

## **UNITING SCIENCE TO ADDRESS CLIMATE CHANGE** **The engagement of US and European Big Science facilities**

**26 October 2021** – Key leaders and researchers from major US and European big science laboratories, namely EIROforum (Europe's eight largest intergovernmental scientific research organisations, including CERN, EMBL, ESA, ESO, ESRF, EUROfusion, European XFEL and ILL) and the US Department of Energy's seventeen National Laboratories (Ames, Argonne, Brookhaven, Fermi, Idaho, Jefferson, Los Alamos, Lawrence Berkeley, Lawrence Livermore, NETL, NREL, Oak Ridge, Pacific Northwest, PPPL, SLAC, Sandia and Savannah River), met by videoconference ahead of the United Nations Framework Convention on Climate Change Conference of Parties (COP26).

Sharing the same values, and convinced that science performs best through collaboration, the EIROforum's directors and NLDC (comprised of directors from the US National Laboratories) affirmed their common commitment to unite science towards a sustainable and resilient global society and economy:

- **By stepping up their scientific collaboration on carbon-neutral energy and climate change**
- **By sharing best practices to improve the climate sustainability and carbon footprint of Europe's and US's big science facilities**
- **By sharing knowledge and fostering public engagement on clean energy and climate change research**

The 2021 United Nations Framework Convention on Climate Change Conference of Parties (COP26), which will take place in a few days' time in Glasgow, will be a pivotal moment to agree coordinated actions to align with the needs of a sustainable and resilient society.

The rapidly accelerating loss of biodiversity across the globe and the impacts of climate change are becoming increasingly visible in the form of outbreaks of zoonotic disease, and progressively extreme heat waves and storms, droughts and flooding.

Throughout history, fundamental research has been a source of scientific breakthroughs, leading to paradigm shifts that have had a profound impact on our lives. The COVID-19 pandemic has thrust science to the centre stage. Thanks to state-of-the-art scientific knowledge and exceptional global scientific collaborations, the development of vaccines to provide a path out of the coronavirus pandemic happened far more rapidly than expected. Therefore, on a complex and wide ranging issue like climate change, science has without any doubt a key role to play, and in particular at big science facilities, where we are constantly pushing forwards the frontiers of knowledge and technology to the highest levels of excellence and inventiveness.

From world-leading environmental science and bio-environmental engineering, geological research and Earth observation to the development of state-of-the-art materials, advanced particle detectors and accelerators, and new, clean energy sources, the research and datasets produced by Europe and United States' big science laboratories provide a foundation on which to build innovative technologies and solutions that not only mitigate the impact of climate change, but also help us protect the Earth's ecosystems, including the human populations around the world vulnerable to a wide array of environmental threats.

As Big Science facilities in Europe and United States, sharing the same values for scientific excellence to the benefit of humankind and our planet, we must act together to address the complex and pressing climate crisis that we are already seeing worldwide, but also to reduce the carbon footprint of our research activities.

These topics were at the heart of an online workshop, co-chaired by Doon Gibbs, Director of Brookhaven National Laboratory and Chair of the NLDC, and Francesco Sette, Director General of The European Synchrotron (ESRF) and Chair of EIROforum, and which included the directors and scientific experts from the eight EIROforum big science facilities and the seventeen DOE National Laboratories, through three round-tables:

- Approaches to Decarbonization: “Reducing the carbon footprint of big science facilities in Europe”, and “Net Zero Carbon and Net Zero Labs”
- Carbon-neutral energy and climate change research and technology at Big Science facilities
- Fostering public engagement on clean energy and climate change research

## Abstracts of the EIROforum – NLDC online event

Three round-tables were organised with participation of EIROforum and NLDC experts:

### 1./ Approaches to Decarbonization

- *ESO Towards Sustainability: A Status Report*, Claudia Burger, Director of Administration, ESO
- *Achieving Net Zero Carbon Emissions Through the Lens of the National Laboratories*, Martin Keller, Director, National Renewable Energy Laboratory
- *A Sustainable Future for Particle Physics at CERN*, Sonja Kleiner, Head of Environmental Protection Group, CERN
- *Overview of the U.S. Department of Energy's Net Zero Laboratory Pilot*, John Wagner, Director, Idaho National Laboratory

