



**BERKELEY LAB**

Bringing Science Solutions to the World



U.S. DEPARTMENT OF  
**ENERGY**  
Office of Science

# Economic Impact Study

Community Advisory Group Presentation

Monday, March 8, 2020

**Don Medley**

**Executive Director**

**Government and Community Relations**

a study of the  
**Economic Impact of  
Lawrence Berkeley National Laboratory**



January 2021

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Prepared for:



Prepared by:



$$1 = 3$$

# Presentation Overview

01

Lab at a Glance

EIS Analytical framework and  
study approach

02

Commercialization and Firm  
Creation

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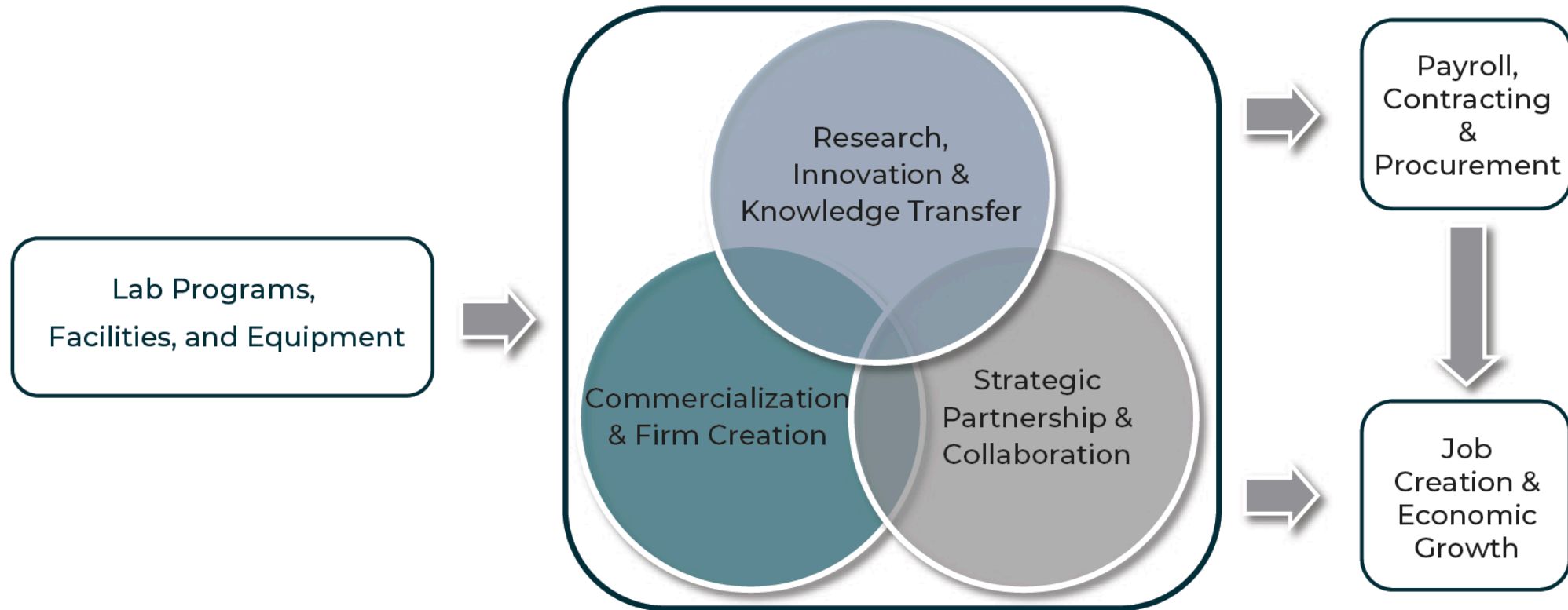
Strategic Partnerships and  
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Direct, indirect, and induced  
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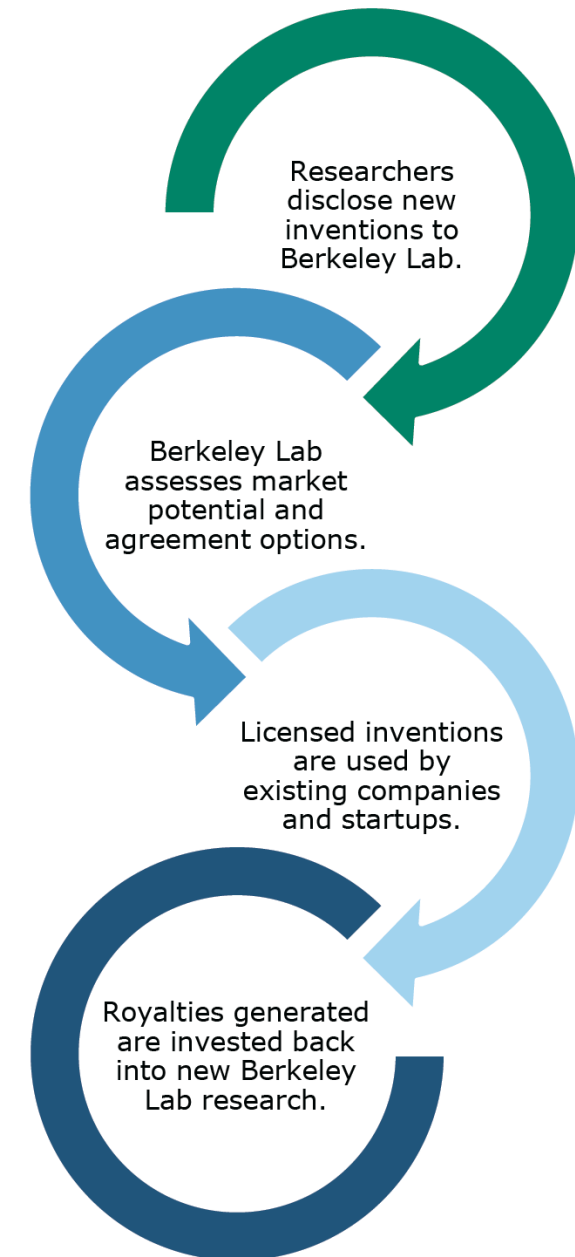
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# Commercialization

