SC-CH F 560-ACQ
(11/05) Previous editions are obsolete.

GRANT 380
Chicago Office NEPA Tracking Number

U. S. DEPARTMENT OF ENERGY
OFFICE OF SCIENCE -- CHICAGO OFFICE

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)
ENVIRONMENTAL EVALUATION NOTIFICATION FORM

To be completed by "financial assistance award" organization receiving Federal funding. For assistance (including a point of contact), see "Instructions for Preparing SC-CH F-560, Environmental Evaluation Notification Form".

Solicitation/Award No. (if applicable): DE-FOA-0000214

Organization Name: California Institute of Technology

Title of Proposed Project/Research: The Joint Center for Artificial Photosynthesis

Total DOE Funding/Total Project Funding: 118,630,000

I. Project Description (use additional pages as necessary):

A. Proposed Project/Action (delineate Federally funded/Non-Federally funded portions)

The Joint Center for Artificial Photosynthesis, JCAP, will develop a scalable manufacturable solar-fuels generator, using Earth-abundant elements, that, with no wires, robustly produces fuel from the sun 10 times more efficiently than (current) crops.

JCAP will develop Earth-abundant, robust materials that are needed to capture and convert sunlight; catalysts that effect the conversion of the absorbed solar energy into chemical fuels such as the production of H2 and reduced hydrocarbons from CO2, water, and sunlight. The Center will also work on the scientific underpinnings for linking together the various light absorbers, catalysts, and membrane units on the nanoscale into fully functional artificial photosynthetic units, directing their assembly into functioning systems on a length scale of METRIC (cm) and incorporating these photosynthetically active elements into hardware scale embodiments of a fully operational solar-fuels generator on the 10 cm x 10 cm scale.

	Yes	No
B. Would the project proceed without Federal funding?	☐	☒

If "yes", describe the impact to the scope:

II. Description of Affected Environment:
See attached Appendix 5

(BERKELEY) STRAWBERRY CANYON - REC. AREA.

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III. Preliminary Questions:

		Yes	No
A.	Is the DOE-funded work *entirely* a "paper study"?	☐	☒

If "Yes", ensure that the description in Section I reflects this and go directly to Section V.

B.	Will the work to be performed take place *entirely* in existing buildings?	☒	☐

*And **NOT:***

1.	Threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety, and health?	☒	☐
2.	Require the siting, construction or major expansion of waste treatment, storage, or disposal facilities?	☒	☐
3.	Disturb hazardous substances, pollutants, or contaminants preexisting in the environment?	☒	☐
4.	Adversely affect environmentally-sensitive resources identified in Section IV.A.?	☒	☐
5.	Be connected to another existing/proposed activity that could potentially create a cumulatively significant impact?	☒	☐
6.	Have an inherent *possibility* for high consequence impacts to human health or the environment (e.g., Biosafety Level 3-4 laboratories, activities involving high levels of radiation)?	☒	☐

If "Yes" to Question III.B. and ALL six subsequent questions, ensure the descriptions in Sections I and II reflect this and go directly to Section V.

IV. Potential Environmental Effects:

Attach/insert an explanation for each "Yes" response.

A. Sensitive Resources: Will the proposed action result in changes and/or disturbances to any of the following resources?

		Yes	No
1.	Threatened/Endangered Species and/or Critical Habitats	☐	☒
2.	Other Protected Species (e.g., Burros, Migratory Birds)	☐	☒
3.	Sensitive Environments (e.g., Tundra/Coral Reefs/Rain Forests)	☐	☒
4.	Archaeological/Historic Resources	☐	☒
5.	Important Farmland	☐	☒
6.	Non-Attainment Areas for Ambient Air Quality Standards	☐	☒
7.	Class I Air Quality Control Region	☐	☒
8.	Special Sources of Groundwater (e.g. Sole Source Aquifer)	☐	☒
9.	Navigable Air Space	☐	☒
10.	Coastal Zones	☐	☒
11.	Areas with Special National Designation (e.g. National Forests, Parks, Trails)	☐	☒
12.	Floodplains and Wetlands	☐	☒

B. Regulated Substances/Activities: Will the proposed action involve any of the following regulated items or activities?

		Yes	No
13.	Natural Resource Damage Assessments	☐	☒
14.	Exotic Organisms	☐	☒
15.	Noxious Weeds	☐	☒
16.	Clearing or Excavation (indicate if greater than one acre)	☐	☒
17.	Dredge or Fill (under Clean Water Act, Section 404, indicate if greater than ten	☐	☒

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B. Regulated Substances/Activities: Will the proposed action involve any of the following regulated items or activities? (continued)

		Yes	No
18.	Noise (in excess of regulations)	☐	☒
19.	Asbestos Removal	☒	☐
20.	PCB's	☐	☒
21.	Import, Manufacture, or Processing of Toxic Substances	☐	☒
22.	Chemical Storage/Use	☒	☐
23.	Pesticide Use	☐	☒
24.	Hazardous, Toxic, or Criteria Pollutant Air Emissions	☐	☒
25.	Liquid Effluents	☐	☒
26.	Underground Injection	☐	☒
27.	Hazardous Waste	☒	☐
28.	Underground Storage Tanks	☐	☒
29.	Radioactive Mixed Waste	☐	☒
30.	Radioactive Waste	☐	☒
31.	Radiation Exposure	☐	☒
32.	Surface Water Protection	☐	☒
33.	Pollution Prevention Act	☐	☒
34.	Ozone Depleting Substances	☐	☒
35.	Off-Road Vehicles	☐	☒
36.	Biosafety Level 3-4 Laboratory	☐	☒

C. Other Relevant Information: Will the proposed action involve the following?

		Yes	No
37.	Potential Violation of Environment, Safety, or Health Regulations/Permits	☐	☒
38.	Siting/Construction/Major Modification of Waste Recovery, or Waste Treatment, Storage, or Disposal Facilities	☐	☒
39.	Disturbance of Pre-existing Contamination	☐	☒
40.	New or Modified Federal/State Permits	☐	☒
41	Public Controversy	☐	☒
42.	Environmental Justice	☐	☒
43.	Action/Involvement of Another Federal Agency (e.g. license, funding, approval)	☐	☒
44.	Action of a State Agency in a State with NEPA-type law. (Does the State Environmental Quality Review Act apply?)	☒	☐
45.	Public Utilities/Services	☐	☒
46.	Depletion of a Non-Renewable Resource	☐	☒
47.	Extraordinary Circumstances	☐	☒
48.	Connected Actions	☐	☒
49.	Exclusively Bench-top Research	☒	☐
50.	Only a Laboratory Setting	☒	☐

V. Financial Assistance Award Organization Concurrence:

A. Organization Official (Name and Title): _____

Signature: _____ Date: 7/29/10

e-mail: _____ Phone: _____

B. Optional Concurrence (Name and Title). _____

Signature: _____ Date: 8/3/2010

e-mail: _____ Phone: _____

GAYLE F. LUND
Associate Director of Sponsored Research

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Remainder to be completed by SC-CH

VI. SC-CH Concurrence/Recommendation/Determination:

A. SC-CH Office of Acquisition and Assistance or Office of Safety, Technical & Infrastructure Services:

Project Director or Contract Specialist (Name and Title): _____

Signature: _____ Date: 8/3/10

B. SC-CH NEPA Team Review:

Is the project/activity appropriate for a determination or a recommendation to the Head of the Field Organization by the NEPA Compliance Officer (NCO) under Subpart D of the DOE NEPA Regulations?