### 2./ Carbon-neutral energy and climate change research and technology at Big Science facilities

- *Leveraging Light Sources in Energy and Climate Research: Cycles of Learning Meet Machine Learning*, Steve Kevan, ALS Director, Lawrence Berkeley National Laboratory
- *Exploring Molecular and Cellular Biodiversity to Mitigate Climate Change*, Detlev Arendt, EMBL
- *Earth System Modeling for Actionable Science*, Ruby Leung, E3SM Chief Scientist, Pacific Northwest National Laboratory
- *Observing Climate Change from Space*, Maurice Borgeaud, Head, Science, Applications, and Climate Department, ESA
- *Accelerating Climate and Clean Energy Innovation - Role of DOE Nanoscience Research Centers*, Jeff Nelson, Manager, Center for Integrated Nanotechnologies, Sandia National Laboratories
- *Energy Storage Research and Applications at Large-Scale Instruments*, Matteo Bianchini, Faculty of Biology, Chemistry and Geosciences Bavarian Centre for Battery Technology (BayBatt), University of Bayreuth

### 3./ Fostering public engagement on clean energy and climate change research

- *Climate Change and Decarbonization: Public Engagement and Industrial Action*, George Crabtree, JCESR Director, Argonne National Laboratory
- *Fostering Public Engagement on Clean Energy and Climate Change Research*, Karl Tischler, Head of Communication, EUROfusion

## EIROforum

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### Detlev Arendt, EMBL

#### **“Exploring molecular and cellular biodiversity to mitigate climate change”**

Climate change and loss of biodiversity are causally linked, and their impact on world ecosystems can only be understood and addressed jointly via concerted efforts. With its new programme ‘Molecules to ecosystems’ the European Molecular Biology Laboratory expands into new areas including planetary biology, human ecosystems, infection biology, and microbial ecosystems, to monitor living systems and their response to anthropogenic change across the planet.

### Prof. Dr. Matteo Bianchini, ILL user, Faculty of Biology, Chemistry and Geosciences Bavarian Centre for Battery Technology (BayBatt), University of Bayreuth

#### **“Energy storage research and applications at large-scale instruments”**

Li-ion batteries are energy storage devices that had a tremendous impact on our daily lives. After powering a portable revolution, putting a smartphone in everyone’s pocket, they have now begun to power the automotive revolution, one of the fundamental pillars of the energetic transition we need

to reduce CO<sub>2</sub> emissions. Large-scale instruments represent unique tools allowing scientists to understand how battery materials with the desired properties can be made, and how they function at the atomic scale. In this contribution, I will highlight how neutrons and synchrotron radiation can be used complementarily to boost battery research. I will focus on two applications, both related to time-resolved studies. Firstly, I will show how in situ x-ray diffraction can provide unique insights into the synthesis, or preparation, at high temperature of battery electrode materials, leading to its optimization. Secondly, I will demonstrate how the working mechanisms of electrode materials for Li-ion batteries can be understood by operando XRD, i.e. by investigating the structural evolution of the materials in real time during battery operation.

**Dr. Maurice Borgeaud, ESA Earth Observation Programmes, Head, Science, Applications, and Climate Department**

**“Observing climate change from space”**

Since 2008, ESA has launched a programme to observe the effects of climate change using satellite data. The so-called ESA Climate Change Initiative is now monitoring 23 Essential Climate Variables (ECV), defined by the UN GCOS (Global Climate Observing System). The use of satellite data is of prime importance to derive the ECV due to the global, accurate, and long-term characteristics. The presentation will describe the CCI activities, show examples of ECV's (e.g. sea level raise, glaciers) and look at the future of this programme.

**Claudia Burger, ESO, Director of Administration**

**“ESO towards sustainability: A status report”**

ESO recognizes environmental protection as an important and value-adding component of the Organisation's projects and operations. The presentation will give an overview on the results of an external audit of ESO's carbon footprint and the follow-up analysis of the main sources of emissions. An action plan is being developed with the objective to improve environmental sustainability and reduce ESO's carbon footprint in the medium term.

