Overview of California State-Funded R&D, 2004-2007:

Understanding the State's Role in Shaping R&D Spending

November 2008

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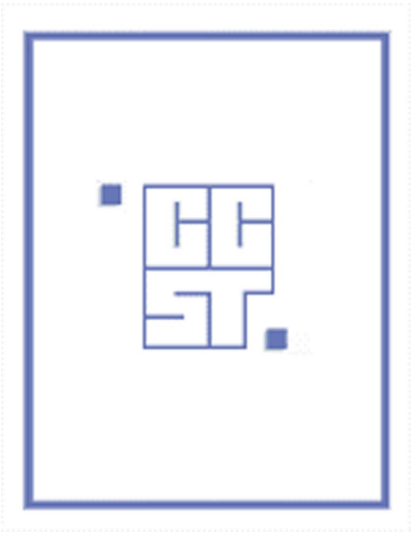
California Council on Science and Technology



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CCST is a non-profit organization established in 1988 at the request of the California state government and sponsored by the major public and private postsecondary institutions of California and affiliate federal laboratories, in conjunction with leading private-sector firms. CCST's mission is to improve science and technology policy and application in California by proposing programs, conducting analyses, and recommending public policies and initiatives that will maintain California's technological leadership and a vigorous economy.

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1. Background and Objectives

Research and development (R&D) funding has undergone significant shifts in pattern over the last several decades. In response to flat or declining federal funding for various R&D efforts, as well as federal policy restrictions on funding for certain areas of research (e.g. stem cell research), states have come to take a more direct role in funding R&D. There exists a variety of indicators tracking R&D spending, but few focus on the state level. The most comprehensive assessment of R&D spending in California was carried out by CCST in 1999, building on a survey initiated by the State Science and Technology Institute two years previously.

The current project is intended as an update to the 1999 report, incorporating data from a variety of sources including a new survey conducted by the National Science Foundation (NSF) and the U.S. Census Bureau. It is intended as part of an overall assessment of the present status and long-term trends affecting California's science and technology infrastructure for the California Innovation Corridor project, funded by a U.S. Department of Labor grant to the state of California and the California Space Authority titled, "Workforce Innovation in Regional Economic Development" (WIRED).

This project explores:

- Available data on R&D spending by California
- What is not possible to know with the current data being gathered at the state and federal level
- Suggested approaches for California to collect additional data needed for a more comprehensive overview of the state's R&D spending

Definition of Terms

Put simply, research and development (R&D) is the process of discovering new knowledge about processes, products, and services, and then applying that knowledge to create new processes, products and services that meet a particular market need (which may include informing public policy). The National Science Foundation (NSF) defines three categories of R&D: basic research, applied research, and development.[1] Basic research is conducted to acquire new knowledge without any specific process or product in mind; applied research is intended to apply knowledge to a specific process or product; and development is the final stage in preparing a product or process for public consumption (primarily conducted by industry).

In 2006, the U.S. conducted approximately $341 billion in R&D, of which 18% ($60 billion) was for basic research.[2] R&D represents nearly a 2.5% share of the Gross

[1] Although these categories have been criticized by some as overly simplistic and falsely implying that innovation is a linear process, at present no alternative models have been adopted by policymakers due to a lack of data and widespread support; see NSB Indicators 2008, Chapter 4.
[2] National Science Board. Science and Engineering Indicators 2008. (Arlington VA: NSB, 2008) Ch. 4.

Domestic Product (GDP) overall. In California, R&D represents a significantly higher percentage of the state GDP (3.93%) than the national average. Moreover, federal R&D spending per capita in California is over 50% higher than the national average (Table 1). According to the NSF 2005-07 State S&E Profiles, in 2006 California ranked first in the nation for federal R&D obligations, receiving over $19 billion.[3]

Table 1: Financial research and development inputs

	Year	California	National Average
R&D as share of gross domestic product (percent)	2004	3.93	2.44
Federal R&D obligations per civilian worker (dollars)	2005	1,155	753
Federal R&D obligations per individual in S&E occupations (dollars)	2005	27,046	20,396

Source: NSB Indicators 2008, Chapter 8: State Indicators, State Data Tool (http://www.nsf.gov/statistics/seind08/c8/data_select.cfm)

Although 66% of development in all R&D nationwide is conducted by private industry, most basic research (59%) is primarily funded by the federal government, and the majority of it is carried out at universities and federal funded research centers. The most comprehensive breakdown of federal research funding is found in the annual *Survey of Federal Science & Engineering (S&E) Support to Universities, Colleges, and Nonprofit Institutions* which is an annual congressionally mandated survey that is the only source of comprehensive data on federal S&E funding to individual academic and nonprofit institutions. As seen in Table 2, the Department of Health and Human Services and the National Institutes of Health are the largest federal funders of scientific research, providing over $15 billion in FY 2005, with the NSF providing over $3.1 billion.

[3] National Science Foundation, State Science & Engineering Profiles: 2005-7 (NSF 08-314: August 2008), http://www.nsf.gov/statistics/nsf08314/.

Table 2. Federal obligations for science and engineering research to universities and colleges, by agency: FY 2005 (dollars in thousands)	
All Agencies	25,010,740
Agency for International Development	13,359
Appalachian Regional Commission	199
Department of Agriculture	726,806
Department of Commerce	222,529
Department of Defense	2,504,260
Department of Education	153,603
Department of Energy	935,529
Department of Health and Human Services	15,817,438
Administration for Children and Families	*22,517*
Agency for Healthcare Research and Quality	*60,643*
Agency for Toxic Substances and Disease Registry	*2,013*
Centers for Disease Control and Prevention	*111,489*
Centers for Medicare & Medicaid Services	*5,387*
Food and Drug Administration	*11,443*
Health Resources and Services Administration	*48,894*
National Institutes of Health	*15,537,467*
Office of the Assistant Secretary, Planning and Evaluation	*5,572*
Substance Abuse and Mental Health Services Administration	*12,013*
Department of Homeland Security	37,339
Science and Technology Directorate	*34,672*
Transportation Security Administration	*2,561*
U.S. Coast Guard	*106*
Department of Housing and Urban Development	1,081
Department of the Interior	69,328
Department of Labor	35,348
Department of Transportation	72,224
Environmental Protection Agency	144,965
National Aeronautics and Space Administration	1,087,421
National Science Foundation	3,151,972
Nuclear Regulatory Commission	3,745
Office of Justice Programs	26,874
Social Security Administration	6,720

Source: NSF 07-333, Federal Science and Engineering Support to Universities, Colleges, and Nonprofit Institutions: FY 2005

California's percentage of the total federal R&D allocation to academic institutions has not varied significantly since 2001 (Table 3) and was 13.6% in 2006.