Yes ☒ No ☐ A7, B1.4, B1.5, B1.7, B1.15, B1.24

Specific class(es) of action from Appendices A-D to Subpart D (10 CFR 1021): B2.1, B2.2, AND B3.6

Name and Title: _____

Signature: _____ Date: 9/21/10

C. SC-CH Counsel (if necessary):

Name and Title: _____

Signature: _____ Date: 9/22/10

D. SC-CH NEPA Compliance Officer:

The preceding pages are a record of documentation required under DOE Final NEPA Regulation, 10 CFR 1021.400.

☒ Action may be categorically excluded from further NEPA review. I have determined that the proposed action meets the requirements for Categorical Exclusion referenced above.

☐ Action requires approval by Head of the Field Organization. Recommend preparation of an Environmental Assessment.

☐ Action requires approval by Head of the Field Organization or a Secretarial Officer. Recommend preparation of an Environmental Impact Statement.

Comments/Limitations if necessary:

Signature: _____ Date: 9/21/10

Peter R. Siebach
SC-CH NEPA Compliance Officer

4

This action includes activities at three primary locations; CalTech, Lawrence Berkely National Laboratory and SLAC National Aecelerator Laboratory. This approval is for the entire action. If the scope of the project changes, additional NEPA review would be warranted.

Responses to "Yes" items in Section IV B.

Item #19-~~Asbestos Removal~~

1. Asbestos removal projects will use only CAL/OSHA certified asbestos contractors for asbestos removal.
2. The contractor must notify CAL/OSHA and the South Coast Air Quality Management District for Projects requiring more than 100 square feet of asbestos removal.
3. All removal will comply with asbestos removal certification and other requirements in 40 CFR 763 (Subpart G) and 40 CFR 61 (Subpart M).

Item #22: ~~Chemical Storage/Use~~

The California Occupational Safety and Health Administration (Cal/OSHA) has promulgated a laboratory standard entitled Occupational Exposure to Hazardous Chemicals in Laboratories, 8CCR5191, which applies to all laboratories that use hazardous chemicals. It specifies that a written chemical hygiene plan must be developed and implemented that includes the necessary work practices, procedures, and policies to ensure that employees are protected from hazardous laboratory chemicals.
As required, an Institute Chemical Hygiene Plan has been prepared for use by division, principal investigator, laboratory manager, and laboratory worker (including students) in the safe operation of chemical laboratories.
This California Institute of Technology Chemical Hygiene Plan sets forth the procedures, equipment, personal protective equipment, and work practices used to protect employees from the health hazards presented by the use of laboratory chemicals at California Institute of Technology. The full fifty-page plan can be obtained upon request from California Institute of Technology.

Components of the Plan include:

- Responsible personnel
- Standard operating procedures for safety and health
- Engineering control measures
- Proper operation of engineering controls
- Provisions for training and information dissemination
- Provisions for medical examination and consultation
- Special precautions
- Identification of particularly hazardous substances

The plan specifies that the storage of chemical meet the following guide lines:

- Store stock quantities of hazardous chemicals in a secured area.
- Keep working quantities of chemicals to a minimum.
- Maintain quantities of chemicals to a minimum.
- Maintain quantities to less than the amounts required for use in one week, except amounts stored in a specific chemical storage area or cabinet that is located within the laboratory work area.
- Store flammable liquids in excess of 10 gallons in approved flammable liquid storage cabinets.
- Storage of flammable liquids outside of a cabinet should be in an approved flammable liquid container or in its original DOT approved container with secondary containment.
- Segregate reactive chemicals from incompatible chemicals (see Appendix).
- Affix appropriate labels to storage containers.

Item #27 – California Institute of Technology generates solvents, corrosives and metals as a Large Quantity Generator. A permitted transporter is used on a quarterly basis and the approximate distance to the TSDF is 33 miles.

Responses to "Yes" items in Section IV C.

Item #44 - California has a NEPA-type law. No Environmental Impact Statement will be needed.

Item #49 – Yes as noted IN THE ATTACHMENT

Item #50 - The renovated Laboratory building will comply with all Federal and State building code and permit requirements related to chemical laboratory buildings.

Appendix 5: Hub Site, Acquisition, Design and Development Plan

5.1 Center Siting

The JCAP team recognizes the necessity of integrating scientists and engineers from a variety of disciplines into a single research team. The challenges of designing and building a solar fuels conversion device span many disciplines and scales of size, and only an integrated team approach has any hopes of success. Thus, the Hub buildings must not only provide space and equipment for research but must also foster interactions between researchers both within and between the various JCAP programs. JCAP will integrate the two Hub centers into a single intellectual unit through the use of full-time video conferencing between the centers. JCAP's facility approach is to develop two centers, one at Caltech close to the collaborating institutions, UCIrvine, UCSB and UCSD (Figure 5.1), and one at LBNL close to UCBerkeley, Stanford, LBNL, SLAC. In the north the team has identified permanent space in a building on the LBNL site with initial start up space in a rental building close to LBNL already equipped with the necessary laboratory facilities. In the south the team has identified a building, Jorgensen Laboratory, on the Caltech campus that will be remodeled for the center with start up space in recently vacated chemistry laboratories.

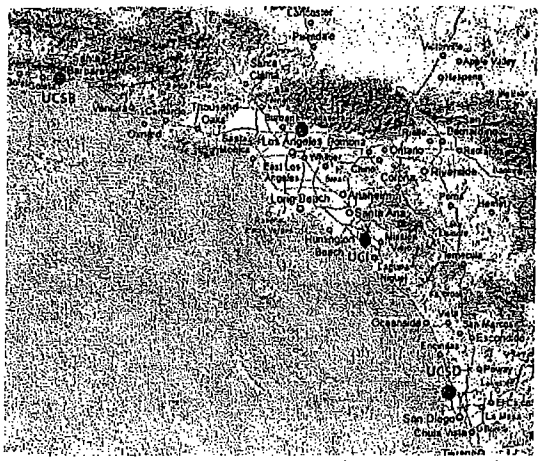

Figure 5.1: Map of area showing collaborating institutions.

Both Pasadena and Berkeley are world famous centers for scientific research and have spin-offs and startup companies associated with high tech centers. The locations of the centers assures access to San Francisco, Silicon Valley, and Los Angeles and their unparalleled mix of industry, education and research, finance, venture capital, and governmental resources. The centers are located in two of the nation's most popular regions to live and work. Both the east Bay and Pasadena area have conveniently located metro, rail and bus transportation systems. The new Los Angles Metro Gold line connects Pasadena with downtown LA. JCAP will be centered in areas with a strong high-technology industrial base that attracts businesses that need room to grow with highly trained workers that live close by.

With 10 million residents, Los Angeles County is the largest county in the US. The growth of the southern California area over the last 20 years has been due to its key location and available land for new residential, commercial and industrial uses. The Los Angles economy is highly diverse but with the present economic down turn highly skilled workers are available at competitive costs. The region's diversity offers exceptional opportunities to foster and promote scientific and technological innovation.

5.2 Center Startup

JCAP will begin operations immediately following the notice of the award. JCAP south will begin operations by using 10,000 square feet (SF) of temporary laboratory space on the Caltech campus. In the north, space currently leased by LBNL will be used. This plan will expedite full operations by allowing the startup of scientific work while permanent space is being completed. In both the North and the South, permanent space will be developed in buildings on the campuses.

