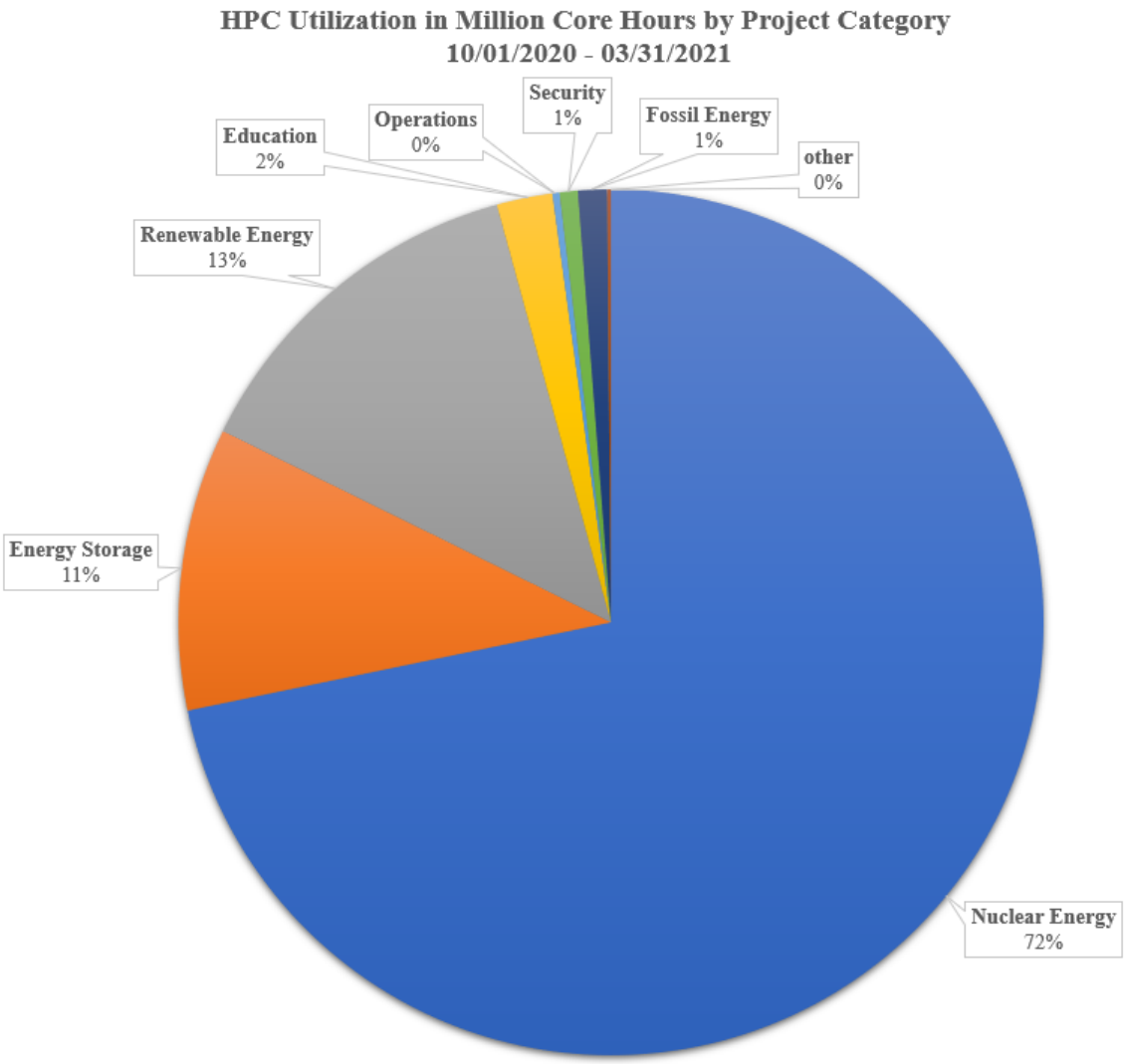

Figure 3.1. Project categories and systems utilization in million core hours from October 1, 2020, through March 31, 2021.

As shown in Figure 3.2 and Figure 3.3, INL HPC capabilities were utilized by 566 researchers from October 1, 2020, through March 31, 2021, with the majority coming from national laboratories (313), using 246.1 million core hours. University researchers and students, as a group, made up the second largest group of users (153) utilizing 177.4 million core hours, while industry partners also accounted for a substantial number of users (100) with 60.0 million core hours.