**Sonja KLEINER, CERN, Head of the Environmental Protection Group**

**“A sustainable future for particle physics at CERN”**

Over the last five years, CERN has strengthened its longstanding commitment to minimise its impact on the environment. The Organization has fixed ambitious environmental objectives linked to climate change and other environmental domains, and initiated actions targeting both its scientific facilities, for example the Large Hadron Collider and its experiments, and its site and conventional facilities. The Organization will shortly be releasing its second Environment Report. This talk will outline CERN's environmental strategy and initiatives, discuss key figures of greenhouse gas emissions and the actions taken to reduce these emissions, and highlight the future plans of the Organization to address environmental challenges.

**Karl Tischler, EUROfusion, Head of Communication**

**“Fostering public engagement on clean energy and climate change research”**

How EUROfusion is fostering public engagement through its new exhibition: Fusion, Power to the People, with focus on the following topics: BREAKING THE MOLD – the exhibition has been designed to reach the non-attentive public, DEMOCRATIZING CONTENT – each visitor collects, connects and keeps all the content; DIALOGUE – the exhibition is just the start of the discussion about developing fusion energy; EMBRACING CONTROVERSY – to build a long term engagement with each visitor, we openly examine the scientific controversy surrounding fusion; DATA & ADAPATION – by learning how our visitors learn, we can adapt content quickly to geographic and demographic variables; FULL AGENCY – knowledge acquisition is determined by each visitor, not the venue.

## NLDC

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**George Crabtree, Argonne National Laboratory and University of Illinois at Chicago**

**"Climate Change and Decarbonization: Public Engagement and Industrial Action"**

Climate change is a unique world-wide threat following an uncertain trajectory, demanding an immediate response, international coordination, new decarbonization technology and with significantly unequal impact across wealth, ethnic and locational boundaries. The status and outlook for motivating public engagement and industrial action will be discussed.

**Martin Keller, National Renewable Energy Laboratory (NREL), Laboratory Director**

**"Achieving Net-Zero Carbon Emissions Through the Lens of the National Laboratories"**

Our planet needs us. More than it ever has before. Climate change, energy inequality, and environmental justice, these are just some of the challenges that face our nation as we work to transform energy and accelerate toward a clean energy transition. The Department of Energy's 17 national laboratories are playing a leading role in this transition to transform our energy systems and our future to realize an energy sector that is free of carbon emissions. This will depend on significant achievements in technology research and development, deployment, and advanced approaches-and the national laboratories are leveraging their unique lens to lead the way.

**Steve Kevan, Lawrence Berkeley National Laboratory**

**"Leveraging Light Sources in Energy and Climate Research: Cycles of Learning Meet Machine Learning"**

X-ray light sources around the world provide an ever-expanding suite of capabilities that have become essential to diverse areas of basic, applied, and industrial research. Nowhere is this breadth and impact more apparent than macromolecular crystallography, which now plays a key role in the development cycle of virtually every new pharmaceutical. I will discuss some of the ingredients for success in this and other areas, and how these ingredients might help leverage light source capabilities to make progress in climate and energy sciences.

**L. Ruby Leung, Pacific Northwest National Laboratory**

**"Earth System Modeling For Actionable Science"**

The impacts of climate change are felt most strongly through changes in extreme weather events that cause damage to infrastructure and the built environments and challenge the management of natural resources. To support mitigation and adaptation planning, storm-resolving Earth system modelling is needed to provide actionable information. I will discuss an ongoing effort to develop such a capability, highlighting the computational challenges and recent successes in building the foundation for taking advantage of exascale computers for Earth system modelling.

**Dr. Jeffrey S. Nelson, Sandia National Laboratories, Center for Integrated Nanotechnologies, Director**

**"Accelerating Climate and Clean Energy Innovation- Role of the DOE Nanoscale Science Research Centers"**

The five Department of Energy Nanoscale Science Research Center (NSRC) user facilities host more than 3500 US and international researchers each year. The NSRCs provide world-leading capabilities to create, characterize, and understand nanostructured materials, and a collaborative research environment where scientist and engineers advance nanoscale science. This presentation will highlight recent advances and the important role the NSRCs play to accelerate climate and clean energy innovation.