Caltech and LBNL, as well as the other JCAP partners, already have many of the world's most advanced and productive research facilities available to address the tasks to be undertaken. These include dedicated chemical and nanotechnology laboratories, specialized facilities for use of both high energy and low energy X-rays for scattering; X-ray, UV, visible and IR spectroscopy; high-resolution imaging systems; supercomputers; surface-science instruments; and supporting research programs. These facilities are already performing artificial-photosynthesis-related research and will be employed to enhance JCAP's scientific productivity. They will allow the center to make use of a vast array of scientific instruments and facilities, to minimize the startup time, and to augment the expertise of the JCAP researchers. A brief description of some of these facilities is included in Appendices 11 and 12.

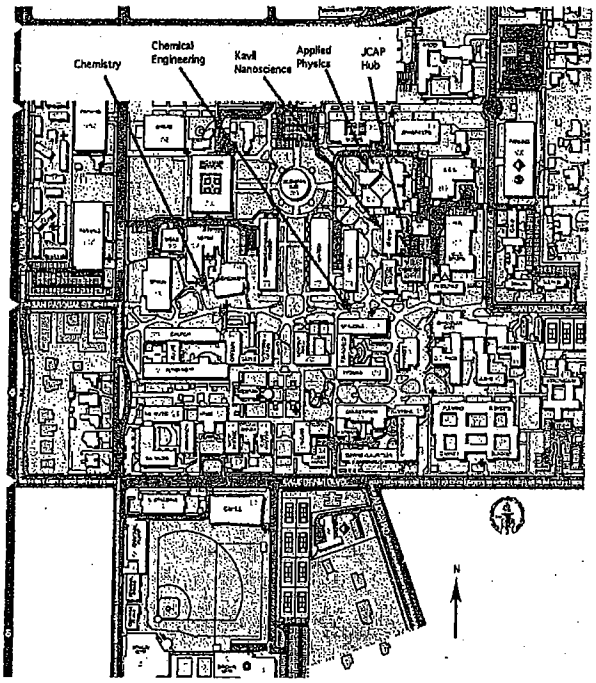

Figure 5.2: Map of Caltech campus showing location of JCAP site along with that of Applied Physics, Chemistry, Chemical Engineering, and the Kavli Nanoscience Institute.

5.3 JCAP Hub South.

At Caltech, plans to reconfigure the Jorgensen Laboratory building are being pursued. The building is centrally located on the Caltech campus and space in the building will be shared with the Resnick Institute for Energy, Science, and Sustainability, see Figure 5.2. The use of a building on the Caltech campus will allow:

- Maximum interaction between the various solar energy research programs at Caltech.
- Sharing of instrumentation already available on campus.
- Attracting of outstanding staff and students to work in the Hub.
- Use of Caltech facilities for Hub outreach, staff recreation, and research.
- Use of Caltech infrastructure such as computer networks, machine shops, support staff, etc.

Conceptually, the JCAP Hub south will occupy about ~17,500 assignable square feet (SF) of space. Jorgensen is located close to the center of the Caltech campus, near the Applied Physics, the Chemical Engineering, and Chemistry buildings. The campus has adequate parking space for JCAP staff, is within the Pasadena urban area and has convenient access to hotels, restaurants, and other urban amenities. The campus has eating, library and athletic facilities all in close proximity. Further, the campus has space to house short-term visitors in the Athenaeum, the university club, located on campus. Figure 5.2 shows the location of the proposed JCAP Hub on the Caltech campus.

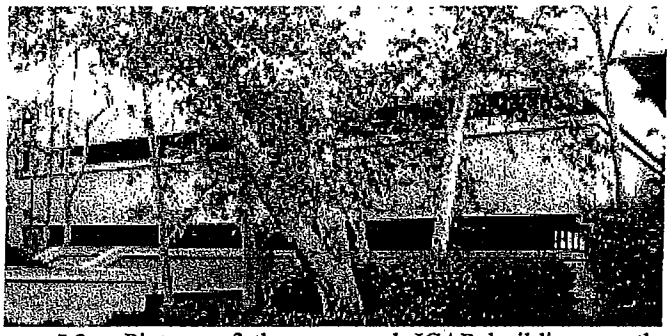

Figure 5.3: Picture of the proposed JCAP building on the Caltech Campus. The building would be rehabilitated before JCAP use

5.4 JCAP Pasadena Hub Building.

Figure 5.3 shows the exterior of the JCAP building. Caltech Facilities engineers and a contractor have made preliminary cost and time estimates for conversion of the building to the JCAP Hub. Jorgensen is a three-story building with windows on all floors, and a total of 31,000 SF of space.

Planning for the new facility will be integrated with JCAP scientific program development to provide a collaborative, adaptable, and sustainable research environment. Final space plans will be developed during planning sessions with the JCAP management team to produce a setting conducive to the integrated research needs of JCAP. The research space will parallel the research proposal above. The facility will be open and flexible to enable reallocation of space as projects expand and contract with time. Further, the larger UHV and imaging instruments needed to characterize the heterogeneous catalysts and light absorbers will be in space shared by all groups

A conceptual layout of the space required to house and support the research program is shown in Figures 5.4 – 5.6, for Caltech. The proposed site plan envisions use of approximately 25,000 SF of space located on three floors for the Hub. It is anticipated that this will yield ~17,500 SF of usable space. The Resnick Institute for Science, Energy, and Sustainability will occupy the remaining space in Jorgensen. The JCAP Labs will incorporate an open design with windows on inside walls to allow researchers both inside and outside of the labs to interact and to encourage interactions between groups. The laboratories in Jorgensen will make use of natural illumination from continuous outside windows to give working areas an open and spacious feeling. Individual desk space will be located in common alcove areas that will have sufficient space to carry out small group meetings and planning sessions. The distributed alcove space will allow for multiple team meetings, and videoconferences, simultaneously. The central conference room will accommodate larger gatherings (30- 40 seats). Still larger meetings will use larger meeting rooms on campus, especially a large auditorium in an adjacent building that

will be equipped with extensive videoconferencing capabilities, while small groups can meet in alcoves of the small conference room on the first floor.

All alcoves and conference rooms will be equipped with built-in remote conferencing capabilities, facilitating continuous communication between north and south Hubs, to create a single intellectual research center. Students and staff working at their desk in the south Hub will be able to view their north colleagues in real time. Over a short period of time, the continuous