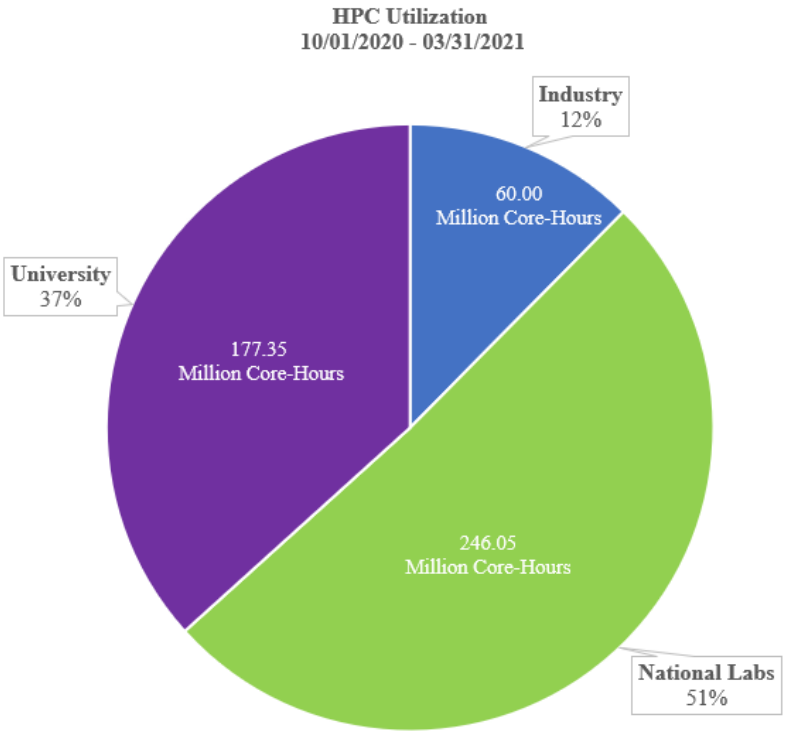

Figure 3.2. HPC utilization in million core hours from October 1, 2020, through March 31, 2021.

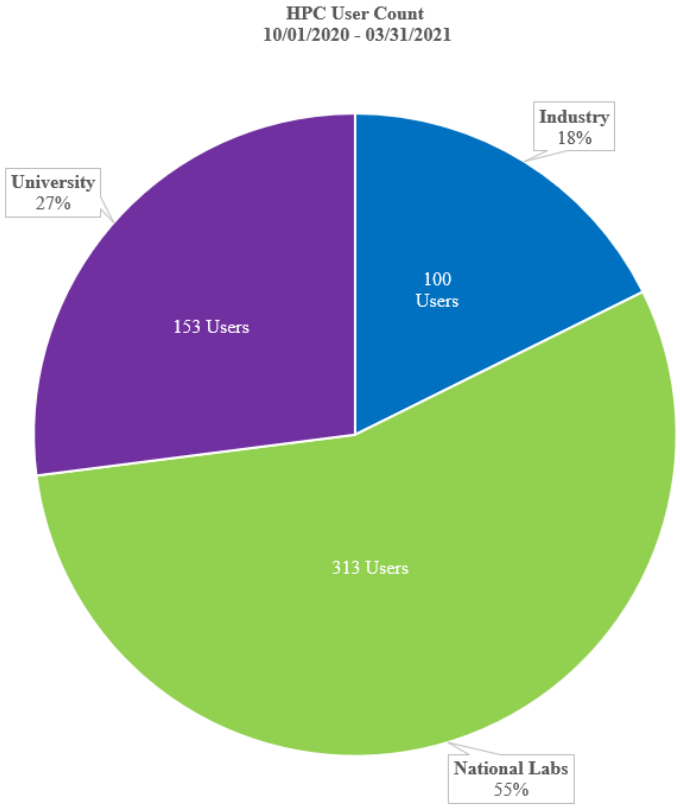

Figure 3.3. HPC active user count from October 1, 2020, through March 31, 2021.

4. SUMMARY

INL HPC capabilities were utilized by individuals at universities, industry, and government laboratories for a wide range of research and engineering activities between October 1, 2020 and March 31, 2021, as shown in utilization data. A large portion of HPC use was geared towards nuclear energy, as well as other energy systems. The subset of utilization data presented in this report gives a clear indication of the high value and strong usage of the INL HPC capabilities supported by DOE-NE. INL HPC continues to observe, each year, compute time that exceeds operational goals. A key foundation of collaboration and innovation in nuclear energy systems research is the availability of HPC capabilities. HPC resources and INL staff directly support the mission and objectives of DOE-NE.