Table 3: R&D expenditures at universities & colleges, nationally and in California, 2001-2006						
	2001	2002	2003	2004	2005	2006
United States	32,811,229	36,393,689	40,086,969	43,242,403	45,777,167	47,760,402
California	4,426,044	4,887,606	5,357,613	6,012,609	6,262,690	6,493,388
CA % of total	13.49	13.43	13.36	13.90	13.68	13.60

Source: NSF Academic Research and Development Expenditures, FY 2006 (NSF 08-300)

Shifts in State-level R&D Funding

Traditionally, state governments have played a limited role in initiating and supporting R&D. Since the Second World War, when the Office of Scientific Research and Development was created to coordinate scientific research for military purposes, there have been no state-managed "mission agencies" dedicated to coordinating or furthering specific areas of R&D. However, as states have worked to attract and retain federal funded research laboratories – which in turn often serve to stimulate local high-tech industries – many states have taken a proprietary interest in selected areas of R&D, with a desire to foster more innovation in their state. R&D is a contributing factor to the innovation process, but only one component of the process.

Innovation has become a focus of how states perceive high-tech competitiveness. Innovation is associated with the development of high-tech sectors, although how it is defined varies widely among policymakers. The framework developed by the Alliance for Science and Technology Research in America (ASTRA) for the U.S. Department of Commerce in 2007 defines innovation as "a process by which value is created for customers through public and private organizations that transform new knowledge and technologies into profitable products and services for national and global markets."[4] As the ASTRA model suggests, R&D is one of four key inputs into the innovation process, and one where policymakers, including those at the state level, can provide momentum to the process overall. Government R&D funding has the ability to impact scientific direction, support the innovation infrastructure of universities and research centers, and support pre-competitive collaboration on basic research outside the bounds of industry.

Functionally, the state's role in R&D funding is akin to that of the federal government. Funds are derived from tax revenues or a special fund financed by fees collected by the state from specific individuals for specific services (e.g. the Genetic Disease Testing Fund). It supports research for the public benefit through agencies such as (in California) the state Department of Health and Human Services and the California Energy Commission in order to inform or achieve desired policy goals established by state officials.

As the NSF noted in a 2007 convocation on state science and technology policy advice, the federal government is no longer the sole focus for S&T policymaking; "As the influence of scientific and engineering research on daily life has steadily increased, the

[4] The Alliance for Science and Technology Research in America, "Defining Innovation", Innovation Vital Signs Project (2007).

states have assumed an increasing responsibility for developing, formalizing, and institutionalizing policies and programs that support R&D and enable S&T evidence and expertise to be incorporated into policymaking."[5] Moreover, despite a strong warning about trends in U.S. R&D spending from the National Academies in the 2005 report, *Rising Above the Gathering Storm*,[6] Congress has not succeeded in increasing appropriations for federal R&D spending. According to the American Association for the Advancement of Science (AAAS), in FY 2008 federal funding for basic and applied research, despite an increase of 1.2%, declined in real terms (accounting for inflation) for the fourth year in a row.[7]

The potential role of states to expand their influence as players in the R&D field has indeed become increasingly recognized, not just as a means of addressing areas that the federal government does not fund, but as a means of providing alternative models of locally responsive innovation partnerships. The Pew Center for the States cites a range of R&D partnerships that have arisen around the country, observing that "states have the capacity to influence the future in a dramatic fashion. Industry tends to fund narrowly, and federal investments have plummeted as a share of total R&D. Of particular significance to governors, their staffs and other stakeholders: states' direct involvement in R&D can spur innovations that serve specific economic and social needs within their own borders."[8]

California is dependent upon state funding to leverage and focus R&D investment from industry and the federal government; for many programs, every dollar spent by the state on R&D brings in up to two dollars from other sources.[9] While data still show that California leads the nation in total R&D dollars by a wide margin (over three and a half times the total of any other state),[10] it is slipping on a per-capita basis; as the 2008 Milken Institute State Technology and Science Index[11] notes, Mississippi and Missouri both rank ahead of California in per-capita R&D spending, and California now ranks 19th in the nation for academic R&D funding relative to its GDP.

Despite these trends, California is still considered a leader in the effort to fund R&D at the state level, making headlines nationwide for its large-scale R&D expenditures such as

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[5] Steve Olson and Jay Labov. State Science and Technology Policy Advice: Issues, Opportunities, and Challenges: Summary of a National Convocation. (National Academies Press: Washington, DC, 2008).

[6] National Research Council Committee on Prospering in the Global Economy of the 21st Century. Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future. (National Academies Press: Washington, D.C. 2005) p.7. The report recommended increasing federal investment in basic R&D by 10% per year for seven years.

[7] AAAS FY 2008 Appropriations Summary Update, December 20, 2007 (http://www.aaas.org/spp/rd/upd1207.htm, accessed 6/9/08).

[8] National Governors' Association and Pew Center for the States. Innovation America: Investing in Innovation. (Pew Charitable Trusts: Washington, DC, 2008).

[9] The Governor Gray Davis Institutes for Science and Innovation, for example, have leveraged their initial investment of $400 million to bring in an additional $800 million from outside sources. See section below, "What the Numbers Don't Tell Us."

[10] NSB Indicators 2008, Table 8-31.

[11] Ross DeVol, Anita Charuworn, and Soojung Kim. California's Position in Technology and Science: A Comparative Benchmarking Assessment. (Milken Institute: Santa Monica, CA, 2008).

the creation of the California Institute for Regenerative Medicine (CIRM) in 2006, at the time the single largest R&D investment committed by any state. However, despite (or perhaps because of) the many R&D efforts California undertakes, it is challenging to obtain a comprehensive overview of California R&D. State budget and contracting offices often are not familiar with research and development categories because the state does not require tracking or reporting of R&D expenditures as such. Moreover, agencies perform a wide range of functions that vary considerably from state to state. In a 2007 National Science Foundation survey, nearly 40% of state agencies contacted by the NSF and plausibly thought to conduct R&D actually did not, according to the definitions used in the survey.

Increasing the understanding of how R&D is funded at the state level is a goal that has the potential to enhance California's ability to effectively leverage this funding and drive innovation. This report is a component of the Economic Development Innovation Toolkit, whose aim is to develop and implement resources to provide support to entrepreneurial businesses that drive innovation across the California Innovation Corridor, a collaborative zone initiated by a $15M/3-Year Department of Labor grant to the state of California and the California Space Authority titled, "Workforce Innovation in Regional Economic Development" (WIRED). The data compiled here, while not comprehensive, will hopefully provide a useful tool to economic development professionals in the corridor and throughout the state, and serve as a baseline for continued analysis of state R&D funding in the future.