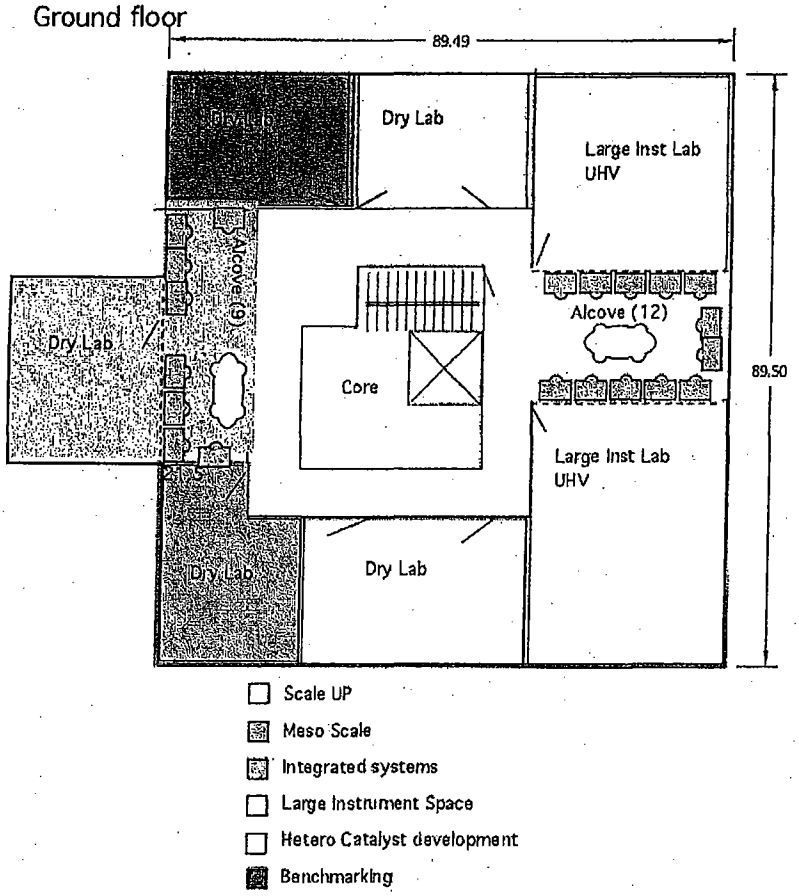

Figure 5.4 Conceptual Layout of Ground Floor of Caltech Hub

video interactions between the two centers will make it possible for researchers in the two hubs to interact similarly to workers sitting at physically adjacent desks. One begins to talk to the other site as if it is actually present, and asks questions and discusses research strategies in a natural way with their remote colleagues. This will be particularly true for two sites located in the same time zone, so that the working hours completely overlap. It has been found that even within one facility, people in continuous video contact will often interact thought the virtual presences rather then get up and walk over to the physical person. This is because it becomes faster to interact this way. Thus at any one time, a number of simultaneous discussions will be taking place between the two centers utilizing different alcove areas and or meeting rooms. It

will be possible for all alcoves to be in communication with different (or the same) groups in the north simultaneously.

Drawings of the proposed layout are show in Figures 5.4, 5.5 and 5.6. The proposed space plan includes approximately 4,200 SF of wet labs, 7,300 SF of instrument labs, plus two seminar rooms with one that can accommodate up to 40 people, 3,900 SF of alcove space, and 12 offices.

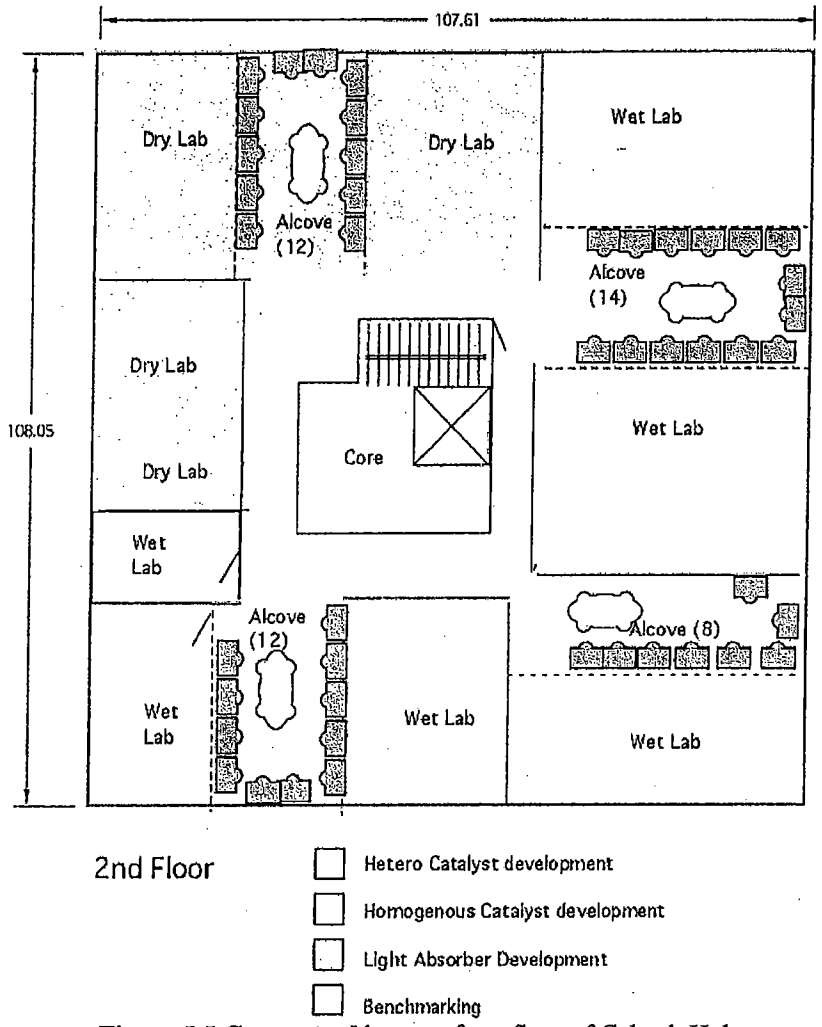

Figure 5.5 Conceptual layout of top floor of Caltech Hub.

The alcove space is projected to seat approximately 65 researches with offices accommodating another 12 to 15 more. The wet and dry lab areas are projected to accommodate almost 100 researches.

Wet laboratories will be equipped with fume hoods, and other facilities normally expected in chemistry laboratories (compressed gases, electricity, vacuum, etc). Dry labs will be specifically designed for the experiments and equipment to be used in each space with laboratories located on the ground and top floors. Two large laboratory spaces on the ground floor are reserved for

heavy UHV and imaging instruments. The wet (chemical) laboratory space will be located on the top floor. The building will enable the development of thematic and common areas, to include: heterogeneous and homogenous catalyst development, the search for new semiconductor light absorbers, benchmarking of catalysts and light absorbers, mesoscale research, and development of large-scale structures. Specialty areas will include high-resolution imaging suites, UHV instrument laboratories, laser and transient measurement laboratories, dark laboratories, high throughput laboratories, etc. Temperature and humidity, air exchange rates, air pressure, and noise levels will be controlled to maintain a safe and high-quality working environment.

Administration and a large and small conference room will be located on the first floor next to the main entrance in close proximity to the labs. All offices, multipurpose meeting spaces, and other support spaces will be configured to encourage an interactive work

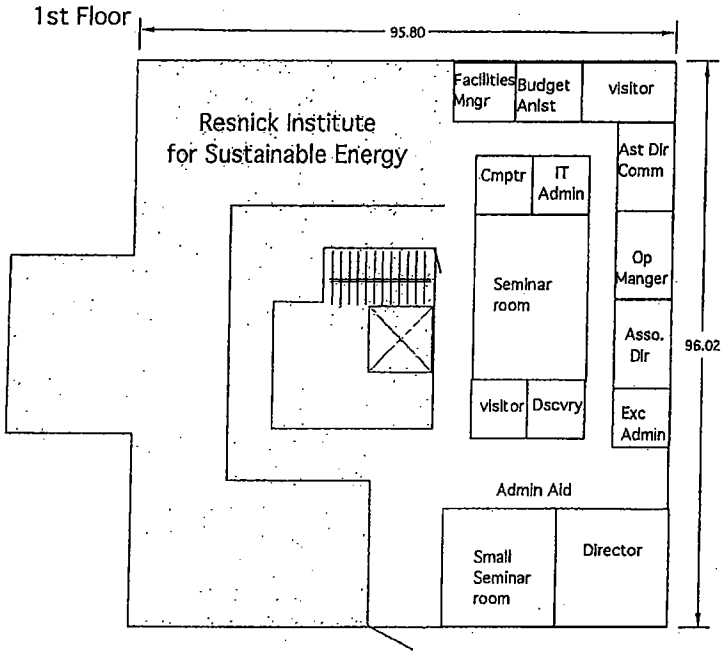

Figure 5.6 Conceptual layout of first floor of the Caltech Hub.

environment.

