Microelectronics Across DOE

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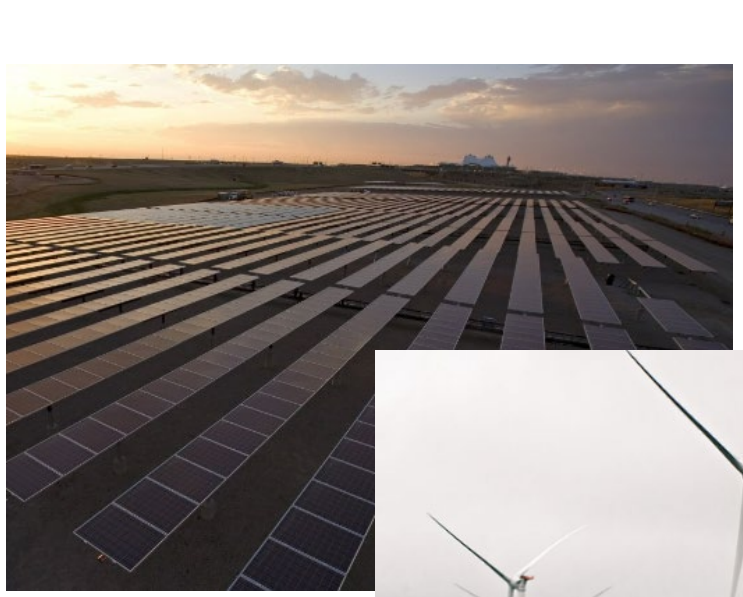
DOE Office of Science

U.S. DEPARTMENT OF ENERGY

Advanced microelectronics technologies underpin the entire DOE mission

DOE missions in Energy, Science & Innovation, and National Security & Safety both rely upon and support advanced computing and semiconductor technologies



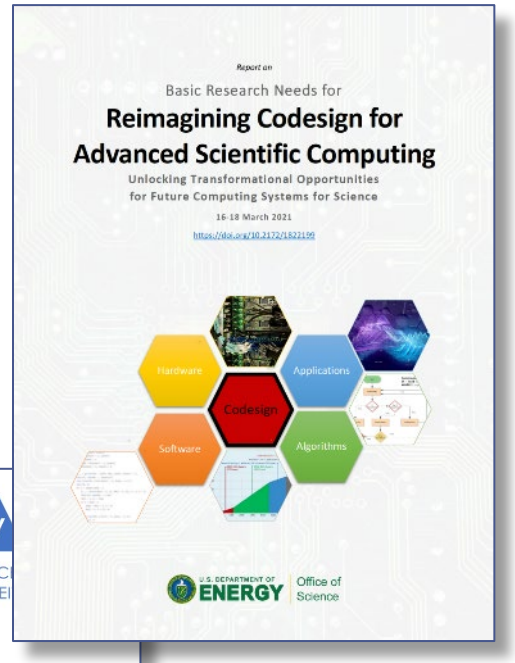
NNSA Microelectronics Efforts

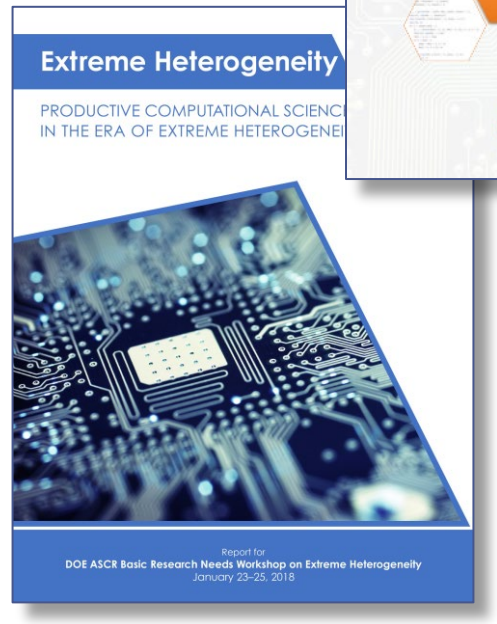
- Sandia MESA
  - Laboratory custom-designed, industry-produced devices accredited by the Trusted Foundry Program (TFP)
  - Electronic Parts Program (EPP)
    - Conducting a risk analysis on commercially available parts required to produce deterrence systems
- United States Nuclear Detonation (NUDET) Detection System (USNDS)
  - Sandia MESA + commercial devices designed together to provide space-based sensor systems
  - NASA-sponsored roadmap includes quantum networking