Funding provided by Department of Labor, Employment & Training Administration: WIRED Initiative

2. State R&D Funding Data Sources

There are several sources for tracking R&D spending at the federal level. These data can be sorted by type of institution and region but are not intended to guide state-level policy. Consequently, they are not readily available in a form that is designed to be useful or accessible by state policymakers, although a new data set being gathered now makes it possible to use federal data to piece together a more complete picture of state R&D spending.

Federal

The primary source for national science and technology related statistics, including R&D spending, is the National Science Board (NSB) Science and Engineering Indicators, published through the NSF Division of Science Resources Statistics (SRS).[12] Traditionally, the indicators have aggregated allocation of resources and educational benchmarks by region, but have not specifically focused on state-level indicators. However, the importance of state-level R&D has changed, resulting in the addition of two relatively recent resources. The first is a section added in 2004 providing an overview of state-specific indicators, as a response to increasing interest in both the policy and research communities about the role of S&T in state and regional economic development.[13]

The second is a new index of R&D expenditures by state agencies,[14] an annual survey conducted by the National Science Foundation (in cooperation with the Census Bureau) designed to measure the extent of R&D activity performed and funded by each of the nation's 50 states, the District of Columbia and Puerto Rico. The FY 2006 survey was the first year this study was conducted; it collected amounts expended for R&D activities by state agencies for state fiscal years ending in 2006.[15]

Despite the limited scope of the NSF state agency expenditure survey, it is important to note that these data have not been gathered previously on a regular basis. The study observed that "systematic state data, using consistent, uniform definitions and collection techniques, are not widely available" and that the survey was carried out specifically to "close the gap… [between] anecdotal evidence of state R&D activities and [actual] state R&D expenditures."[16]

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[12] http://www.nsf.gov/statistics.
[13] NSB Indicators 2008, Ch. 8.
[14] National Science Foundation, Division of Science Resources Statistics. 2008. State Agency Research and Development Expenditures: Fiscal Year 2006. Detailed Statistical Tables NSF 08-310. Arlington, VA.
[15] See Appendix A for details on the implementation and parameters of the survey.
[16] "New NSF Survey Finds Six States Account for Nearly Half of State Agencies' R&D Expenditures." (NSF 08-309).

Non-federal Analyses

In 1997, the State Science and Technology Institute (SSTI) gathered California data on R&D expenditures in 1994-1995.[17] Over the next two years CCST conducted follow-up surveys with the contacts used by SSTI to extend the database through the 1996-1997 fiscal year. The results were published as a component of the *California Report on the Environment for Science and Technology* in 1999.[18] The CCST study was undertaken to assess funding consistency and variability within the span in question, check the reliability of the SSTI data by asking respondents to review and reassess earlier data, and, most importantly, identify constraints or guidelines affecting the administration of research monies in the state of California.

The 1999 report is the last comprehensive assessment of R&D spending in California. In the intervening years, although the National Science Board has disaggregated federal R&D funding obligations by state in the Science and Engineering Indicators, there has been little assessment of spending at the state level from other sources as well, including state agencies themselves. In 2006, CCST undertook a brief overview of California's investment in research as part of a report on state-level intellectual property policy.[19] In that report, which sought primarily to establish the relative scale of state and federal R&D spending, CCST estimated that state spending totaled approximately $600 million, of which half was for the newly created California Institute for Regenerative Medicine.[20]

Assessments such as the Milken Institute State Technology and Science Index provide an overall S&T index[21] that ranks California against other states, but while the index employs a large number of valuable indicators, including several related to the acquisition of R&D funding (primarily from federal sources), it does not detail state-level spending. The only other means of assessing R&D spending are directly via the state budget and through direct communication with agencies, where applicable. For the current study, CCST contacted directly the California Institutes for Science and Innovation and the University of California Industry-University Cooperative Research Program (IUCRP). Some agencies, such as CIRM, publish their financial data publicly in annual reports.

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[17] Battelle Memorial Institute and State Science & Technology Institute. Survey of State Research and Development Expenditures: Fiscal Year 1995. (SSTI: Columbus, OH, 1998).

[18] Victoria Koehler-Jones. Analysis of California R&D Funding from 1994-1995 to 1996-1997. (CCST: Sacramento, 1999).

[19] California Council on Science and Technology. Policy Framework for Intellectual Property Derived from State-Funded Research: Final Report to the California Legislature and Governor of the State of California. (CCST: Sacramento, 2006) .

[20] CCST, Policy Framework for Intellectual Property, pp. 19-20.

[21] Ross DeVol, Anita Charuworn, and Soojung Kim. California's Position in Technology and Science: A Comparative Benchmarking Assessment. (Milken Institute: Santa Monica, CA, 2008).

3. Overview of Available Data: What the Numbers Tell Us

Overall, data gathered by federal sources indicate that California directly funded approximately $347 million in R&D during FY 2006, a decrease of over 12% in real dollars from 1999.

The Numbers in California

According to the NSB Indicators, total state and local funded R&D spending at academic institutions in California in 2006 was $266,911,000, an increase of just 4% from 2001 totals.[22]

In addition, the NSF survey on state-funded research found that California agencies contacted spent nearly $108 million in FY 2006 on R&D (Table 4).

Table 4: R&D expenditures at California universities & colleges by source, 2006
(Dollars in thousands)

	TOTAL	Federal	State & local	Industry	Institutional	All other sources
California	6,493,388	3,994,693	266,911	286,084	1,235,819	709,881

Source: National Science Foundation/Division of Science Resources Statistics, Survey of Research and Development Expenditures at Universities and Colleges, FY 2006

However, it is important to note that the NSF totals in Table 5 include R&D performed by state agencies regardless of source. In a separate table the authors note that the actual state-funded, state-conducted R&D total is $79,925,191. This provides a combined total of $346,836,191 in R&D funded directly by the state of California during FY 2006. Although higher than the most recent totals arrived at by CCST in its 1999 report ($316 million in 1996-1997), this total represents a decrease of over 12% in real dollars once inflation is factored in.[23] (R&D plant refers to direct investments in facilities and equipment. Internal performers are agencies that perform R&D themselves; external performers are other agencies or institutions contracted to conduct R&D on behalf of an agency.)

Table 5: State agency expenditures for R&D and R&D plant, by state and performer: FY 2006

State or equivalent	Total	Internal performers	External performers	R&D plant
United States	1,022,475,684	261,469,260	761,006,425	73,198,491
Alabama	7,269,319	4,339,426	2,929,893	1,191,780
Alaska	10,019,060	5,356,472	4,662,588	0
Arizona	37,151,471	8,576,436	28,575,035	0
Arkansas	4,869,648	1,073,285	3,796,363	0

[22] National Science Foundation, Division of Science Resources Statistics. 2007. Academic Research and Development Expenditures: Fiscal Year 2006. NSF 08-300. Ronda Britt, project officer. (NSF: Arlington, VA, 2008) Table 21.
[23] Comparison made using Consumer Price Index between 1997 and 2006.