The facility design will promote JCAP collaborative relationships geared to multidisciplinary teams and will allow for close collaboration between all Hub researchers independent of where they are physically located. Infrastructure such as for computing and data systems will be distributed with all areas having easy access. The ground floor is on grade and can accommodate ultra-low vibration instruments such as EMs, STMs, AFMs, and other instruments that have nm and sub-nm resolving capabilities.

An outline of the JCAP south development activities, and their projected schedule through the achievement of full scientific operations is shown in the table below. While the exact costs for build-out of the facility will depend on the specific plans; preliminary estimates developed by the Caltech Facilities Department suggest a cost of about $10.1 million. The difference between

the total cost of renovation, estimated to be $10.1 million, and the funds request for rehabilitation from DOE, will be provided in the form of cost sharing. The current cost estimate for research equipment is $12 million, as described in detail in the budget.

Competitive Lease Acquisition	Start Date	End Date
Award announcement	June 2010	June 2011
Scientific ramp-up in on site Caltech Facilities	July 2010	March 2010
Build-out Design	June 2010	Oct 2010
Construction	Oct 2010	March 2011
Initial Occupancy	March 2011	
Full Occupancy	April 2011	
Full Scientific Operations	June 2011	

Table 5.1 Time line for operation of Caltech JCAP Hub.

5.5 Instrumentation in JCAP Pasadena

JCAP Pasadena will outfit its laboratories with equipment following a staged capital equipment acquisition plan of approximately $12 million over 5 years.

Major acquisitions and their cost are shown below:

Automated high Throughput Powder XRD $355K

Used to determination the crystal structure of high throughput semiconductors and materials. For many of the materials synthesized by the Light Capture, and Conversion Materials, and Heterogeneous Catalysts groups we will need to know the crystal structure of the material. This high throughput powder diffractometer will allow the rapid collection of XRD data for many compounds.

Auto PVD system: $750K

Used to prepare specific solid-state compounds and structures, to allow studies of thin films of materials in a high-throughput fashion, and to prepare compounds that cannot be produced by ink jet or liquid phase deposition techniques. The Heterogeneous Catalysts and Light Capture and Conversion groups will use this instrument.

Electrochemistry/PEC (4): $350K

A screening instrument used to evaluate the properties of the compounds produced by the high throughput synthesis methods of the Light Capture, and Conversion Materials, and Heterogeneous Catalysts groups. This system will allow measurement of the electrochemical and photoelectrochemical properties of these materials. The electrochemical properties of catalysts will determine if the material can effectively catalyze water oxidation or reduction, or CO_2 reduction, while the photoelectrochemical properties are important for the semiconductor light absorbers. Heterogeneous Catalysts, Light Capture and Conversion Materials groups will use this instrument.

XPS high throughput system: $500K

High throughput, XPS instrument with depth profiling ion gun source and a rapid sample entry chamber that could be coupled to an inert atmosphere transfer chamber to transfer from a glove box environment. This instrument would be essentially an XPS only instrument that would be an analytical workhorse for chemical analysis of the surface of solids. The Heterogeneous Catalysts, and Molecular-Nanoscale Interface groups will use the instrument.

XPS/UPS/Auger/reaction chamber Ambient Pressure, $998K

High resolution XPS/UPS instrument used for detailed chemical analysis of materials surfaces at ambient pressure. SPECS is now marketing a system with a differentially pumped electron energy analyzer aimed at lab based ambient pressure XPS. The high intensity of the synchrotrons is often not important for the ambient pressure experiments because of beam damage issues. A lab based ambient pressure photoemission system would allow us to study samples with thin films of adsorbed water (thin being many monolayers of water---enough to simulate bulk). This system would be equipped with a reaction or sample preparation chamber that will allow electrochemical modifications, in-situ photochemistry, etc. The analysis chamber will be equipped with a high quality manipulator so that connections can be made to the samples with heating and cooling capabilities. The Heterogeneous Catalysts and Light Capture and Conversion Materials groups will use this instrument.

SEM Field emission/EDX/EBIC: $1,000K

A High-resolution field emission scanning electron microscope (SEM) with EDX and EBIC used for observing the structure of photoelectrodes and heterogeneous catalysts. This SEM will be used to image the novel semiconductor and catalyst structures used to increase the effectiveness of the light absorbers and increase the surface area of the catalysts on the electrodes. This SEM (<10 nm spatial resolution) would be a workhorse instrument for the Heterogeneous Catalysis, Light Capture and Conversion Materials, and Membrane, and Mesoscale Assembly groups. Also the EDX and EBIC will allow both elemental analysis of the structures and the measure of electron/hole lifetimes in semiconductor wire materials. The Heterogeneous Catalysts, Light Capture and Conversion Materials, and Molecular-Nanoscale Interface groups will use this instrument.

Surface Reaction Chamber $700K

A flexible surface reaction chamber that can do high quality TDS experiments (differentially pumped mass spec, and pseudo molecular beam dosers), coupled with a range of surface analytical capability, for the catalyst studies. The instrument will have an electron energy analyzer for doing standard XPS, UPS and possibly Auger experiments with a sample preparation chamber. The Heterogeneous Catalysts, Light Capture and Conversion Materials, and Molecular-Nanoscale Interface groups will use the instrument.

UHV variable temperature STM/AFM with electrochemical cell imaging $800K

STM imaging in an electrochemical environment has become possible through the work of a number of groups in Germany. We would build one of these chambers to allow STM and AFM imaging in a working electrochemical cell. This chamber would also have other analysis

capabilities and flexible sample mounting (heating, cooling, in-situ electrical measurements). The Heterogeneous Catalysts, and Light Capture and Conversion groups will use the instrument

Raman Micro Probe $300K

Based on a confocal microscope optical arrangement, this instrument would provide spectroscopic characterization of modified sample surfaces with sub-wavelength spatial resolution. Single molecule studies of the properties and chemistry of surface attached molecular species will provide detailed information about the molecules on the modified surfaces. Shifts in Raman-scattered light also correspond to strain in semiconductor crystals that subsequently leads to defects and a general decrease in device performance. The Raman microprobe instrument will characterize Raman scattering on semiconductors. Quantifying crystal strain and growth, will enable us to grow large-area novel semiconductor devices with low strain and high performance. The Heterogeneous Catalysts, the Light Capture and Conversion, and Molecular Catalysts groups will use this instrument.