Source: Sandia National Laboratories. | GAO-20-357

Advanced Scientific Computing Research: Basic Research To Exascale Systems

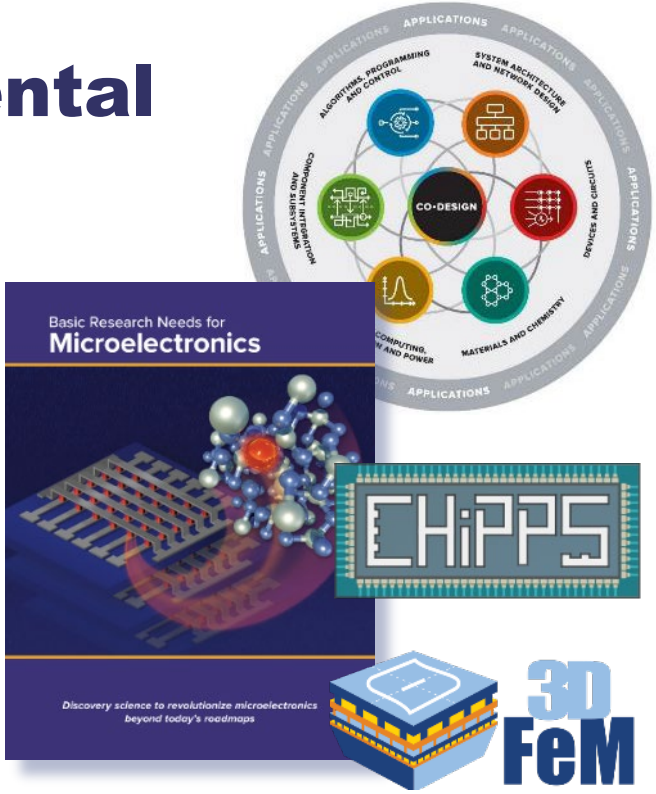
- DOE has a long history of innovating at the leading edge in energy-efficient computing.
- Exascale is an energy-efficiency achievement and required partnering between researchers and industry on co-design from the circuits to the data center.
- DOE's holistic approach, including basic-research, testbeds, industry partnerships, and first-of-a-kind deployments, is essential to feeding the innovation pipeline for both DOE's use cases and the CHIPS programs.





Basic Energy Sciences Research: Fundamental Materials, Chemistry, and User Facilities

- Office of Science Basic Research Needs for Microelectronics Report defined Priority Research Directions
- DOE has expanded investments in basic research for microelectronics through programs such as the
  - Energy Frontier Research Centers
  - DOE Lab Microelectronics Co-Design Projects
- DOE Office of Science operates numerous open-access user facilities that support basic and applied microelectronics research, including
  - X-Ray light sources
  - Nanoscale Science Research Centers
  - Neutron scattering