California	107,793,045	16,494,016	91,299,029	0
Colorado	8,997,236	6,594,969	2,402,267	3,000
Connecticut	19,209,064	14,519,731	4,689,333	0
Delaware	2,812,102	1,207,011	1,605,091	0
D.C.	1,173,076	302,000	871,076	0
Florida	42,329,624	10,013,516	32,316,108	0
Georgia	10,620,188	861,231	9,758,957	0
Hawaii	12,067,849	2,329,186	9,738,663	0
Idaho	2,280,873	257,926	2,022,947	0
Illinois	37,184,281	17,617,332	19,566,949	15,146,506
Indiana	6,220,575	2,364,046	3,856,529	1,000,000
Iowa	13,564,062	5,754,032	7,810,030	0
Kansas	14,348,384	2,137,741	12,210,643	0
Kentucky	17,558,997	3,702,849	13,856,148	0
Louisiana	11,216,568	7,530,897	3,685,671	0
Maine	17,509,051	0	17,509,051	12,000,000
Maryland	24,945,119	6,086,183	18,858,937	825,000
Massachusetts	10,729,419	3,623,773	7,105,646	0
Michigan	75,016,589	1,527,314	73,489,275	5,500,000
Minnesota	6,219,201	2,132,277	4,086,924	0
Mississippi	2,744,882	1,484,612	1,260,270	0
Missouri	18,465,303	12,171,794	6,293,509	0
Montana	8,606,319	2,404,391	6,201,928	0
Nebraska	5,602,163	436,000	5,166,163	0
Nevada	1,397,463	323,042	1,074,421	0
New Hampshire	2,040,544	424,762	1,615,782	471,000
New Jersey	25,900,482	5,483,784	20,416,698	4,881,065
New Mexico	3,105,000	3,000,000	105,000	0
New York	103,597,135	42,047,823	61,549,312	6,741,864
North Carolina	14,344,310	3,789,289	10,555,021	0
North Dakota	21,062,090	762,297	20,299,793	2,500,000
Ohio	55,068,629	1,515,058	53,553,571	8,750,000
Oklahoma	8,922,036	83,333	8,838,703	0
Oregon	7,382,722	3,318,194	4,064,527	1,692,030
Pennsylvania	117,320,158	3,310,731	114,009,428	11,564,981
Rhode Island	150,000	0	150,000	0
South Carolina	22,427,746	15,780,585	6,647,161	18,750
South Dakota	5,791,586	2,318,754	3,472,832	0
Tennessee	5,355,000	704,000	4,651,000	0
Texas	28,019,645	5,870,258	22,149,387	605,257
Utah	3,214,170	964,170	2,250,000	100,000
Vermont	1,680,533	848,787	831,746	0
Virginia	11,579,623	5,045,794	6,533,829	0
Washington	22,834,218	12,187,408	10,646,810	2,500
West Virginia	6,024,577	1,767,688	4,256,889	67,258
Wisconsin	10,949,155	5,534,273	5,414,882	137,500
Wyoming	6,326,604	4,216,426	2,110,178	0
Puerto Rico	1,458,790	1,274,358	184,432	0

SOURCE: National Science Foundation/Division of Science Resources Statistics, Survey of FY 2006 State R&D Expenditures.

The University of California receives the most state R&D funding, and indeed UC schools in 2006 occupy five of the ten top spots on the list of academic institutions ranked by nonfederally financed R&D expenditures, including industry funding. During this time UC institutions conducted over $216 million of the $266 million in state funded R&D in California academic institutions, accounting for 81% of state funding to academic institutions for R&D. The University of California system, in fact, received more state funding for R&D than the combined universities of any other state except the University of Texas system (Table 8), which, although comparable in student body size to UC, has fifteen institutions compared to the University of California's ten.

A detailed breakdown of R&D conducted by academic institution in California is in Table 6.

Table 6: R&D expenditures at California universities and colleges, by system and source of funds: FY 2006 (dollars in thousands)

State, control, and institution	All R&D expenditures	Federal government	State and local government	Industry	Institutional funds	All other sources
California Total	6,493,388	3,994,693	266,911	286,084	1,235,819	709,881
Public	4,621,898	2,518,158	253,111	197,943	1,037,743	614,943
Cal Poly Pomona	2,502	2,502	0	0	0	0
Cal Poly SLO	12,529	6,461	2,026	807	1,812	1,423
CSU Bakersfield	6,379	2,301	3,388	215	475	0
CSU Chico	2,767	1,083	1,453	113	0	118
CSU Dominguez Hills	3,190	2,530	362	0	67	231
CSU East Bay	2,833	2,037	309	80	84	323
CSU Fresno	9,749	1,561	6,773	416	999	0
CSU Fullerton	4,522	4,083	47	238	154	0
CSU Long Beach	10,322	8,368	574	397	423	560
CSU Los Angeles	8,956	8,672	124	44	0	116
CSU Monterey Bay	4,107	3,779	215	0	0	113
CSU Northridge	7,490	5,200	655	96	1,210	329
CSU Sacramento	4,372	4,372	0	0	0	0
CSU San Bernardino	11,120	5,367	855	4,134	577	187
Humboldt State U.	6,500	2,548	2,082	190	920	760
Naval Postgraduate School	56,780	54,528	980	999	0	273
San Diego State U.	73,777	35,351	6,929	508	24,061	6,928
San Francisco State U.	27,333	17,255	3,593	51	4,447	1,987
San Jose State U.	34,687	23,197	7,634	308	1,319	2,229
Sonoma State U.	637	219	324	0	48	46
UC Office of the President	128,770	796	43,736	661	75,685	7,892
UC Berkeley	546,035	261,718	36,418	24,744	146,469	76,686
UC Davis	573,002	248,190	44,982	26,221	192,843	60,766
UC Irvine	300,229	169,983	9,862	16,224	64,683	39,477