## Intellectual Property Office (IPO)

- In FY 2018, there were **153 invention and software disclosures and 77 patents** were issued to Berkeley Lab and its researchers.
- Overall, as of April 2020, more than **80 Lab technologies, protected by more than 250 patents and patent applications**, are being commercialized by the Lab's licensees.
- For FY 2019, licensed inventions and copyrighted software and books earned **royalties of more than \$2,456,000**.
- After patenting costs are reimbursed, **65 percent of net royalties are used to fund Berkeley Lab research** through innovation grants and other initiatives, and 35 percent go to the researchers themselves.



# Commercialization

## Intellectual Property Office (IPO)



**Corelight** is based on open source software program called Zeek, created at Berkeley Lab. The company has created a tool used to track activity on networks and block cybersecurity attacks. The research addresses cybersecurity issues that governments, companies, and individuals face today.



**Nexceris** licensed a portfolio of novel materials, structural design, and processes for the fabrication and manufacturing of solid oxide fuel cells for use as a power extender in vehicles. Nexceris focuses their materials science expertise on creating innovative products that improve the quality, efficiency and safety of energy and environmental systems



A boron nitride (BN) portfolio, licensed by **Epic Advanced Materials**, offers a unique mix of properties to enable new material applications. These properties include mechanical strength, high thermal conductivity, and electrically insulating behavior.



# Firm Creation

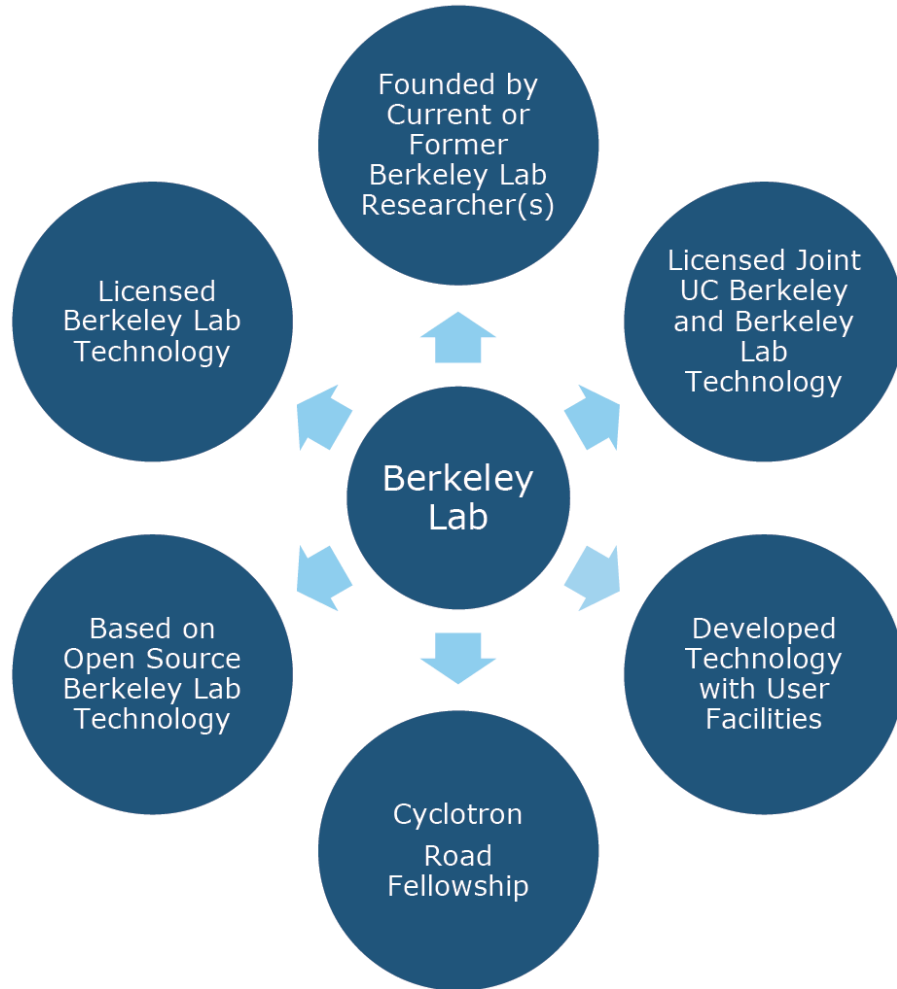
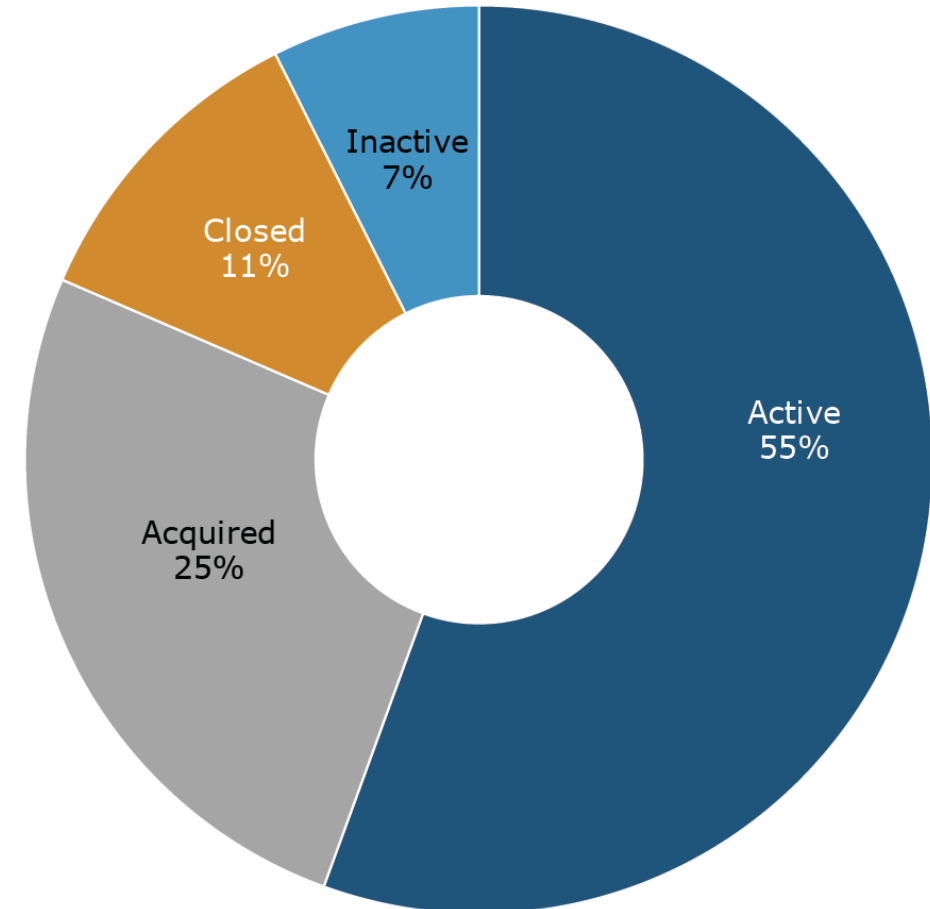


