CHAPTER 2.0
PURPOSE AND NEED

The Proposed Action would help implement DOE's participation in the National Nanotechnology Initiative by locating a nanoscale research facility in a collaborative National Laboratory environment that integrates users and researchers from diverse scientific disciplines, and that is in close proximity to a synchrotron radiation source (LBNL's Advanced Light Source, or "ALS") and electron microscopy facilities (National Center for Electron Microscopy).

The NNI proposes significant increases in the national investment in nanotechnology to ensure that the United States maintains and exploits its competitive position in this rapidly developing field. The proposed Molecular Foundry would be consistent with the recommendation of the Interagency Working Group on Nanoscale Science, Engineering, and Technology (IWGN) of the National Science and Technology Council (NSTC), which urges that the DOE make nanoscale research facilities part of its contribution to the NNI.

European nations and Japan are already heavily committed to nanoscale science, which promises to revolutionize technology in the 21st century. An example of this commitment is the planned $300 million center for microtechnology and nanotechnology to be located near Grenoble, France. Grenoble is a major research center that is already home to the European Synchrotron Radiation Facility (ESRF) and the Institut Laue-Langevin (ILL) neutron source. This choice of sites reflects the importance of pairing nanotechnology centers with synchrotron radiation – a fact also recognized by the IWGN. The LBNL's proposed Molecular Foundry would also be consistent with the mission of the Office of Science: "To advance basic research and the instruments of science that are the foundations for DOE's applied missions, a base for U.S. technology innovation, and a source of remarkable insights into our physical and biological world and the nature of matter and energy." LBNL's proposed Molecular Foundry would provide a unique opportunity for a major advance in carrying out that mission.

The nanoscale research facilities envisioned by DOE would have unique scientific and engineering capabilities that combine state-of-the-art nanofabrication equipment with advanced nanocharacterization tools, theory, and computation. They will form a cornerstone of the nation's nanotechnology revolution, shedding light on the full spectrum of nanomaterials and providing an invaluable resource for universities and industry. In summary, nanoscale research facilities, and the Molecular Foundry in particular, would:

- Advance fundamental understanding and control of materials at the nanoscale dimension.

- Create an environment that would support multidisciplinary, multi-investigator research having a scope and complexity far beyond the traditional scale of the individual investigator or small group efforts.

- Establish the foundation for developing nanotechnologies important to DOE.

- Furnish users from the entire nation, and in fact the world, from government labs, universities, and industry with state-of-the-art equipment, and optimize use of existing LBNL national user facilities that harness electrons and photons for materials characterization.

- Provide a formal mechanism for short-term and long-term collaborations and partnerships among DOE laboratory, academic, and industrial researchers.

- Produce training opportunities for graduate students and postdoctoral associates in interdisciplinary nanoscale science, engineering, and technology research.

The Molecular Foundry would integrate researchers from various fields, including materials science, chemistry, biology, and computational science, to work and conduct research collaboratively. A few examples of the types of products and innovations hoped for with this sort of collaborative nanoscience and technology at the proposed Molecular Foundry include:

- Inexpensive and accessible terabyte-scale computer memories for personal computers and electronic devices;

- Quantum computers capable of making advances in complex, enormous tasks such as cryptography and climate modeling;

- Compact, ultra-sensitive, broad-spectrum chemical and biological sensors for homeland security protection of the food and water supply, and for diagnosis of disease;

- Remote sensing devices;

- High-efficiency machine lubricants for increased efficiency and performance;

- light-weight, durable materials;

- Low-cost, high-efficiency photovoltaic cells for increased energy self-sufficiency;

- Ultrahigh selectivity catalysts for energy-efficient, low-waste production of products for industry and consumer use;

- Biologically based devices and energy transduction systems for increased efficiency;

- Nanoscale (and thereby highly selective, effective, and safer) drug delivery agents, biomedical and microsurgical devices;

- Efficient, durable displays for electronic devices;

- New instruments to image and manipulate atoms, molecules, and small particles for miniaturization of devices and instruments;

- Faster, more compact computer chips.

The proposed Molecular Foundry laboratories would be designed and constructed to facilitate research activities in a wide variety of fields required for progress in this new area of science. These labs would support a broad research effort focusing on "hard" nanometer-sized materials (e.g., rigid, static, structural elements such as nanocrystals, tubes and lithographically patterned structures) as well as "soft" nanometer-sized materials (e.g., flexible, dynamic, organic materials such as polymers, dendrimers, DNA, proteins and whole cells).

The Molecular Foundry would house facilities for research in six areas: 1) nanofabrication, 2) inorganic nanostructures, 3) organic, polymer/biopolymer synthesis, 4) biological nanostructures, 5) theory, and 6) imaging and manipulation. These facilities would be equipped with state-of-the-art instruments and would be staffed by full-time scientists and technicians. The facilities would function as user facilities, available to scientists from universities, industry, and government laboratories whose research proposals have been peer-reviewed by a study panel. This combination of equipment, collaborative staff and disciplines would allow users a highly interdisciplinary approach.