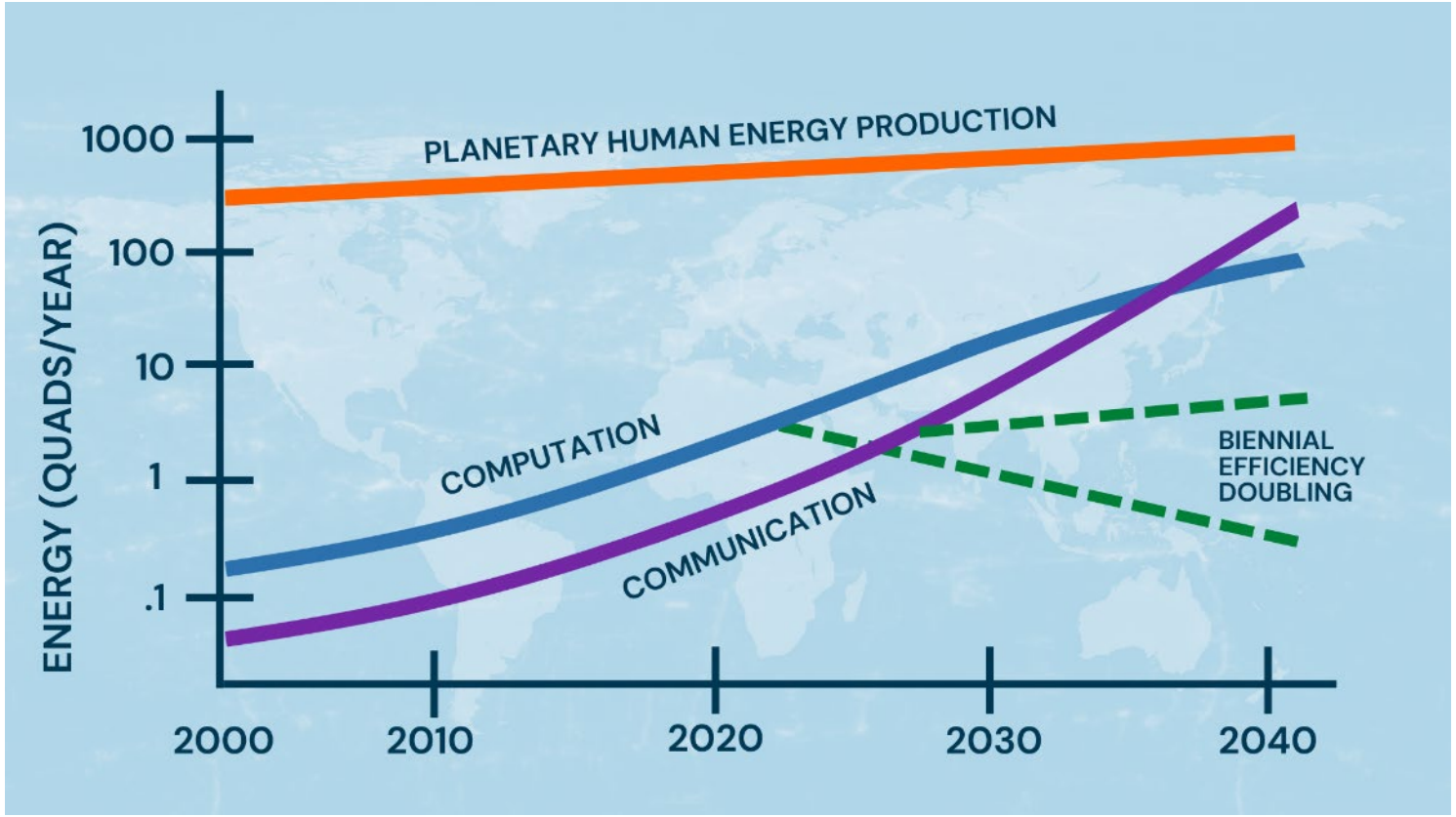


ARPA-E Activities Related to the CHIPS Act

- The Advanced Research Projects Agency-Energy catalyzes and accelerates disruptive energy technologies that will enhance the economic and energy security of the United States
- Investment in power electronic materials, devices, modules and circuits to improve energy efficiency, reduce green house gas emissions, and improve the resilience, reliability, and security of the energy infrastructure
- Over $300M invested in more than 75 semiconductor related projects under such programs as: ADEPT, SWITCHES, PNDIODES, ENLITENED, ULTRAFAST, OPEN Programs, IDEAS, and SCALEUP
- Tech to market activities are integral to every funded project to support commercialization transition

6” SiC wafer processed in Si CMOS foundry

Advanced Materials and Manufacturing Office: Energy Efficiency Scaling for 2 Decades (EES2)



SOURCE: Non-dotted lines based on Chart in SRC MAPT April 2023;
Dotted lines are EES2 estimates

- Shift from R&D Roadmaps based on length-based scaling (e.g., Moore's law) to ultra-energy-efficiency scaling and ensure all R&D includes some energy-efficiency focus
- Develop an EES2 RDD&D roadmap in partnership with the U.S. and allied country Semiconductor Industry