Figure 10. Berkeley Lab Spin-Off Firm Affiliation Map

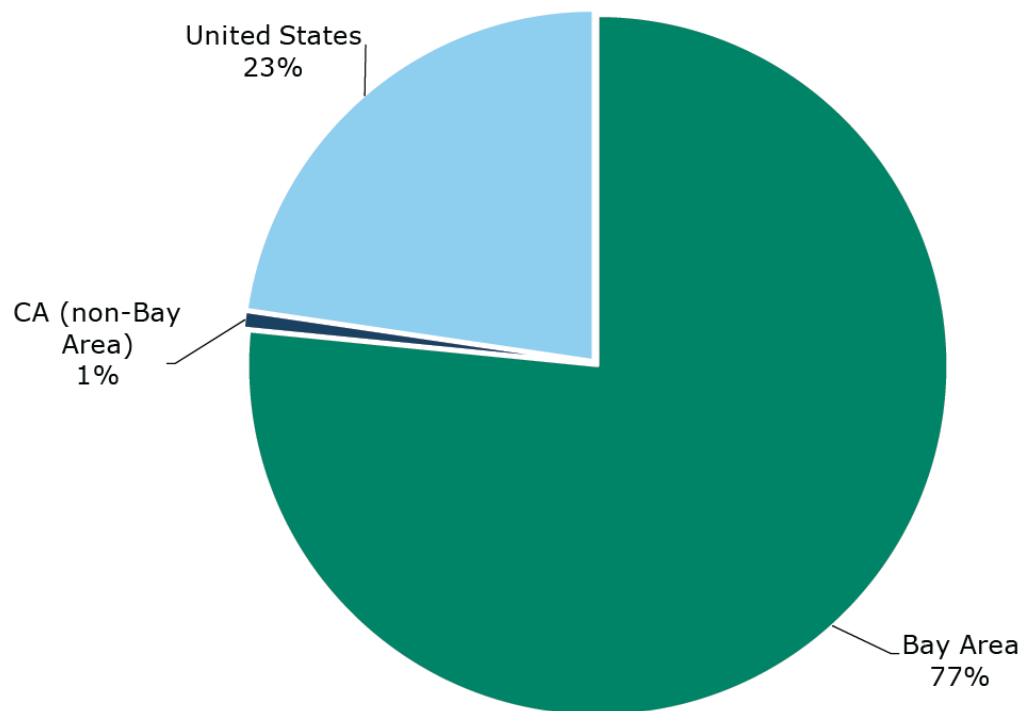
Figure 12. Status of Startups Founded on Berkeley Lab Technology



Source: Lawrence Berkeley National Laboratory, Economic & Planning Systems  
Note: Inactive companies are those that are potentially closed but the exact status of the company is unconfirmed.

# Firm Creation

## Active Berkeley Lab Startups



Source: Respective Company Websites and Job Sites (LinkedIn, Owler, AngelList); Lawrence Berkeley National Laboratory, Economic & Planning Systems

Company Name	Region	Year Founded
Boost Biomes	Bay Area	2019
Scuba Probe	Bay Area	2019
GraphAudio	Bay Area	2018
EPIC Advanced Materials	CA	2018
Acepodia	Bay Area	2018
Green Light Labs	Bay Area	2018
Sepion	Bay Area	2018
NexTech Batteries	USA	2017
Whisker Labs (formerly Watts	USA	2015
Simple Water	Bay Area	2014
Optokey	Bay Area	2013
Heliotrope	Bay Area	2013
CinderBio (Cinder Biological)	Bay Area	2013
Seismos	USA	2013
Newomics	Bay Area	2013
Peptineo	USA	2013
Da Tung Hydrogen Energy	Bay Area	2013
TeselaGen Biotechnology	Bay Area	2012
Lygos	Bay Area	2011
Second Genome, Inc.	Bay Area	2010
Alphabet Energy	Bay Area	2010
View	Bay Area	2008
Siva Power	Bay Area	2008
Artery Therapeutics, Inc.	Bay Area	2006
Momenta Pharmaceuticals, In	USA	2002
Nanosys, Inc.	Bay Area	2002
Live Cell Assays	Bay Area	2002
Nanomix, Inc.	Bay Area	2001
Aeroseal, LLC	USA	1997
WaterHealth International	CA	1996
PolyPlus Battery Company	Bay Area	1990