**Dr. John Wagner, Idaho National Laboratory, Director**

**“Overview of the U.S. Department of Energy’s Net Zero National Laboratory Pilot”**

On March 31, U.S. Department of Energy Secretary Jennifer Granholm challenged the national laboratory complex to build more sustainability into their operations and to significantly reduce carbon emissions. This talk discusses how four national laboratories – INL, NETL, NREL and PNNL, in coordination with DOE and the other national labs, will be demonstrating pathways to a net-zero carbon emissions future.

## EIROforum and NLDC in brief

**EIROforum, Europe's eight largest intergovernmental scientific research organisations, includes CERN, EMBL, ESA, ESO, ESRF, EUROfusion, European XFEL and ILL.**

**NLDC, the National Laboratory Directors' Council, is comprised of the directors of DOE's seventeen National Laboratories: Ames, Argonne, Brookhaven, Fermi, Idaho, Jefferson, Lawrence Berkeley, Lawrence Livermore, Los Alamos, National Energy Technology, National Renewable Energy, Oak Ridge, Pacific Northwest, Princeton Plasma Physics, Sandia, SLAC National Accelerator, Savannah River.**

### EIROforum

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#### **CERN**

CERN, the European Organization for Nuclear Research, is one of the world's leading laboratories for particle physics. The Organization is located on the French-Swiss border, with its headquarters in Geneva. At CERN, physicists and engineers probe the fundamental structure of the universe, by providing a unique range of particle accelerator facilities that enable research at the forefront of human knowledge. CERN's world-class research in fundamental physics unites people from all over the world to push the frontiers of science and technology, for the benefit of society.

Director General: Fabiola Gianotti

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#### **EMBL**

The European Molecular Biology Laboratory (EMBL) is Europe's only intergovernmental research organisation for the life sciences. Working from six sites in France, Germany, Italy, Spain and the United Kingdom, and with partners across Europe, EMBL's mission is to understand the mechanisms of life, from its molecular building blocks to cells and organisms – helping improve human and planetary health. EMBL also provides a unique portfolio of scientific services and technology development for European scientists, with access to essential data bases, and to world-leading biological research infrastructures and facilities. We also work closely with industry to transfer our knowledge and technologies for wider application. Our special mission to integrate and promote the life sciences across the continent includes nurturing young talent, and more than 9,000 EMBL-trained alumni enrich and lead life sciences research in industry and academia across the globe. We disseminate and share knowledge and skills through our courses and conferences to more than 7,500 scientists and technicians each year, and our policy work informs government and public health decision-making. Our next five-year scientific programme seeks to understand the molecular basis of life in context, in order to tackle global challenges including the emergence of pathogens, loss of biodiversity and the spread of antimicrobial resistance, as well as the impact of pollution, climate change, and food insecurity

Director General: Edith Heard

Press contact: Terry O'Connor - [Terry.OConnor@embl.org](mailto:Terry.OConnor@embl.org)

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#### **ESA**

European Space Agency (ESA) is Europe's gateway to space. Its mission is to shape the development of Europe's space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe and the world. It is an international organisation with 22 member states, and by coordinating the financial and intellectual resources of its members, it can undertake space programmes and activities far beyond the scope of any single European country. Its programmes and missions cover astronomy, planetary, solar, and fundamental physics, human spaceflight and robotic exploration, Earth observation, launchers, navigation, telecommunications and applications, and space engineering research and development.

Director General: Josef Aschbacher

Website/Twitter: [www.esa.int](http://www.esa.int) - @esa

## ESO

ESO is the foremost intergovernmental astronomy organisation in Europe and the world's most productive ground-based astronomical observatory by far. It has 16 Member States: Austria, Belgium, the Czech Republic, Denmark, France, Finland, Germany, Ireland, Italy, the Netherlands, Poland, Portugal, Spain, Sweden, Switzerland and the United Kingdom, along with the host state of Chile and with Australia as a Strategic Partner. ESO carries out an ambitious programme focused on the design, construction and operation of powerful ground-based observing facilities enabling astronomers to make important scientific discoveries. ESO also plays a leading role in promoting and organising cooperation in astronomical research. ESO operates three unique world-class observing sites in Chile: La Silla, Paranal and Chajnantor. At Paranal, ESO operates the Very Large Telescope and its world-leading Very Large Telescope Interferometer as well as two survey telescopes, VISTA working in the infrared and the visible-light VLT Survey Telescope. Also at Paranal ESO will host and operate the Cherenkov Telescope Array South, the world's largest and most sensitive gamma-ray observatory. ESO is also a major partner in two facilities on Chajnantor, APEX and ALMA, the largest astronomical project in existence. And on Cerro Armazones, close to Paranal, ESO is building the 39-metre Extremely Large Telescope, the ELT, which will become "the world's biggest eye on the sky".