ALD system $355K

Will be used to prepare specific solid-state compounds and structures to allow studies of thin films of materials. The high throughput methods will identify materials that are promising and this instrument will allow preparation of well-defined materials for detained follow up studies of the initial high throughput results. The ALD will allow synthesis of well-defined materials that have shown promise by other methods and to prepare compounds that cannot be produced by ink jet or liquid phase deposition techniques. The Heterogeneous Catalysts and Light Capture and Conversion groups will use this instrument.

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(11/05) Previous editions are obsolete.

LB-ER-10-09
BSO NEPA Tracking Number

U. S. DEPARTMENT OF ENERGY
OFFICE OF SCIENCE -- CHICAGO OFFICE

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)
ENVIRONMENTAL EVALUATION NOTIFICATION FORM

To be completed by "financial assistance award" organization receiving Federal funding. For assistance (including a point of contact), see "Instructions for Preparing SC-CH F-560, Environmental Evaluation Notification Form".

Solicitation/Award No. (if applicable):
Organization Name: Lawrence Berkeley National Laboratory
Title of Proposed Project/Research: The Joint Center for Artificial Photosynthesis(JCAP): A DOE Energy Innovation Hub
Total DOE Funding/Total Project Funding: $122M

I.	Project Description (use additional pages as necessary	
	A.	Proposed Project/Action (delineate Federally funded/Non-Federally funded portions
		The proposed Federal Action would include the five-year leasing and renovation of approximately 25,000 square feet of lab/office space in Berkeley or Emeryville and the operation of the JCAP program. The mission of JCAP is to demonstrate a scalable and cost-effective solar fuels generator that, without use of rare materials or wires, robustly produces fuel from the sun 10 times more efficiently than typical current crops. To achieve this goal, JCAP will address the critical R&D gaps spanning multiple physical scales from the nanoscale to the operational macroscale and those between the distinct components that, when integrated, will comprise a full artificial photosynthetic system prototype. The five year research program at LBNL would focus on developing both theoretical and experimental activities related to: a) Design and development of homogeneous and heterogeneous catalysts. b) Design and development of semiconductor light absorber. c) Photoelectrochemical Membranes. JCAP would design and synthesize photoelectrochemical membrane layers that provide ionic pathways, good optical and light-scattering properties, and be impermeable to the product fuel and oxygen. d) Assembly of Components into a Device. JCAP would develop the strategies and molecular tool kits for linking the various needed individual components into a fully functioning nanoscale artificial photosynthetic assembly e) Scale-Up from Nanoscale to Macroscale. JCAP would develop methods for orienting, assembling, and interconnecting nanoscale functional assemblies into macroscale fully functional materials and systems f) Benchmarking catalysts and integrated systems g) Scalability and Sustainability Analysis. JCAP would, from inception, analyze all components, materials and chemical inputs, hardware designs, assembly methods, form factors, and system implementations with respect to manufacturability and life-cycle analysis, reuse, and remanufacturing, to ensure that the final operational systems are in fact scalably and sustainably manufacturable. The approximately 50 employees, guests, and collaborators would need lab spaces for general research and development laboratories, and office space for associated support, office, and administrative functions. The rented space would be improved to accommodate the JCAP. The space would be reconfigured into research laboratory, support, utility, and office space. In addition, a mechanical room and roof space would be used for mechanical equipment that serves the research equipment. Modifications would also be made to the building plumbing, mechanical, electrical, HVAC, and nitrogen systems. The development of low-carbon fuels that can meet demand while reducing carbon dioxide emissions is critical to energy, environmental and economic security for the United States and the world. The overarching

		goals of the Joint Center for Artificial Photosynthesis (JCAP) are to develop the science and technology of artificial photosynthesis, in which the system performs the same function as that of plants, but with a robustness and efficiency that is at least a factor of 10 greater than the best-known biological photosynthetic systems		
			Yes	No
	B.	Would the project proceed without Federal funding?	☐	☒
		If "yes", describe the impact to the scope:		
II.	Description of Affected Environment:			
		Proposed building modifications and research work would be carried out in an existing leased facility in an industrial area of Berkeley or Emeryville California.		

III. Preliminary Questions:

		Yes	No
A.	Is the DOE-funded work *entirely* a "paper study"?	☐	☒

If "Yes", ensure that the description in Section I reflects this and go directly to Section V.

B.	Will the work to be performed take place *entirely* in existing buildings?	☒	☐

*And **NOT**:*

1.	Threaten a violation of applicable statutory, regulatory, or permit requirements for environment, safety, and health?	☒	☐
2.	Require the siting, construction or major expansion of waste treatment, storage, or disposal facilities?	☒	☐
3.	Disturb hazardous substances, pollutants, or contaminants preexisting in the environment?	☒	☐
4.	Adversely affect environmentally-sensitive resources identified in Section IV.A.?	☒	☐
5.	Be connected to another existing/proposed activity that could potentially create a cumulatively significant impact?	☒	☐
6.	Have an inherent *possibility* for high consequence impacts to human health or the environment (e.g., Biosafety Level 3-4 laboratories, activities involving high levels of radiation)?	☒	☐

If "Yes" to Question III.B. and ALL six subsequent questions, ensure the descriptions in Sections I and II reflect this and go directly to Section V.

IV. Potential Environmental Effects:

Attach/insert an explanation for each "Yes" response.

A. Sensitive Resources: Will the proposed action result in changes and/or disturbances to any of the following resources?

		Yes	No
1.	Threatened/Endangered Species and/or Critical Habitats	☐	☐
2.	Other Protected Species (e.g., Burros, Migratory Birds)	☐	☐
3.	Sensitive Environments (e.g., Tundra/Coral Reefs/Rain Forests)	☐	☐
4.	Archaeological/Historic Resources	☐	☐
5.	Important Farmland	☐	☐
6.	Non-Attainment Areas for Ambient Air Quality Standards	☐	☐
7.	Class I Air Quality Control Region	☐	☐
8.	Special Sources of Groundwater (e.g. Sole Source Aquifer)	☐	☐

9.	Navigable Air Space	☐	☐
10.	Coastal Zones	☐	☐
11.	Areas with Special National Designation (e.g. National Forests, Parks, Trails)	☐	☐
12.	Floodplains and Wetlands	☐	☐

B. Regulated Substances/Activities: Will the proposed action involve any of the following regulated items or activities?

		Yes	No
13.	Natural Resource Damage Assessments	☐	☐
14.	Exotic Organisms	☐	☐
15.	Noxious Weeds	☐	☐
16.	Clearing or Excavation (indicate if greater than one acre)	☐	☐
17.	Dredge or Fill (under Clean Water Act, Section 404, indicate if greater than ten acres)	☐	☐

B. Regulated Substances/Activities: Will the proposed action involve any of the following regulated Items or activities? (continued)

		Yes	No
18.	Noise (in excess of regulations)	☐	☐
19.	Asbestos Removal	☐	☐
20.	PCB's	☐	☐
21.	Import, Manufacture, or Processing of Toxic Substances	☐	☐
22.	Chemical Storage/Use	☐	☐
23.	Pesticide Use	☐	☐
24.	Hazardous, Toxic, or Criteria Pollutant Air Emissions	☐	☐
25.	Liquid Effluents	☐	☐
26.	Underground Injection	☐	☐
27.	Hazardous Waste	☐	☐
28.	Underground Storage Tanks	☐	☐
29.	Radioactive Mixed Waste	☐	☐
30.	Radioactive Waste	☐	☐
31.	Radiation Exposure	☐	☐
32.	Surface Water Protection	☐	☐
33.	Pollution Prevention Act	☐	☐
34.	Ozone Depleting Substances	☐	☐
35.	Off-Road Vehicles	☐	☐
36.	Biosafety Level 3-4 Laboratory	☐	☐