Source: Lawrence Berkeley National Laboratory, Economic & Planning Systems

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# Strategic Partnerships and Collaborations

## Strategic Partnerships Office (SPO)

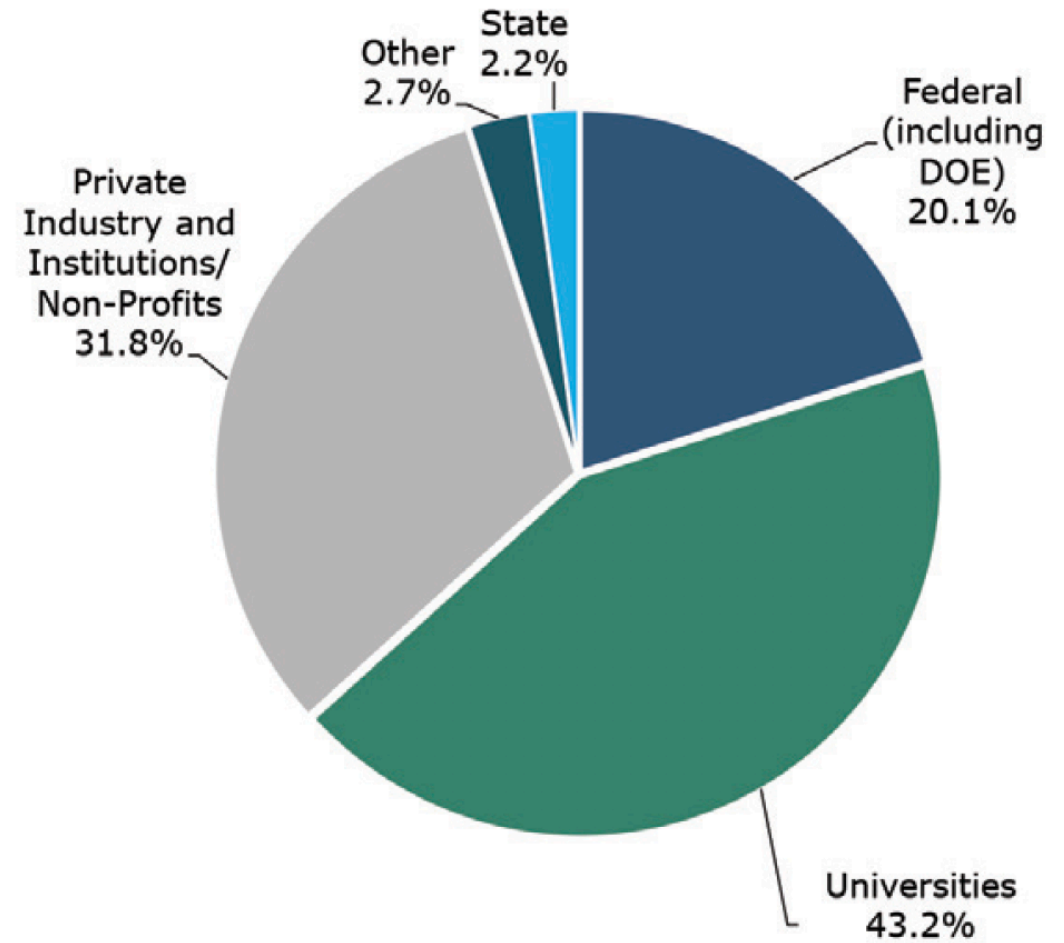
R&D partnerships, collaborations, and user agreements at Berkeley Lab take a variety of forms and can last from a few weeks to several years

- **Industry-University-Lab Collaborations**
  - Enables industry partners to access the complementary capabilities and facilities of the Lab and university partners
- **Strategic Partnership Projects (SPP)**
  - Provides direct access to Lab expertise and resources.
- **Cooperative Research and Development Agreements (CRADA)**
  - CRADAs allow the Lab and partners to more closely share resources and costs with even deeper collaboration and joint development than seen in most SPP initiatives and User Agreements.
- **National User Facilities**
  - Approximately 14,000 individual researchers access Berkeley Lab resources through “User Agreements” (UAs).

# Strategic Partnerships and Collaborations

## Strategic Partnerships Office (SPO)

- **4,600 new agreements totaling about \$1.2 billion** from 2010 to 2019 (an annual average of 465 new agreements and \$122 million).
- Since 2014, there have been more than **2,000 active agreements** with separate organizations.
- In terms of the composition, slightly **over 40 percent of these agreements are with universities** while almost a third are with private or non-profit entities. Other federal agencies account for about 20 percent of the total.



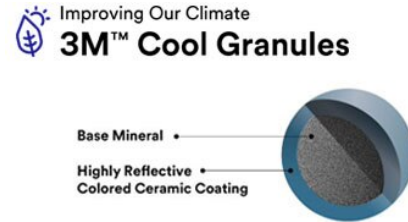
Source: Lawrence Berkeley National Laboratory, Economic & Planning Systems

# Strategic Partnerships and Collaborations

## Strategic Partnerships Office (SPO)



**Enhanced carbon capture technology** – Laboratory tests indicate novel materials called metal organic frameworks (MOFs) capture carbon dioxide emissions up to six times more effectively than conventional technology. The research successfully demonstrated that MOFs are highly selective and could capture more than 90 percent of the CO<sub>2</sub> emitted from industrial sources.