Director General, Xavier Barcons

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## ESRF

The ESRF, the European Synchrotron in Grenoble – France, is an international organisation supported by 21 countries, welcoming more than 9 000 scientists from all the world, each year. It provides the scientific community with extremely brilliant synchrotron X-rays for the analytical study of the complexity of condensed and living matter down to single-atom resolution. A landmark facility for fundamental and innovation-driven research, 25% of its research is linked to climate change, clean energy, environment, green engineering and sustainable materials.

Director General: Francesco Sette

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Website/Twitter: [www.esrf.eu](http://www.esrf.eu) - @esrfsynchrotron

## EUROfusion

EUROfusion, the European Consortium for the Development of Fusion Energy, consists of 30 research organisations and about 150 affiliated entities including universities and companies, from 25 European Union member states plus the United Kingdom, Switzerland and Ukraine, aiming at paving the way for the development of fusion energy.

Programme Manager (CEO): Tony Donné, +49 89 3299 4211

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## European XFEL

The European XFEL in the Hamburg area is an international research facility of superlatives: 27,000 X-ray flashes per second and a brilliance that is a billion times higher than that of conventional X-ray sources open up completely new opportunities for science. Research groups are able to map the atomic details of viruses, decipher the molecular composition of cells, take three-dimensional "photos" of the nanoworld, "film" chemical reactions, and study processes such as those occurring deep inside planets. More than half of the research done at the facility addresses clean energy, climate change, environmental issues, alternative energies, resource efficiency as well as sustainable use and supply of raw materials.

Director General: Robert Feidenhans'l

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## ILL

The Institut Laue-Langevin (ILL) is an international research centre at the leading edge of neutron science and technology. ILL is funded and managed by France, Germany and the United Kingdom, in partnership with 11 other countries. As the world's flagship centre for neutron science, the ILL provides scientists with a very high flux of neutrons feeding some 40 state-of-the-art instruments. Every year, about 1400 researchers from about 40 countries visit the ILL. Fundamental and applied research is conducted in a variety of fields: magnetism, chemistry, biology, nuclear physics, materials & engineering science, etc.

Director: Paul Langan

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## NLDC

### Ames Laboratory

Ames Laboratory is a global leader in the discovery, synthesis, analysis and application of new materials, novel chemistries and transformational analytical tools. We conduct fundamental and applied research that helps the world to better understand the nature of the building blocks that make up our universe, and we translate that knowledge into new and unique materials, processes, and technologies.

Director: Adam Schwartz

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### Argonne National Laboratory

For 75 years, Argonne National Laboratory has delivered end-to-end impact through its broad and deep research expertise and powerful scientific tools and facilities. We are recognized internationally for pioneering discoveries in multiple fields of research and innovations in climate science and clean energy technologies to help decarbonize our economy and strengthen global security. Our expanding research enterprise, exceptional user facilities and worldclass community of talent enable us to deliver breakthrough technologies and lead key industries of the future, such as artificial intelligence and quantum information science, that are critical to economic prosperity and national security.

Director: Paul Kearns

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### Brookhaven National Laboratory

Brookhaven National Laboratory delivers discovery science and transformative technology to power and secure the nation's future. Established in 1947, Brookhaven is a multidisciplinary laboratory with seven Nobel Prize-winning discoveries and more than 70 years of pioneering research. The Lab's enduring priorities include discovery science and technology, developing and operating transformational user facilities, and applying our capabilities to new opportunities. Our current, forward looking initiatives include nuclear physics (toward the Electron-Ion Collider); clean energy and climate; quantum information science and technology; human-AI-facility integration; high energy physics; and isotope production, among many others. Brookhaven is managed and operated for DOE by [Brookhaven Science Associates](http://www.bnl.gov).