C. Other Relevant Information: Will the proposed action involve the following?

		Yes	No
37.	Potential Violation of Environment, Safety, or Health Regulations/Permits	☐	☐
38.	Siting/Construction/Major Modification of Waste Recovery, or Waste Treatment, Storage, or Disposal Facilities	☐	☐
39.	Disturbance of Pre-existing Contamination	☐	☐
40.	New or Modified Federal/State Permits	☐	☐
41	Public Controversy	☐	☐
42.	Environmental Justice	☐	☐
43.	Action/Involvement of Another Federal Agency (e.g. license, funding, approval)	☐	☐
44.	Action of a State Agency in a State with NEPA-type law. (Does the State Environmental Quality Review Act apply?)	☐	☐
45.	Public Utilities/Services	☐	☐
46.	Depletion of a Non-Renewable Resource	☐	☐
47.	Extraordinary Circumstances	☐	☐
48.	Connected Actions	☐	☐

49.	Exclusively Bench-top Research	☐	☐
50.	Only a Laboratory Setting	☐	☐

V. Financial Assistance Award Organization Concurrence:

A. Organization Official (Name and Title): Jeff Philliber, LBNL Environmental Planning Coordinator

Signature: _____ Date: 9-21-10

e-mail: _____ Phone: _____

B. Optional Concurrence (Name and Title): _____

Signature: _____ Date: _____

e-mail: _____ Phone: _____

Remainder to be completed by SC-CH

VI. SC-BSO Concurrence/Recommendation/Determination:

A. SC-BSO Office of Acquisition and Assistance or Office of Safety, Technical & Infrastructure Services:

Project Director or Contract Specialist (Name and Title): _____

Signature: _____ Date: 9/21/10

B. SC-BSO NEPA Team Review:

Is the project/activity appropriate for a determination or a recommendation to the Head of the Field Organization by the NEPA Compliance Officer (NCO) under Subpart D of the DOE NEPA Regulations?

Yes ☒ No ☐

Specific class(es) of action from Appendices A-D to Subpart D (10 CFR 1021): A7, B1.4, B1.5, B1.7, B1.15, B1.24, B2.1, B2.2, and B3.6

Name and Title: Kim Abbott

Signature: _____ Date: 9/21/10

C. SC-CH Counsel (if necessary):

Name and Title: N/A

Signature: _____ Date: _____

D. SC-CH NEPA Compliance Officer:

The preceding pages are a record of documentation required under DOE Final NEPA Regulation, 10 CFR 1021.400.

☐ Action may be categorically excluded from further NEPA review. I have determined that the proposed action meets the requirements for Categorical Exclusion referenced above.

☐ Action requires approval by Head of the Field Organization. Recommend preparation of an Environmental Assessment.

☐ Action requires approval by Head of the Field Organization or a Secretarial Officer. Recommend preparation of an Environmental Impact Statement.

Comments/Limitations if necessary:

Signature: SEE BELOW NOTE Date: —

Peter R. Siebach
SC-CH NEPA Compliance Officer

This action includes activities at three Primary locations: CalTech, Lawrence Berkeley National Laboratory and SLAC National Accelerator Laboratory. The CX approval at CalTech dated 9/21/10 by SC-CH NEPA Compliance Officer is for the entire action. CalTech is the lead participant for this action. If the scope of the project changes, additional NEPA review would be warranted.

TITLE: Joint Center for Artificial Photosynthesis (JCAP) Project
PROPOSED ACTION: Contribute a new generation of solar fuel forming science that can lead to the implementation of new technologies for solar fuel production.

10. Generic CX SLAC Notification:

A: SLAC NEPA Recommendation :

Is the project/activity covered under one of the following existing documents:

	NO	YES	(if **YES**, site reference below, sign/date section 10 & forward to SSO with a copy of the Environmental Compliance Checklist)
Generic Categorical Exclusion	_____	_____	_____
Categorical Exclusion	_____	_____	_____
Environmental Assessment	_____	X	SPEAR3 DOE/EA-1243

(if all **NOs**, sign/date section 10 and forward to SSO with a copy of the Environmental Compliance Checklist and an attach cover letter summarizing the proposed action and NEPA determination recommendation)

Name and Title: Charlotte Chang, OCFO Division Administration

Signature: _____ Date: 7/30/2010

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11. SC Concurrence /Recommendation/Determination:

A: SC SSO Federal Project Director :

Project Director or Contract Specialist (Name and Title): _____

Signature: _____ Date: _____

B: SSO NEPA Review:

Is the project/activity appropriate for a determination or a recommendation by the ISC NEPA Compliance Officer (NCO) under Subpart D or the DOE NEPA Regulations?

Yes ____ No ____

Specific class(es) of action from Appendices A-D to Subpart D (10 CFR 1021):
CX(s):

Name and Title: Dave Osugi, SSO NEPA Coordinator

Signature: _____ Date: _____

TITLE: Joint Center for Artificial Photosynthesis (JCAP) Project
PROPOSED ACTION: Contribute a new generation of solar fuel forming science that can lead to the implementation of new technologies for solar fuel production.

10. Generic CX SLAC Notification:

A: SLAC NEPA Recommendation :

Is the project/activity covered under one of the following existing documents:

	NO	YES	(if **YES**, site reference below, sign/date section 10 & forward to SSO with a copy of the Environmental Compliance Checklist)
Generic Categorical Exclusion	____	____	_____
Categorical Exclusion	____	____	_____
Environmental Assessment	____	X	SPEAR3 DOE/EA-1243

(if all **NOs**, sign/date section 10 and forward to SSO with a copy of the Environmental Compliance Checklist and an attach cover letter summarizing the proposed action and NEPA determination recommendation)

Name and Title: Charlotte Chang, OCFO Division Administration

Signature: _____ Date: 7/30/2010

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11. SC Concurrence /Recommendation/Determination:

A: SC SSO Federal Project Director :

Project Director or Contract Specialist (Name and Title): _____

Signature: _____ Date: _____

B: SSO NEPA Review:

Is the project/activity appropriate for a determination or a recommendation by the ISC NEPA Compliance Officer (NCO) under Subpart D or the DOE NEPA Regulations?

Yes ____ No ____

Specific class(es) of action from Appendices A-D to Subpart D (10 CFR 1021):
CX(s):

Name and Title: Dave Osugi, SSO NEPA Coordinator

Signature: _____ Date: _____

ENVIRONMENTAL COMPLIANCE CHECKLIST

1. ADMINISTRATIVE INFORMATION

Project Title: JCAP – Fuels from Sunlight			Date: **07/27/2010**
Lead Department: SSRL	Estimated Start Work Date:9/1/2010	Individual Submitting Checklist: Anders Nilsson	
Project Engineer/Manager:		Bldg/MS/Phone No/Fax No.: E. Caplun xt 2008	
Project Location (Bldg No. /Area.):		Environmental Compliance Rep:	Safety Advocate: Matt Padilla

2. LOCATION OF PROPOSED ACTION: Describe the location at which the action would take place. Attach maps where appropriate. If applicable, provide the square footage of the areas that are to be disturbed during construction activities (construction activities include any clearing, grading, excavating, grubbing, and/or filling).