**Smog eating roof shingles testing with 3M** - Berkeley Lab researchers collaborated with 3M on the development of a new type of roof shingle that will help reduce air pollution. The roof shingle granules, which were listed by TIME magazine as one of the best inventions of 2018, work by using sunlight to catalyze reactions that remove pollution from the air

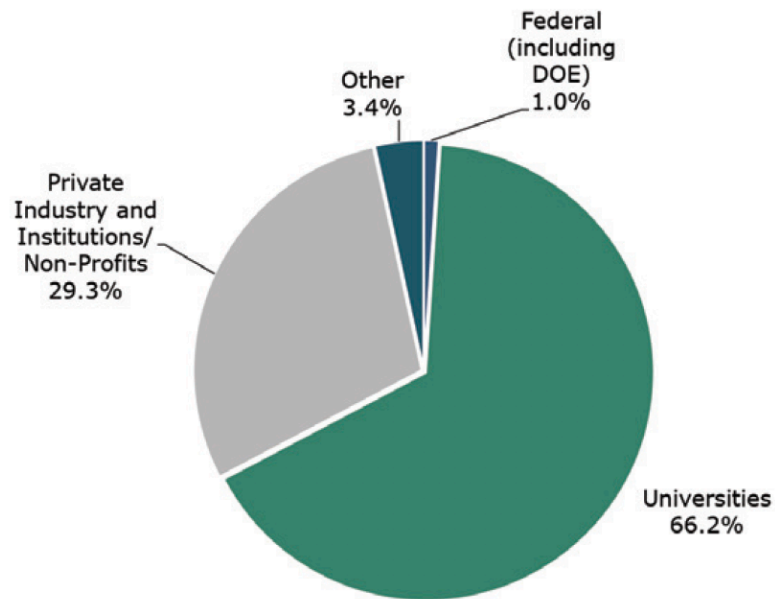


**Lithium extraction to drive battery deployment** - Lithium is a key ingredient of most batteries and global demand for it is expected to skyrocket in coming years, growing tenfold by 2030. Sites in the United States, such as the Salton Sea in southern California, are some of the world's largest sources of lithium – however, the lithium is one of many substances in the water and not easily extracted.

# Strategic Partnerships and Collaborations

## National User Facilities

### 14,000 Users from around the world



Source: Lawrence Berkeley National Laboratory, Economic & Planning Systems

**Advanced Light Source:** *Specialized particle accelerator that generates bright beams of x-ray light through ~40 beamlines to experimental end stations.*

- Hosts 50 to 100 on-site users at a time and 2,000 on-site and remote users annually (ranging from one hour to 10 days)
- 925 annual publications, 20% in “high-impact journals”

**Energy Sciences Network (ESnet):** *A high performance, unclassified network built to support scientific research and the entire DOE National Lab system.*

- Linked to more than 200 research and educational networks around the world
- Carries more than 90 petabytes a month or more than an exabyte per year

**Joint Genome Institute:** *Multi-disciplinary research in support of the Human Genome Project.*

- 2,000 unique users in FY 2020
- Generates ~300 human genome equivalents in plant and microbial DNA per day
- Generated 326 trillion letters of genetic code in 2019

**Molecular Foundry:** *State-of-the-art expertise, methods, and knowledge in nanoscale science and host to National Center for Electron Microscopy.*

- 1,500 users in FY 2020
- 150 users on-site daily (ranging from several weeks to over a year)
- Over 1,000 publications, 36% in high-impact journals from FY 2016-2018

**National Energy Research Scientific Computing Center (NERSC):** *The mission high performance computing facility for the DOE Office of Science.*

- Over 8,000 users annually
- 10,000 million computing hours every year
- Nearly 2,500 peer-reviewed publications involving computing at NERSC published in 2019



# Strategic Partnerships and Collaborations

## Additional Research Assets and Facilities

**Cyclotron Road** — a unique program for entrepreneurs to move ideas to prototypes that includes access to leading research facilities as well as coaching and networking to translate innovations into new companies - a model now replicated by other national labs.

**Agile Biofoundry and Advanced Biofuels and Bioproducts Process Development Unit (ABPDU)** — state-of-the art tools to help young companies develop and produce new sustainable bio-based products.

**High Performance Computing for Advanced Manufacturing (HPC4Mfg)** — access to leading supercomputers, to help U.S. industries optimize production processes, lower energy costs, and become more competitive.

**FLEXLAB®** — the world's most advanced integrated building and grid technologies testbed, used to develop and test building energy management technologies.

**The Materials Project** — cloud-based computational services that allow researchers to predict the properties of materials before they are synthesized, allowing researchers in areas such as battery development to target the most promising candidate materials.