UC Los Angeles	811,493	483,873	14,984	24,480	162,219	125,937
UC Merced	7,527	3,135	2,182	175	1,408	627
UC Riverside	124,820	58,023	4,937	4,947	45,153	11,760
UC San Diego	754,766	463,807	25,758	39,825	124,987	100,389
UC San Francisco	796,149	464,660	26,804	35,621	129,527	139,537
UC Santa Barbara	174,429	106,169	2,830	13,918	29,634	21,878
UC Santa Cruz	114,126	66,390	2,295	2,531	28,539	14,371
Private	1,871,490	1,476,535	13,800	88,141	198,076	94,938
Caltech	270,269	248,591	1,809	7,981	4,150	7,738
Chapman U.	833	236	5	114	289	189
Charles R. Drew U. of Medicine and Science	47,188	44,394	762	199	1,833	0
Claremont Graduate U.	3,100	1,093	74	129	525	1,279
Fuller Theological Seminary	729	500	0	0	25	204
Harvey Mudd C.	2,301	1,003	0	623	424	251
Loma Linda U.	32,451	28,788	53	814	1,007	1,789
Loyola Marymount U.	1,599	1,044	7	0	484	64
Mills C.	550	550	0	0	0	0
Mt. St. Mary's C. (L.A.)	581	581	0	0	0	0
Occidental C.	1,449	690	118	630	9	2
Pitzer C.	269	146	0	0	123	0
Point Loma Nazarene C.	376	376	0	0	0	0
Pomona C.	2,584	1,053	0	0	1,454	77
Santa Clara U.	1,684	1,671	0	0	0	13
Scripps Research Institute	367,375	268,533	73	16,277	59,544	22,948
Stanford U.	679,196	540,069	4,595	34,637	40,742	59,153
U. Redlands	1,172	1,126	10	2	0	34
U. San Diego	499	280	0	38	0	181
U. San Francisco	1,376	386	58	1	449	482
U. Southern CA	450,173	333,378	4,940	24,952	86,903	0
U. of the Pacific	4,161	1,142	1,275	1,744	0	0
Western U. of Health Sciences	1,575	905	21	0	115	534

SOURCE: NSF/Division of Science Resources Statistics, Survey of FY 2006 State R&D Expenditures

It is important to note that most state R&D funding is heavily leveraged, often matching either federal or industry contributions. For example, the UC Discovery Grant program has awarded $282 million since 1996 in grants to UC researchers who obtain matching industry sponsorship for basic and applied research. The program is an initiative in collaboration with the state of California that, through use of research funds and tax credits, and by providing access to UC's scientists and students, encourages California-based companies to pursue breakthrough research in UC laboratories.

Most but not all research is conducted through colleges and universities. While the published NSF survey on state R&D expenditures did not include agency-specific details,

CCST was able to obtain access to some of these data after correspondence with the NSF and Census Bureau directors responsible for the study.[24]

How Does California Compare?

The total amount of R&D conducted in California's academic institutions continues to lead the nation by a significant margin; total R&D conducted at California universities and colleges exceeds that of the second place state (New York) by 71% (Table 7). However, most of this funding is from federal and industry sources. If the totals are sorted by state and local government totals, then California ranks second, behind Texas (which, as noted above, has a larger research university system). On a per-capita basis California remains among the top five in the nation, with only Massachusetts and Maryland scoring higher on the Milken composite R&D index. The NSF State Agency Expenditures for R&D survey, which was restricted to R&D exclusive of universities, ranked California second, behind Pennsylvania, in state-funded R&D (Table 8).

Table 7. Top ten state R&D expenditure totals at universities and colleges, with details on funding sources: FY 2006 (dollars in thousands)

Division and state	All R&D expenditures	Federal government	State and local government	Industry	Institutional funds	All other sources
United States	47,760,402	30,033,156	3,016,240	2,427,627	9,062,058	3,221,321
California	6,493,388	3,994,693	266,911	286,084	1,235,819	709,881
New York	3,789,658	2,461,792	201,728	161,373	688,256	276,509
Texas	3,270,728	1,814,073	409,255	180,867	531,938	334,595
Maryland	2,530,231	1,861,057	63,874	72,943	373,289	159,068
Pennsylvania	2,428,346	1,703,935	121,023	170,292	295,465	137,631
Massachusetts	2,158,748	1,682,351	53,406	131,683	132,945	158,363
Illinois	1,823,787	1,117,050	67,523	65,892	459,446	113,876
North Carolina	1,710,496	1,083,603	138,796	202,821	240,208	45,068
Ohio	1,636,473	1,005,905	150,297	136,151	264,701	79,419
Florida	1,527,666	816,525	169,020	122,342	351,629	68,150

[24] We wish to acknowledge the assistance of James Berry, Census Bureau, and John Jankowski, NSF, as well as Fred Klass of the California Department of Finance for authorizing the release of these data to CCST.

Table 8. State agency expenditures for R&D, ranked by all R&D expenditures: 2006		
Rank	State	All R&D expenditures
1	Pennsylvania	117,320,158
2	California	107,793,045
3	New York	103,597,135
4	Michigan	75,016,589
5	Ohio	55,068,629
6	Florida	42,329,624
7	Illinois	37,184,281
8	Arizona	37,151,471
9	Texas	28,019,645
10	New Jersey	25,900,482

SOURCE: NSF/Division of Science Resources Statistics, Survey of FY 2006 State R&D Expenditures

Despite the fact that states such as Texas, New York, and Pennsylvania appear to have comparable or greater state funding devoted directly to R&D, California is still generally cited as a national leader in state-initiated and funded R&D. There are several reasons for this perception:

- California state R&D funding is designed to encourage matching funds from federal and private industry investment.

- California is home to several collaborative regional and sector-specific networks such as the Bay Area Science and Innovation Consortium (BASIC) that foster interaction between the private sector, university sector, and federal facilities. Such collaborations are an essential part of what the Alliance for Science and Technology Research in America (ASTRA) describes as the innovation infrastructure, providing a suitable framework for R&D investments to contribute effectively to the overall process of sustaining innovation. As a result, California is frequently cited as a national example by such organizations as the National Governor's Association (NGA).[25]

- Although other states such as Pennsylvania, New York, and Texas have all made strong strides in state-funded or seeded R&D, no single effort approaches the price tag of the California Institute for Regenerative Medicine (CIRM), $3 billion over ten years. The actual return on investment and controversies over the institute notwithstanding, CIRM generated considerable national publicity during its inception.

The ability of state funding to attract federal and industry dollars is a key measure of the state's overall R&D performance. The Milken Institute, in its 2008 composite index ranking of states by R&D input, ranked California third after Massachusetts and

[25] NGA and Pew Center for the States, Innovation America, p. 18.

Maryland, based essentially on strong per-capita improvements made by the two smaller states.[26] The ranking does not include a specific category for state-funded R&D, focusing instead on federal, industry, and academic inputs (it is noted that the latter includes a combination of funding including state money). Milken ranked California among the top five states for industry R&D inputs, noting that the state's foothold in the top echelon of the R&D composite index results largely from its "ability to attract R&D in many of the key fields that excel at commercialization," including engineering and life sciences (including biomedical).[27] The Milken analysis concluded that California's interest in agricultural research and clean technology development – including energy development – would be essential to provide fertile ground for companies to settle down and develop the next stage of their projects. These are precisely the areas where state R&D seed funding may have the greatest impact.