17 DOE National Laboratories

Office of Science Laboratories

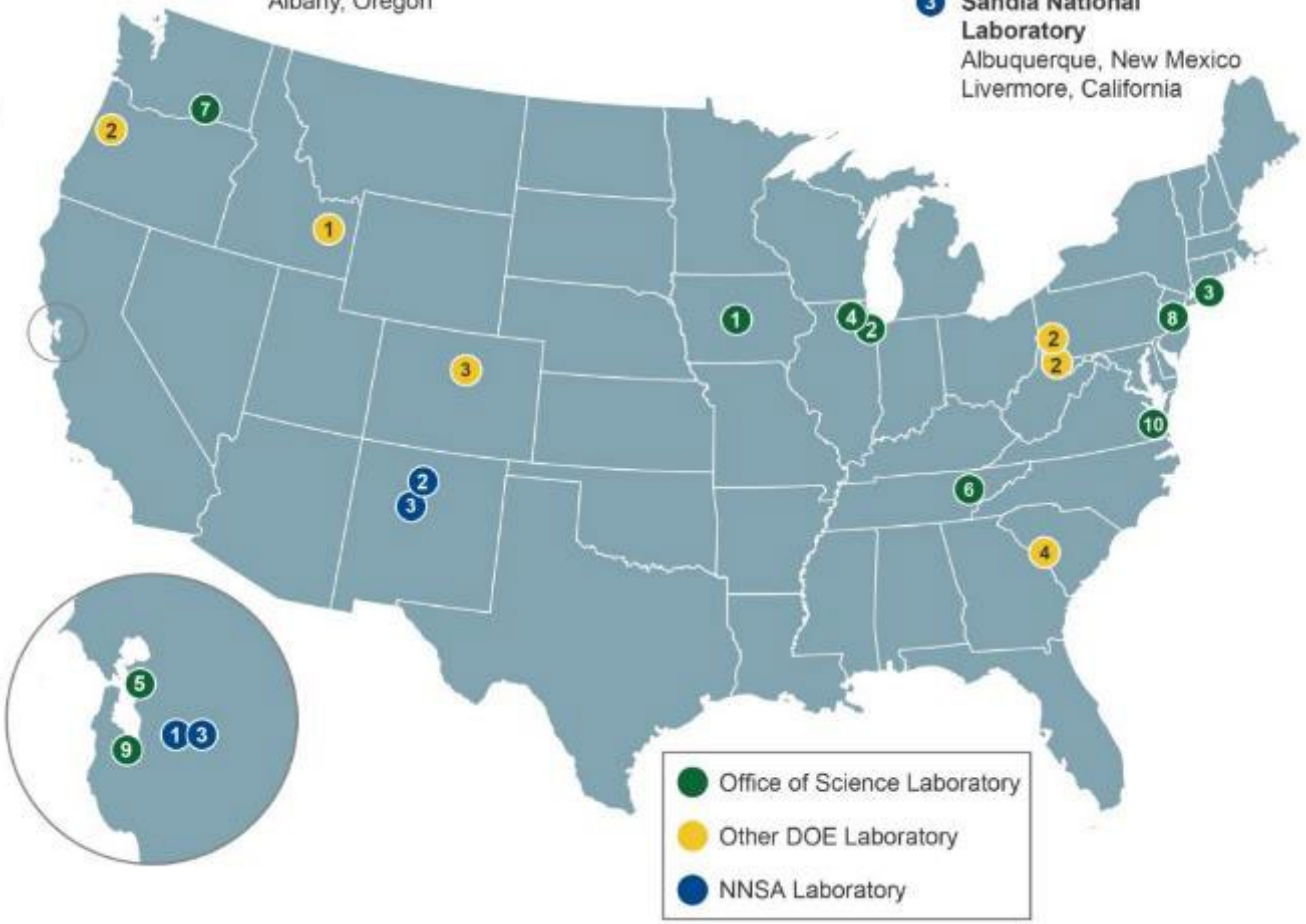
1. **Ames Laboratory**
   Ames, Iowa
2. **Argonne National Laboratory**
   Argonne, Illinois
3. **Brookhaven National Laboratory**
   Upton, New York
4. **Fermi National Accelerator Laboratory**
   Batavia, Illinois
5. **Lawrence Berkeley National Laboratory**
   Berkeley, California
6. **Oak Ridge National Laboratory**
   Oak Ridge, Tennessee
7. **Pacific Northwest National Laboratory**
   Richland, Washington
8. **Princeton Plasma Physics Laboratory**
   Princeton, New Jersey
9. **SLAC National Accelerator Laboratory**
   Menlo Park, California
10. **Thomas Jefferson National Accelerator Facility**
    Newport News, Virginia