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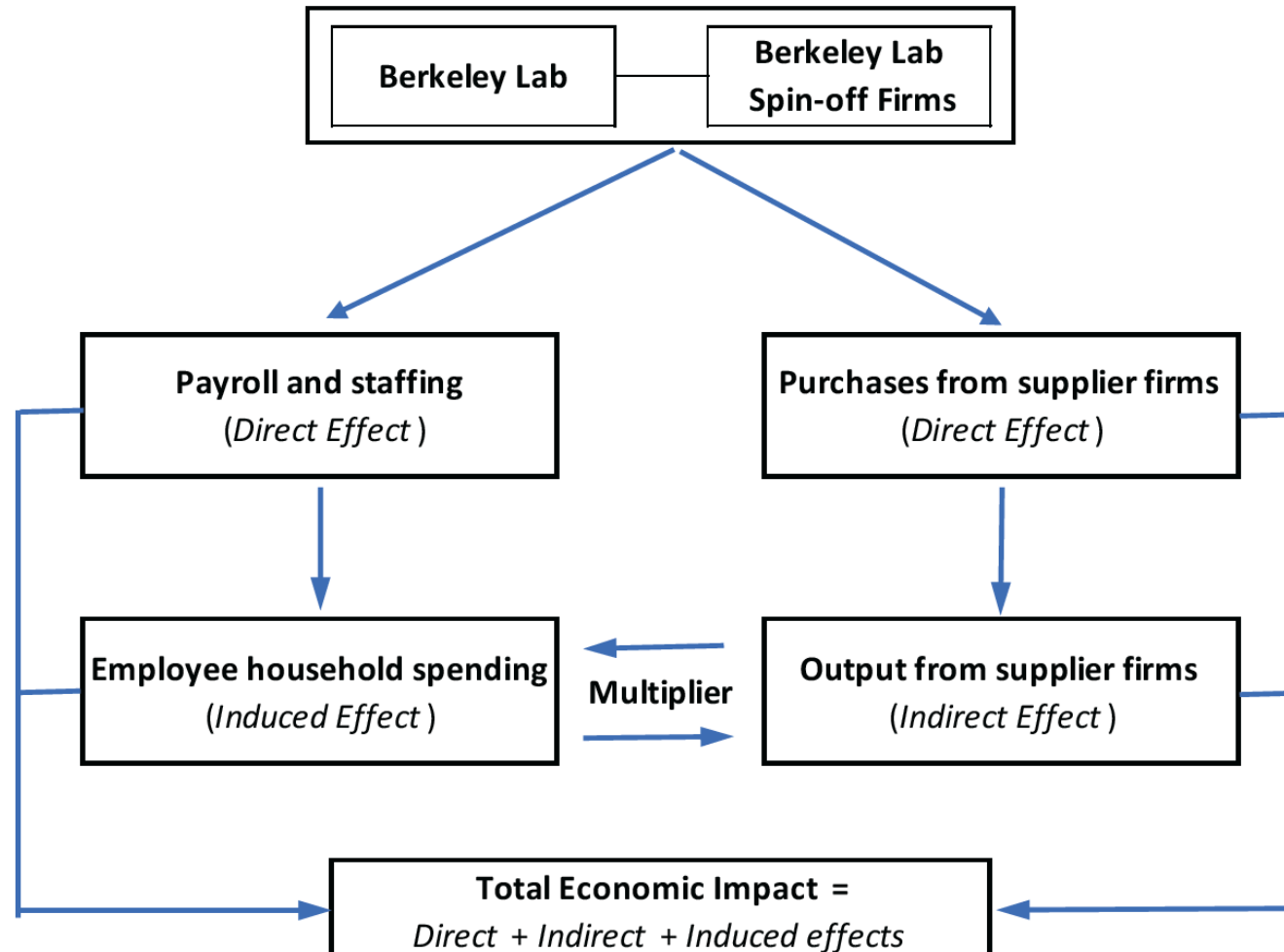
# Economic Output and Job Creation

## Direct, Indirect and Induced Economic Impact

- The **Direct Effect** is a measure of the economic value of the initial injection of spending into the economy that is made by Berkeley Lab and its employees.
- The **Indirect Effect** is a measure of the economic value of “upstream” industry-to-industry transactions that supply inputs to the production of goods and services consumed by Berkeley Lab and its employees.
- The **Induced Effect** is a measure of the economic value of labor income that recirculates in the economy as a result of the initial expenditures made by Berkeley Lab and its employees.
- The **Total Impact** is the sum of the direct, indirect, and induced effects. The total impact measures the overall impact of Berkeley Lab activities on the economy.

# Economic Output and Job Creation

## Combined Effect of Berkeley Lab Activities Flow Chart



# Economic Output and Job Creation

## Total Economic Impact from Berkeley Lab Spending by Geography

Economic Impact	Employment	Employee Compensation	Value Added	Economic Output
<b>Bay Area</b>				
Direct Effect	3,813	378,700,000	573,300,000	860,100,000
Indirect Effect	1,190	134,300,000	203,500,000	297,900,000
Induced Effect	1,569	114,800,000	210,700,000	312,100,000
<b>Total Impact</b>	<b>6,571</b>	<b>\$627,800,000</b>	<b>\$987,500,000</b>	<b>\$1,470,100,000</b>
<b>California</b>				
Direct Effect	3,819	379,600,000	574,600,000	862,200,000
Indirect Effect	2,019	197,100,000	300,100,000	460,900,000
Induced Effect	1,669	120,500,000	221,200,000	329,100,000
<b>Total Impact</b>	<b>7,507</b>	<b>\$697,200,000</b>	<b>\$1,095,900,000</b>	<b>\$1,652,200,000</b>
<b>United States</b>				
Direct Effect	3,954	389,500,000	589,100,000	897,000,000
Indirect Effect	3,360	237,400,000	394,300,000	648,300,000
Induced Effect	5,314	293,500,000	569,100,000	927,800,000
<b>Total Impact</b>	<b>12,628</b>	<b>\$920,400,000</b>	<b>\$1,552,500,000</b>	<b>\$2,473,100,000</b>

Source: IMPLAN, Lawrence Berkeley National Laboratory, Economic & Planning Systems