[26] Milken Institute, California's Position in Technology and Science, p.19.
[27] Milken Institute, California's Position in Technology and Science, p.23.

4. What the Numbers Don't Tell Us

From the different data sources gathered at the federal level, we get an approximate number of $346 million in state-funded R&D – a very small number compared to the $19.4 billion in federal funded R&D committed to California in FY 2005, or the more than $50 billion in industry R&D conducted in California during the same period. But this is an incomplete picture of the impact that California's R&D expenditures have. Although the total represents a convenient benchmark against other states and previous analyses, it should not be construed as either complete or representative.

There is no central data collection within California on its R&D programs, nor is there a comprehensive strategy to coordinate or even define what constitutes R&D spending by the state. All the different entities which have examined state-level R&D funding (including the NSF, Battelle, and CCST) found confusion among state agencies and programs as to whether or not they funded R&D. Moreover the state's current research portfolio includes a wide range of programs, most of which draw on funding from a variety of sources and some of which have garnered significant public attention. Because of the manner in which state R&D funding is generally leveraged with federal and industry funding, and because of the multi-year nature of these programs, it is often challenging to reconcile the public profile of these programs with the R&D totals collected by the NSF. A relatively small amount of "seed money" from the state can lead to a disproportionately large shift in R&D funding within California.

For example, the California Institute for Regenerative Medicine (CIRM) is a widely-touted and unprecedented state initiative with a stated total commitment of $3 billion over ten years, the money for which will be obtained through the sale of bonds. Although voters approved the bond sales for CIRM in 2004, the program faced immediate opposition and the issuance of bonds was delayed by lawsuits through early 2007.[28] Consequently, as of FY 2006 (the last year included in the NSF statistics) CIRM's operating budget was funded entirely by private donations and a $100 million loan authorized by Governor Schwarzenegger, and only training grants were issued (no research was funded). Consequently, although CIRM is cited by such documents as the recent National Governors Association/Pew Center for the States report,[29] it has not yet impacted on the statistics for state-funded research.[30]

It is also challenging to identify totals for major R&D expenditures from the state budget because the state does not currently track R&D expenditures separately. As noted above, not every agency is even clear on whether its activities fall in the realm of R&D, and even the NSF cannot always determine which state agencies are funding R&D. The

[28] California Family Bioethics Council vs. CIRM and People's Advocate vs. ICOC; final decision from Alameda County Superior Court, 2/26/07.
[29] National Governors' Association and Pew Center for the States. Innovation America: Investing in Innovation, pp. 28-29, "Show me the money: how do states fund these investments?"
[30] Per the CIRM 2007 annual report, at the conclusion of FY 2006 it had a deficit of $15.2 million; http://www.cirm.ca.gov/press/pdf/annual_rpt.pdf.

Public Interest Energy Research (PIER) program, for example, has been the state's largest R&D program since 1997, spending at least $62.5 million per year on projects intended to help improve the quality of life in California by bringing "environmentally safe, affordable and reliable energy services and products to the marketplace."[31] However, PIER does not appear as a line item in the budget. In addition, total R&D expenditures for the California Energy Commission listed according to the NSF survey, as seen in Table 9, were just under $30 million for the year surveyed. It is clear that the survey is not capturing all of California's R&D spending.

Table 9: Detail of R&D spending by agency, source, and agent: FY 2006

Agency	Internal (state)	Internal (federal)	Internal (other)	External (academic)	External (industry)
Dept. of Fish and Game	843,000	509,000	0	2,181,529	31,039
Dept. of Transportation	6,679,000	3,150,000	0	26,450,000	1,350,000
Dept. of Conservation	0	0	0	42,998	1,236,950
Energy Commission	0	0	0	16,968,713	12,993,470
Dept. of Health Services	761,000	1,939,000	0	3,138,000	0
Dept. of Food and Agriculture	221,931	2,360,590	30,495	8,442,080	2,195,875

Source: Correspondence with John Jankowski, project officer, NSF Research and Development Statistics Program

Previous efforts to establish levels of state R&D spending have encountered similar challenges. The seminal Battelle State Science and Technology Institute study in 1998, the only widespread study of state R&D spending prior to CCST's own analysis, noted that direct state support of R&D performed in the academic sector is about 20% of that reported by universities, leading to significant discrepancies in state totals obtained by the Battelle Survey and the NSF due to differences in definition.[32] The inception of the new NSF survey tracking R&D expenditures through state agencies is intended to address this discrepancy, but it is unclear if the survey covers state money flowing to academia exclusive of specific state agency research efforts.

It is perhaps most instructive to view the manner in which state funding has leveraged other funding in specific programs. Note that some of these programs include funding from state academic institutions, which may in cases include direct R&D contracts from the state. The following sections are not intended as a comprehensive list of R&D programs in California which include state funding, nor can the data be combined for a reliable 'total' of state investment in R&D due to differences in the manner that budget numbers are tracked for each program. The Pew Center on the States has repeatedly singled out three seminal programs in California as examples of sustained state research funding efforts: CIRM, the California Institutes for Science and Innovation (Cal ISIs), and the UC Discovery Grant Program.[33]

[31] http://www.energy.ca.gov/pier.
[32] Battelle & SSTI, Survey of State Research and Development Expenditures, p.29.
[33] Mary Jo Waits, Pew Center on the States, "Investing in Innovation: the Role of R&D Investment (presentation delivered September 5, 2007).

Moreover, the state makes another substantial financial commitment to R&D which is not captured by any of these sources: its R&D tax credit. The R&D tax credit is traditionally treated as a distinct program, but it represents an outlay (in the form of deferred income) that contributes to R&D performed in the state. Arguably, if the state were to evaluate its R&D expenditures on a comprehensive basis, its R&D tax credit would need to be considered as well.

To put some of these programs into perspective, and highlight what the raw numbers do not capture, we present here a brief overview of the programs listed above, the state funding that they involve, and their broader impact on R&D funding. It should be noted that the following is not intended as a comprehensive list but as a sampling of some of the largest identifiable programs by state dollar amount.