Other DOE Laboratories

1. **Idaho National Laboratory**
   Idaho Falls, Idaho
2. **National Energy Technology Laboratory**
   Morgantown, West Virginia
   Pittsburgh, Pennsylvania
   Albany, Oregon
3. **National Renewable Energy Laboratory**
   Golden, Colorado
4. **Savannah River National Laboratory**
   Aiken, South Carolina

NNSA Laboratories

1. **Lawrence Livermore National Laboratory**
   Livermore, California
2. **Los Alamos National Laboratory**
   Los Alamos, New Mexico
3. **Sandia National Laboratory**
   Albuquerque, New Mexico
   Livermore, California



Center for X-Ray Optics (CXRO) at LBNL

"Superchips" Partnership Teams Intel and Three National Labs

September 19, 1997

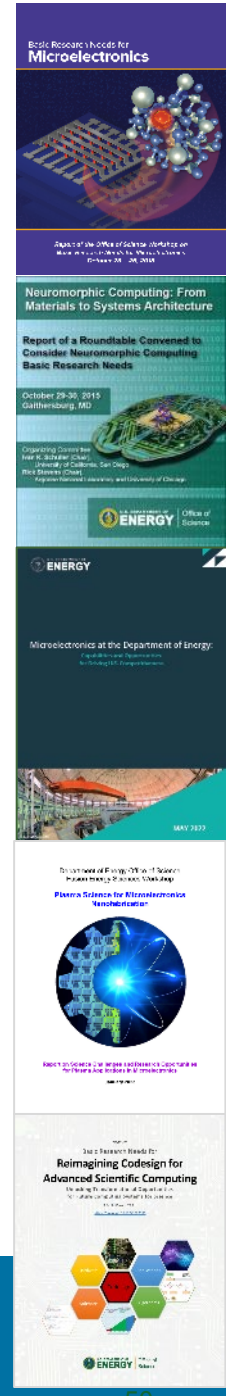
Scientists from Berkeley Lab will add their expertise in the field of precision optics to a historic partnership announced last week to develop the technology for manufacturing future generations of faster, more powerful computer chips.

From left, Lawrence Livermore National Lab Director Bruce Tarter, Secretary of Energy Federico Peña, Intel cofounder Gordon Moore, Berkeley Lab Director Charles Shank, and Sandia Deputy Drector John Crawford examine a 5X lithography tool. Photo courtesy of Sandia Labs

- CXRO is a Strategic Partnership Project at LBNL
- Operates two dedicated cleanrooms and is a regular user of the Molecular Foundry clean room
- It leverages Lab capabilities and PI expertise via user projects and joint LDRD support in the area of EUV radiation and low-energy electron chemistry

DOE Microelectronics Science Research Centers

- As authorized by the CHIPS and Science Act (Section 10731, Micro Act) the DOE FY 2024 President's Budget request includes $60M/year to establish **Microelectronics Science Research Centers.**
- Centers would perform mission-driven research to address foundational challenges in the design, development, characterization, prototyping, demonstration, and fabrication of microelectronics.
- Centers to focus on fundamental science and early-stage research, complementing the investments already being made through the CHIPS Act, such as:
  - ❖ National Semiconductor Technology Center (NSTC)
  - ❖ Microelectronics Commons
- Centers would leverage infrastructure and expertise at DOE National Labs.



Thank You

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