# Economic Output and Job Creation

## Berkeley Lab Startup Impact by Geography

Economic Impact	Employment	Employee Compensation	Value Added	Economic Output
<b>Bay Area</b>				
Direct Effect	1,429	\$295,600,000	\$434,900,000	\$600,300,000
Indirect Effect	847	\$96,100,000	\$145,400,000	\$211,700,000
Induced Effect	1,204	\$88,100,000	\$161,700,000	\$239,500,000
<b>Total Impact</b>	<b>3,480</b>	<b>\$479,800,000</b>	<b>\$742,100,000</b>	<b>\$1,051,500,000</b>
<b>California</b>				
Direct Effect	1,443	\$297,800,000	\$438,100,000	\$605,300,000
Indirect Effect	1,448	\$141,600,000	\$215,500,000	\$329,100,000
Induced Effect	1,286	\$92,800,000	\$170,300,000	\$253,400,000
<b>Total Impact</b>	<b>4,177</b>	<b>\$532,200,000</b>	<b>\$823,900,000</b>	<b>\$1,187,700,000</b>
<b>United States</b>				
Direct Effect	1,866	\$213,300,000	\$304,500,000	\$541,000,000
Indirect Effect	2,049	\$144,800,000	\$218,300,000	\$391,100,000
Induced Effect	3,035	\$167,700,000	\$296,300,000	\$529,900,000
<b>Total Impact</b>	<b>6,950</b>	<b>\$525,700,000</b>	<b>\$819,100,000</b>	<b>\$1,461,900,000</b>

Source: IMPLAN, Lawrence Berkeley National Laboratory, Economic & Planning Systems

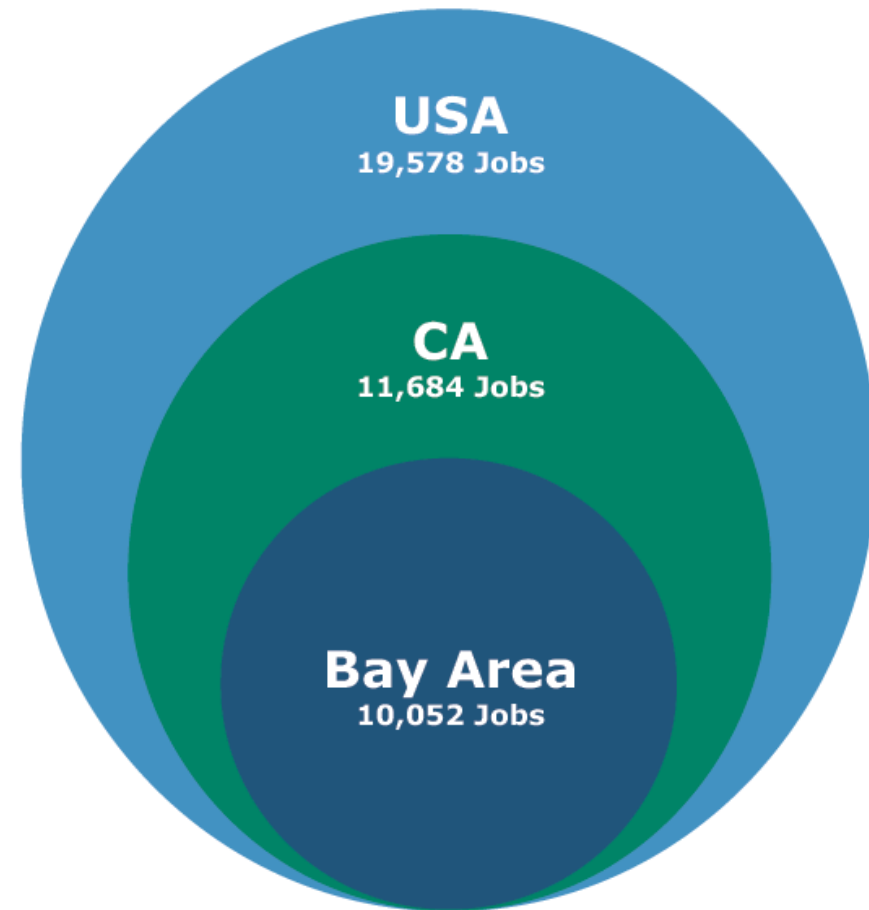
# Economic Output and Job Creation

## Combined Effect of Berkeley Lab Activities on Total Jobs by Geography

**Figure 4. Combined Effect of Berkeley Lab Activities on Total Jobs by Geography**

Expenditure Category	Bay Area	California	United States
Operations	6,140	7,003	11,400
Capital and Construction	432	504	1,228
Startups	3,480	4,177	6,950
<b>Total Jobs</b>	<b>10,052</b>	<b>11,684</b>	<b>19,578</b>

Source: IMPLAN, Lawrence Berkeley National Laboratory, Economic & Planning Systems