California Institute for Regenerative Medicine (CIRM)

Stem cell research has in recent years been promoted as holding a great deal of promise for California. In 2004, in response to the high degree of public interest and restrictions for stem cell research funding at the federal level, California voters passed Proposition 71, which committed $3 billion in state funds over ten years to support embryonic stem cell and other biomedical research through the California Institute for Regenerative Medicine. Because CIRM focuses specifically on an area of research restricted at the federal level, it does not rely on leveraging federal funding. Because of the legal challenges that delayed sales of the bonds, CIRM has not yet been a major source of R&D funding in the state. With the resolution of the court case in 2008, CIRM has begun approving applications for funding. To date, CIRM has committed over $554 million to over 200 research grants and 29 facilities grants, which include:[34]

- $37.5 million to train 169 pre-doctoral, post-doctoral and clinical fellows at 16 non-profit and academic research institutions.
- $46 million to fund 73 Leon J. Thal SEED Grants to bring new ideas and new investigators into the field of human embryonic stem cell (hESC) research.
- $72 million for 28 Comprehensive Research Grants to support mature, ongoing studies on human embryonic stem cells (hESCs) by scientists with a record of accomplishment in the field.
- $50 million for 17 Shared Research Laboratory Grants (including 6 Stem Cell Techniques Courses) to fund for the design and renovation of laboratory space, equipment for the new research facilities, and operating expenses for three years.
- $54 million for 22 New Faculty Awards to encourage and support the next generation of clinical and scientific leaders in stem cell research.
- $271 million to 12 institutions for the construction stem cell research facilities.
- $23 million to fund the derivation of new lines of pluripotent human stem cells.
- $1 million to fund the planning stages of an innovative model for disease team research.

[34] Approved CIRM grants as of June 2008, http://www.cirm.ca.gov/info/grants.asp, accessed 8/29/08.

- $59 million for 23 New Faculty II Awards to encourage and support the next generation of clinical and scientific leaders in stem cell research.

CIRM is a state agency, although it does not conduct R&D activities itself. Its impact on state R&D totals will most likely be reflected in academic R&D totals collected by NSF, rather than the state agency survey. Consequently, although it comprises the largest single state R&D outlay in the country, it's unclear how it will be captured in future NSF surveys.

Governor Gray Davis Institutes for Science and Innovation (GGDISI)

The GGDISI (formerly the California ISIs) were launched in 2000 as a statewide initiative to support research in fields that were recognized as critical to the economic growth of the state - biomedicine, bioengineering, nanosystems, telecommunications and information technology. Moreover, like the Discovery Grant program, the GGDISI were conceived as a means of catalyzing partnerships between university research interests and private industry with the potential to expand the state economy into new industries. Unlike the Discovery Grant program, these are dedicated facilities with structured collaborations among campuses, disciplines, academics researchers, research professionals, and students.

Each institute is hosted by at least two UC campuses. There are four: the California Institute for Quantitative Biological Research (QB3), the California NanoSystems Institute (CNSI), the California Institute for Telecommunications and Information Technology (Calit2), and the Center for Information Technology Research in the Interest of Society (CITRIS). The state's start-up funding totaled $100 million for four years of support (from 2000 to 2004) for each of the centers, with the expectation that the state funds provided for the institutes would be matched 2-to-1 by non-state dollars. (Lease revenue bonds, a common source of funding for capital projects, were used to generate initial construction costs for the institutes.) The GGDISI succeeded in procuring an additional $800 million from federal and private sector partners, resulting in a total investment of over $1.2 billion (which the NGA cites as one of the largest state-seeded R&D investments in the nation).[35]

The state still contributes annually to the operating budgets of the institutes through the UC budget, allocating $4.75 million in general funds for operations of the institutes in the 2007-08 budget as part of the Research & Innovation initiative.[36] However, the amount of money the institutes contribute to R&D in the state each year is substantially higher. In contrast to the Industry-University Cooperative Research Program (IUCRP), which focuses on university-industry partnerships, the GGDISI leverages most of its funding from federal sources. At the NanoSystems Institute, for example, over 94% of grant funding in FY 2006-07 derived from federal or industry sources (Table 10).

[35] NGA and Pew Center for the States, Innovation America, p. 11.
[36] State of California 2007-2008 Final Budget Summary, item 6440-005-0001. NB the Governor's original budget for the year would have provided $20 million.

Table 10: Funding for California NanoSystems Institute at UCLA by source, FY 2006-2007			
	Direct Costs	Facilities & Administrative costs	Total Awards
Federal Agencies	$34,430,437	$13,482,709	$47,913,146
Industry	$13,251,977	$4,358,419	$17,610,396
Other - Universities	$1,233,786	$609,151	$1,842,937
Other - UC/State	$1,236,400	$36,333	$1,272,733
Foundations	$317,039	$27,954	$344,993
Total	$50,469,639	$18,514,566	$68,984,205

Source: Correspondence with California NanoSystems Institute, 6/16/08

Similarly, Calit2 raised over $79 million in R&D grants from federal, industry, and foundation sources between 2006 and 2008 (Table 11). During the first five years of its operation, Calit2 was able to bring in nearly $468 million in funding, over 75% of which was from federal sources (Table 12).[37] However, over $90 million was also raised from industry, which was seen from the inception as a key partner in the collaborative structure of the GGDISI. As federal funding available for R&D diminishes, the ability to engage industry funding is a vital indicator of success for the institutes.

Table 11: External funding for Calit2 grants by source, July 2006-June 2008	
Source	Awards
Federal Agencies	$63,563,654
Industry	$12,801,918
Foundations	$2,875,933
Total	$79,241,505

Source: Correspondence with Calit2, 8/14/08

Table 12: External Funding for Calit2 grants by source, 2001-2006	
Source	Awards
Federal Agencies	$351,254,623
Industry	$77,856,515
Foundations	$38,710,485
Total	$467,821,623

Source: Correspondence with Calit2, 8/14/08

The investment in the GGDISI represents perhaps the greatest ratio of federal dollars to state R&D expenditures in the state. It is important to recognize, however, that core funding for operations remains dependent upon state funds through the University of California.

[37] NB figures for the GGDISI do not differentiate between R&D plant expenditures (facilities and fixed equipment) and research expenditures.

The UC Discovery Grant Program

The UC Discovery Grant Program, administered by the Industry-University Cooperative Research Program (IUCRP), was established in 1997 at the University of California and is intended to promote research partnerships with industry in disciplines deemed critical to the state's economic competitiveness. It is a matching grants program that promotes essential early-stage research in science and engineering in UC laboratories as well as accelerating research as a foundation for new products and technologies, new markets, and business expansion. Discovery Grants are awarded in the fields of biotechnology, communications and networking, digital media, electronics manufacturing, and information technology for life sciences, as well as pilot projects in multidisciplinary research in energy and the environment, health and wellness, and adoption of nanotechnology. As seen below in Table 13, industry contributions comprised 58% of the total funding provided to IUCRP during FY 2007-2008. (Totals included prorated percentages of multi-year grants.)