SSRL experimental facilities (beamlines 13-2, 6-2 and 11-2).
See http://www-ssrl.slac.stanford.edu/userresources/beamlines/beamlines.html

3. WORK SCOPE DESCRIPTION: Describe your proposed action's work scope in detail providing as much specific information as possible. Also, include all support facilities/activities that would be involved. Include attachments where appropriate.

We will contribute a new generation of solar fuel forming science that can lead to the implementation of new technologies for solar fuel production: the synthesis of liquid fuels from CO_2, H_2O, and sunlight. We will combine high level theory, *in situ* spectroscopic studies of catalysts using synchrotron radiation, metal electrochemical and semiconductor photoelectrochemical reduction of CO_2, and catalyst discovery. Led by Nilsson, *in situ* spectroscopic studies at the SSRL synchrotron radiation facility will involve hard x-ray spectroscopy of the metal atoms in the catalysts, soft x-ray spectroscopy of C- and O-containing intermediates at the interface, and ambient pressure x-ray photoelectron spectroscopy of model electrocatalytic systems with a ultrathin electrolyte layer on top of the catalyst. These high level experiments will be combined with density functional theoretical investigations under the leadership of Nørskov to develop a fundamental understanding of the reduction of CO_2 at metal electrode surfaces. The theoretical studies will involve finding descriptors related to various adsorption bond strength of intermediates that control the kinetic parameters for the rate limiting steps in the CO_2 reduction process. Based on computed trends of the descriptors new materials will be proposed that can have higher activity and more selectivity towards specific products.

4. ENVIRONMENTAL ASPECTS/POTENTIAL SOURCES OF IMPACT: Check the appropriate box for any environmental hazard or impact associated with the project.

ENVIRONMENTAL ASPECT/IMPACT	Yes	ENVIRONMENTAL ASPECT/IMPACT	Yes
1. Air emissions (e.g., combustion, dust, greenhouse gases, ozone depleting substances, chemical gases)		**10. Environmental Radiation and Radioactivity** (e.g., activities that have the potential to generate and/or release radioactivity)	
2. Chemical Use, Storage, and Inventory (e.g., lab chemicals, fuel, oils, coolants, cleaners, solvents)	X	**11. Biohazards** (e.g., activities using or generating biological materials such as microorganisms)	
3. Soil and Groundwater Contamination (e.g.,		**12. Interaction with Wildlife/Habitat** (e.g., soil	

activities that have the potential to impact soil and groundwater)		disturbance in habitat areas, construction in bird nesting areas)	
4. Discharge to Wastewater Systems (e.g., discharge to sanitary sewer)		**13. Cultural/Historical Resource Disturbance**	
5. Industrial and Hazardous Waste Generation, Management, Storage, Transportation and Disposal (e.g., chemicals, fuel, oils, solvents. PCBs, Asbestos)		**14. Noise**	
6. Radioactive Materials Reduction and Ractioactive Mixed Waste Generation, Management, Storage, Transportation and Disposal		**15. Nanotechnology** (e.g., activities using or generating nanosubstances)	
7. Surface and Stormwater Contamination (e.g., activities that have the potential to impact surface or stormwater, including potential discharge to storm drain system)		**16. Other** (e.g., drinking water systems)	
8a. Use, Reuse, Recycling (e.g., activities that have potential to minimize waste through reuse, recycling, and environmentally preferable purchasing such as purchasing recycled content materials)			
8b. Conservation of Resources (e.g., activities that use natural resources such as water, energy, fuel)			
9. Construction, Renovation, and Demolition By-Products (e.g., activities generating construction debris, clearing or excavation, disturbance of lead or asbestos-containing materials)			

5. EXPLAIN THOSE AREAS IDENTIFIED IN ITEM 4 THAT WERE CHECKED AND THE CORRESPONDING CONTROLS TO BE EXECUTED TO REDUCE POTENTIAL ENVIRONMENTAL IMPACTS (e.g., spill prevention, erosion controls, air emission controls including dust suppression, selection of materials etc.). Provide details of the activities/impact of each box and the proposed mitigations. Include attachments where appropriate.

Experiments will be conducted using SSRL beamlines and laboratory space, in accordance with appropriate WPC and standard operating procedures.

Theoretical work will be conducted in office space.

6. DESCRIBE SUSTAINABLE PRACTICES BEING IMPLEMENTED INCLUDING ENVIRONMENTALLY PREFERABLE PURCHASING (e.g, sustainable building, energy, water, and fuel conservation and/or efficiency measures, purchasing of non or less toxic materials, purchasing of recycled content and biobased products, energy and water efficient products, electronics stewardship, etc.)

NA

7. WASTE MINIMIZATION: Describe waste management plans including (1) recycling of non-hazardous construction and demolition debris and (2) the plans for minimizing the generation of hazardous waste (Class I), designated waste (Class II) or radiological or mixed wastes, both during the project construction period and the project lifecycle.

NA

8. DESCRIPTION OF WASTES AND DISPOSAL METHODS: Describe the type of waste (Radioactive, RCRA, Mixed, etc.); the waste form (solid, liquid, gas, etc.); approximate amount of waste expected to be generated; waste disposal method (landfill, storm sewer, other); and, if known, the disposal container (boxes, drums, etc.).

Waste Type	Waste Form (Solid, Liquid, Gas, Sludge) (list all that apply)	Amount Expected to be Generated (specify units of measure)	[1]Waste Disposal Method (landfills [specify], sanitary sewer, etc.) and Disposal or Recycling Container (boxes, drums, etc.)
Radioactive			
Mixed Waste-having hazardous and radioactive components			
Hazardous- Class I including chemically impacted soil, concrete, asphalt			
Designated-Class II including chemically impacted soil, concrete, asphalt			
Soil, non-hazardous			

[1] Completion of this column may require input from Waste Management Group.

PCB			
Asbestos			
Mercury			
Treated Wood			
Oils, solvents, etc.			
Biohazard			
Nanosubstances			
Non-hazardous Construction Debris -untreated wood -concrete -wall board -cardboard -metals -green waste -others			
Other			

9. PROJECT SIGNATURE: This section is to be completed by the Project Evaluator (individual completing this checklist).

I have reviewed this action and to the best of my knowledge have answered all questions completely to describe the proposed action.

Project Signature: _____ **Date:** 7/28/2010

Please note: Any changes or unanticipated events to the project must be documented by updating this form.

This section to be completed by the Environmental Compliance Representative

9. ENVIRONMENTAL COMPLIANCE (EC) REPRESENTATIVE:

I have reviewed the proposed project and based on the actions described in this checklist, the following hazard controls should be implemented.

Check	Environmental Compliance Hazard Control Issue	Hazard Control Measure(s) to be Implemented
	Air Permit -New source -Mobile source -Special conditions	
	Demolition or Asbestos Removal -BAAQMD Notification -Other	
	Excavation/Penetration Permit	
	Floodplain/Wetland/Outfall Controls	
	Hazardous Materials -Purchase -Use -Other alternatives/substitutes	
	NESHAPs (RAD) Controls	
	Spill Prevention	
	Stormwater Controls	
	Waste Management	
	Wetland Permits -JARPA Permit -Corps of Engineer Permit -Other	
X	**Other**	Use SSRL SOP's when handling samples

EC Rep Signature: _____ **Date:** 7/28/10