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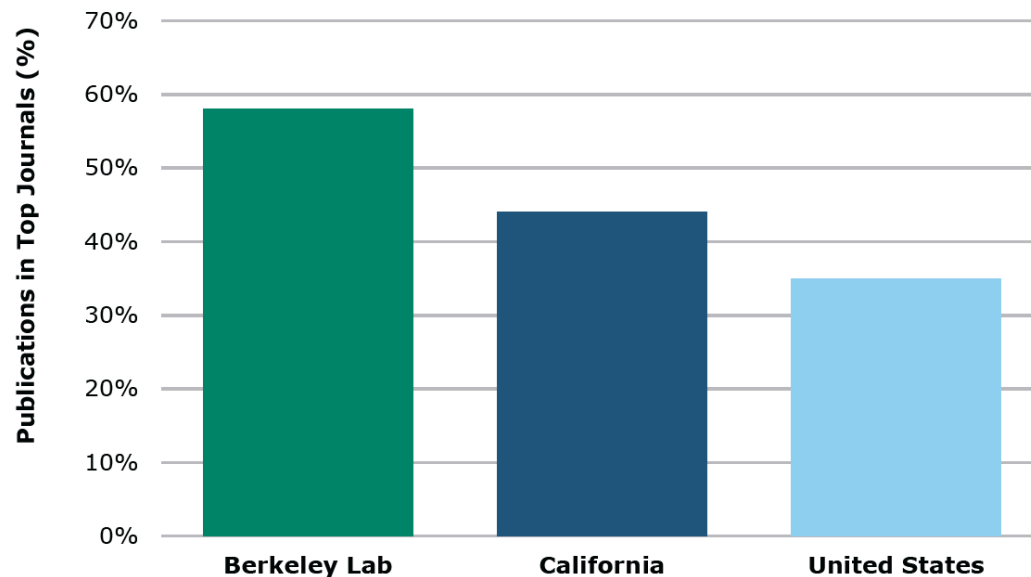
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Research, Innovation and  
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# Research, Innovation and Knowledge Transfer

## Publication Leadership

Figure 6. Comparison of Berkeley Lab Publications in Top Journals with Other Institutions



Source: Lawrence Berkeley National Laboratory, SciVal, © 2020 Elsevier B.V.; Economic & Planning Systems

Research affiliated with Berkeley Lab generates over **2,000 publications annually**

Berkeley Lab has **58% of publications in “top journals”**, compared to other institutions in California at 44% and the U.S. at 35%

Berkeley Lab’s **publications consistently have higher average views and citations** per publication than those from institutions in California and the U.S.

Berkeley Lab’s publications consistently **have higher patent citations per publication** than those from institutions in California and the U.S.




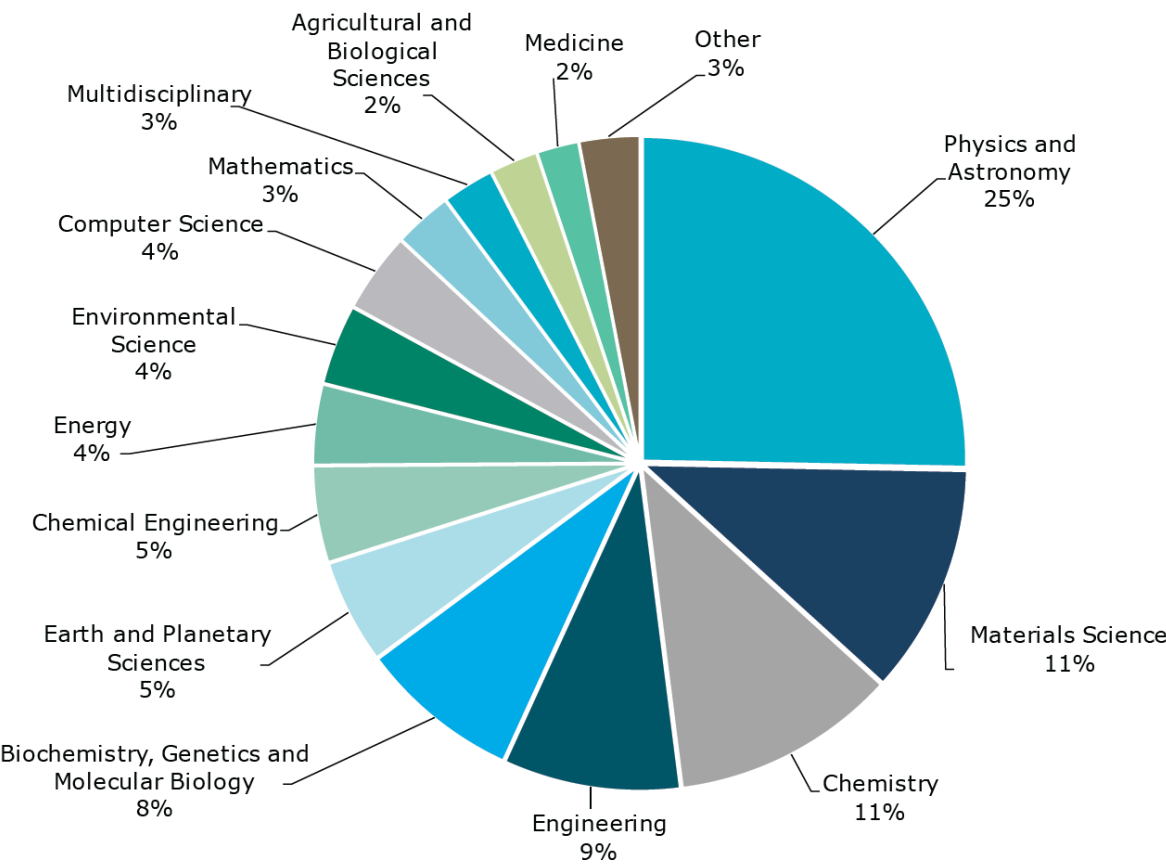
# Research, Innovation and Knowledge Transfer

## International Scientific Leadership

nature index

Berkeley Lab ranks fifth worldwide among government research institutions according to Nature Index

Institution	Count	Share
1.  Chinese Academy of Sciences (CAS)	5741	1876.31
2. French National Centre for Scientific Research (CNRS)	4417	700.85
3.  National Institutes of Health (NIH)	1085	404.29
4.  Spanish National Research Council (CSIC)	1219	206.73
5. Lawrence Berkeley National Laboratory (LBNL)	880	168.81



# THANK YOU

## BERKELEY LAB