Director: Doon Gibbs

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### Fermi National Accelerator Laboratory

Fermilab is America's particle physics and accelerator laboratory, aiming to solve the mysteries of matter, energy, space and time for the benefit of all. Fermilab operates the largest US particle accelerator complex delivering the world's most powerful neutrino beam and enabling groundbreaking science with muon beams. The laboratory is poised to host the international neutrino community at the LBNF/DUNE facility, powered by PIP-II, a new high power, state-of-art SRF particle accelerator, presently under construction. PIP-II is exploring strategies and technologies to develop and implement sustainable energy solutions for particle accelerators and the facilities that house them on three fronts: reducing energy consumption; reusing waste process heat; utilizing sustainable energy sources, such as solar, for the construction and operation of the accelerator. PIP-II aspires to demonstrate such solutions as a pilot project.

Director: Nigel Lockyer

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### **Idaho National Laboratory**

Within the Department of Energy's system of multiprogram research and development laboratories, Idaho National Laboratory occupies a unique niche at the nexus of energy supply and security. DOE's designated nuclear energy research and development leader, INL plays a key role in the global nuclear energy renaissance – the worldwide reconsideration and expansion of nuclear energy based on its capacity to deliver power cleanly, safely, reliably and on a massive scale. Management and operation of the laboratory is the responsibility of Battelle Energy Alliance.

Director: Dr. John Wagner

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### **Thomas Jefferson National Accelerator Facility (Jefferson Lab)**

Thomas Jefferson National Accelerator Facility (Jefferson Lab) is a U.S. Department of Energy Office of Science national laboratory. Scientists worldwide utilize the lab's unique particle accelerator, known as the Continuous Electron Beam Accelerator Facility (CEBAF), to probe the most basic building blocks of matter - helping us to better understand these particles and the forces that bind them - and ultimately our world. In addition, the lab capitalizes on its unique technologies and expertise to perform advanced computing and applied research with industry and university partners, and provides programs designed to help educate the next generation in science and technology. Managing and operating the lab for DOE is [Jefferson Science Associates, LLC](http://www.jeffsci.com).

Director: Stuart Henderson

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### **Lawrence Berkeley National Laboratory (Berkeley Lab)**

Founded in 1931 on the belief that the biggest scientific challenges are best addressed by teams, [Lawrence Berkeley National Laboratory](http://www.lbl.gov) and its scientists have been recognized with 14 Nobel Prizes. Today, Berkeley Lab researchers develop sustainable energy and environmental solutions, create useful new materials, advance the frontiers of computing, and probe the mysteries of life, matter, and the universe. Scientists from around the world rely on the Lab's five national user facilities for their own discovery science. Berkeley Lab is a multiprogram national laboratory, managed by the University of California for the U.S. Department of Energy's Office of Science.

Director: Michael Witherell

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### **Lawrence Livermore National Laboratory**

Since its inception in 1952, LLNL has embraced its role as a "new ideas" laboratory, focusing on novel concepts and innovative approaches to national security science and engineering. Its defining responsibility is stockpile stewardship—ensuring the safety, security, and reliability of the nation's nuclear stockpile. Yet LLNL's mission is broader than stockpile stewardship, as dangers ranging from nuclear proliferation and terrorism to cyber attacks and climate change threaten national security and global stability. The Laboratory's science and technology are being applied to achieve breakthroughs for counterterrorism and nonproliferation, defense and intelligence, energy and environmental security.

Director: Kimberly Budil

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### **Los Alamos National Laboratory (LANL)**

Los Alamos National Laboratory, a multidisciplinary research institution engaged in strategic science on behalf of national security, is managed by Triad, a public service oriented, national security science organization equally owned by its three founding members: Battelle Memorial Institute (Battelle), the Texas A&M University System (TAMUS), and the Regents of the University of California (UC) for the Department of Energy's National Nuclear Security Administration.

Los Alamos enhances national security by ensuring the safety and reliability of the U.S. nuclear stockpile, developing technologies to reduce threats from weapons of mass destruction, and solving problems related to energy, environment, infrastructure, health, and global security concerns.

Director: Thomas Mason

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## **National Energy Technology Laboratory (NETL)**

NETL is at the center of technology development that will enable low- and zero-carbon energy and industry. For more than a century, NETL has been driving innovation and delivering solutions for an environmentally sustainable and prosperous energy future. The lab helps ensure affordable, abundant, and reliable energy that powers a robust economy and enhances national security, while developing technologies to manage carbon across the full life cycle, and enabling environmental sustainability for all Americans.

Director: Brian J. Anderson

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## **National Renewable Energy Laboratory (NREL)**

Founded in 1977, the National Renewable Energy Laboratory (NREL) is the U.S. Department of Energy's primary national laboratory for renewable energy and energy efficiency research. From scientific discovery to accelerating market adoption, NREL deploys its deep technical expertise and unmatched breadth of capabilities to drive the transformation of our nation's energy resources and systems. NREL's innovations span the spectrum of clean energy, renewable electricity, and energy efficiency. The laboratory is home to three national research centers—for solar, wind, and bioenergy—and several programs that advance cutting-edge research in areas such as strategic energy analysis and energy systems integration.

Director: Martin Keller

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## **Oak Ridge National Laboratory**

Oak Ridge National Laboratory (ORNL) is the largest and most diverse laboratory within the US Department of Energy's Office of Science. Founded in 1943, ORNL is distinguished by its close coupling of basic and applied R&D and by signature strengths in materials, neutrons, nuclear, isotopes, and computing. Oak Ridge also has a rich history in biological sciences and is addressing compelling challenges in energy and national security through the convergence of physical sciences, biological and environmental sciences, advanced manufacturing technology, and engineering. ORNL operates the Spallation Neutron Source, the High Flux Isotope Reactor, the Center for Nanophase Materials Sciences, the Oak Ridge Leadership Computing Facility, and several other major DOE facilities for the research community to enable scientific discovery and innovation.

Director: Thomas Zacharia

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## **Pacific Northwest National Laboratory**

Pacific Northwest National Laboratory advances the frontiers of knowledge, taking on some of the world's greatest science and technology challenges. Distinctive strengths in chemistry, Earth sciences, biology, and data science are central to PNNL's scientific discovery mission. PNNL's research lays a foundation for innovations that advance sustainable energy through decarbonization and energy storage and enhance national security through nuclear materials and threat analyses. PNNL is operated by Battelle for the U.S. Department of Energy.

Director: Dr. Steven Ashby

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## **Princeton Plasma Physics Laboratory**

The Princeton Plasma Physics Laboratory (PPPL) is a world-class fusion energy research laboratory managed by Princeton University for the U.S. Department of Energy. PPPL is dedicated to developing the scientific knowledge and advanced engineering to enable fusion to power the U.S. and the world; advancing the science

of nanoscale fabrication for technologies of tomorrow; and furthering the scientific understanding of the plasma universe from laboratory to astrophysical scales.

Director: Steven Cowley

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Website/Twitter: [www.pppl.gov](http://www.pppl.gov) - @ppplab

### **Sandia National Laboratories**

Sandia National Laboratories is a multimission laboratory with major research and development responsibilities in nuclear deterrence, global security, defense, energy technologies and economic competitiveness, with main facilities in Albuquerque, New Mexico, and Livermore, California. We secure the nation's critical infrastructures and environment against attacks, threats, and climate change by performing world-class research and development.

Director: James Peery

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Website/Twitter: <https://www.sandia.gov/> - @SandiaLabs

### **Savannah River National Laboratory (SRNL)**

SRNL is known for its scientific and technical expertise in nuclear, chemical and materials manufacturing; an ability to translate innovations into industrial-scale operations; a focus on environmental management, hydrogen storage, mesoscale atmospheric modelling, and clean energy. Our innovations have improved process efficiencies for producing nuclear materials and rare isotopes, manufacturing stable waste forms, remediating contaminated soil and groundwater, and decommissioning contaminated facilities.

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Website/Twitter: <https://srnl.doe.gov/> - @SRNLAB

### **SLAC National Accelerator Laboratory**

SLAC is a vibrant multiprogram laboratory that explores how the universe works at the biggest, smallest and fastest scales and invents powerful tools used by scientists around the globe. With research spanning particle physics, astrophysics and cosmology, materials, chemistry, bio- and energy sciences and scientific computing, we help solve real-world problems and advance the interests of the nation.

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