Table 13: Industry-University Cooperative Research Program UC Discovery Grant funding, FY 07-08

Field	#	IUCRP Contribution	Industry Contribution
Biotechnology	12	$3,601,004	$5,073,338.87
Communications & Networking	8	$1,293,380	$2,077,767.76
Digital Media	4	$2,907,452.37	$3,912,766.82
Electronics Manufacturing	12	$5,699,647.04	$7,301,462.01
Information Technology for Life Sciences	2	$529,356.99	$694,144.06
Multidisciplinary research in:	8	$1,089,395.99	$1,561,385.84
Energy & Environment			
Health and Wellness			
Rapid application of nanotechnologies			
Total	46	$15,120,236	$20,620,865

Source: University of California Office of the President

Because of the manner in which the funding is leveraged, changes in funding for IUCRP have a proportionally substantial impact on industry matching funds. Due to state budget cuts, IUCRP decreased its contribution by just over $2.5 million between FY 06-07 and FY 07-08. This led to a resulting drop of over $4.5 million in industry contributions. In other words, the actual net impact of the $2.5 million reduction in IUCRP funding was approximately $7 million.

The Public Interest Energy Research (PIER) Program

PIER represents the largest single research program in the state administered by a state agency rather than through a university or separate research entity such as CIRM. Managed by the California Energy Commission (CEC), the PIER program is funded by a collection of surcharges on retail energy sales; it was founded in 1996. Its charge is to implement R&D activities and advanced science not adequately advanced and commercialized by competitive and regulated markets. It awards $62.5 million annually.

Up through 2007, funding was focused on seven areas: buildings, industrial, agriculture and water, advanced electricity generation, renewables, energy systems integration, environmental areas, and program administration. During the most recent 5-year period reported (2002-2006), the two largest areas receiving grant money were energy systems integration (23%, or $67.6 million from 2002-2006) and environmental energy research (21%, or $63 million).[38] In 2007, following the mandate of Senate Bill 1250, PIER created a new research and reporting structure, comprised of transportation, energy efficiency and demand response, advanced electricity generation, renewables, transmission and distribution, energy and climate science.

As with other programs, PIER frequently leverages funding with other sources where applicable. For example, the CEC has provided West Coast Regional Carbon Sequestration Partnership (WESTCARB), the joint carbon sequestration study undertaken by several supporting western states, with $5.1 million of PIER support that already returned $11.4 million and may return $62 million beginning in 2008.[39]

Because PIER is intended to benefit California by helping to bring innovations to market, its success has been measured in terms of estimated economic return to the state rather than in terms of research dollars leveraged from other sources. A study commissioned in 2004 examined whether PIER's entire investment portfolio returned more benefit to California citizens than it cost over a five-year period. Although the study did not fully account for indirect benefits such as job creation and environmental improvements, it found that 33 products were placed into commercial use through 2003 as a result of PIER investment. The total investment of $200 million during the time span in question was estimated to have returned benefits of between $246 and $645 million, a ratio of $1.30–$3.40 in benefits to the state's economy for every dollar spent by PIER.[40]

PIER awards funded a range of research partners, including industry (30%), nonprofit organizations (29%), universities (14%), and national laboratories (12%), as well as the state (4%). PIER funding is thus not likely to be captured in its entirety in either the academic or state agency R&D funding surveys.

The California State R&D Tax Credit

While California spends money directly on R&D, it also spends money indirectly in the form of deferred income through a state R&D tax credit. As with its other R&D related expenditures, the goal of this program is to encourage R&D spending within the state of California; however, unlike programs where the state invests seed money directly, the tax credit is only applicable to industry R&D. As noted above, this is the significant majority of R&D performed in the state. However, unlike with direct R&D expenditures, the R&D

[38] California Energy Commission, Public Interest Energy Research (PIER) Annual Report, 2007 (April 2008: CEC-500-2008-026-CMF), p.2.
[39] PIER 2007 Annual Report, p.16.
[40] Gerald D. Pine, Jing Tong, and Xun Zhou, Evaluation of Benefits to California Electric Ratepayers from the Public Interest Energy Research Program, 1998-2003.

tax credit is industry-wide, and cannot be focused to foster innovation or R&D in specific areas.

Economic theory suggests that without some form of subsidy, overall research and development (R&D) spending in society would be lower than the economically optimal level. A strong case can be made that such a subsidy is appropriate at the federal level. Many states, including California, have taken the position that subsidies are also appropriate at the state level, in order to encourage the establishment and retention of high-tech industries.

Over the past two decades, R&D tax credits offered by U.S. states have become widespread. The process began when Minnesota became the first state to enact an R&D tax credit in 1982, one year after the introduction of the federal R&D tax credit. The number of states offering such a credit has risen steadily since then. Currently, 31 states provide a tax credit on general, company-funded R&D.[41] A number of other states offer narrowly targeted tax credits for R&D spending in specific fields, in particular geographic zones, or only by small or start-up companies.

California's R&D credit was enacted in 1986. In 1996, the state's qualified research credit was increased from 8% to 11%, and the basic research credit was increased from 12% to 24% (SB 38, Lockyer, Ch. 954).

Most tax returns with R&D claims are filed by small- and medium-sized businesses; in 2002, over 60 percent of returns with research and development credit (RDC) claims were filed by businesses with gross revenues of under $1 million.

The RDC features two separate programs:

- ***Qualified Research Credit.*** The credit for *qualified* research is available for certain types of research activities conducted by the taxpayer, and is available to both personal income taxpayers and corporation taxpayers. The credit is equal to 15 percent of the amount of qualified incremental expenditures over a calculated "base amount" (as discussed below) of R&D expenditures.

- ***Basic Research Credit.*** The credit for *basic* research is available for certain types of research activities conducted by selected outside entities on behalf of the taxpayer, and is available to corporation taxpayers only. The credit is equal to 24 percent of expenditures over a calculated base amount for certain types of research carried out by independent research institutions and universities.

California has legislated incremental changes during the past decade to make its R&D credit more attractive to R&D-dependent businesses, including those in the high-tech, biotech, and aerospace industries.

[41] Dan Wilson, " The Rise and Spread of State R&D Tax Credits." Federal Reserve Bank of San Francisco Economic Letter (10/14/2005).

The cost to the state in terms of reduced revenue is significant, reaching over $500 million in 2003-04; the last year data are available from the Legislative Analyst's Office (LAO). The net revenue loss, according to the Department of Finance, is actually 10% lower than the direct revenue loss due to increased economic activity. This would mean that the total net revenue loss for 2003-04 was approximately $467 million (see Figure 1). And in fact, as part of the budget deal in 2008, restrictions were added to the R&D tax credit which would limit their use by as much as 50% for the next two years.[42]

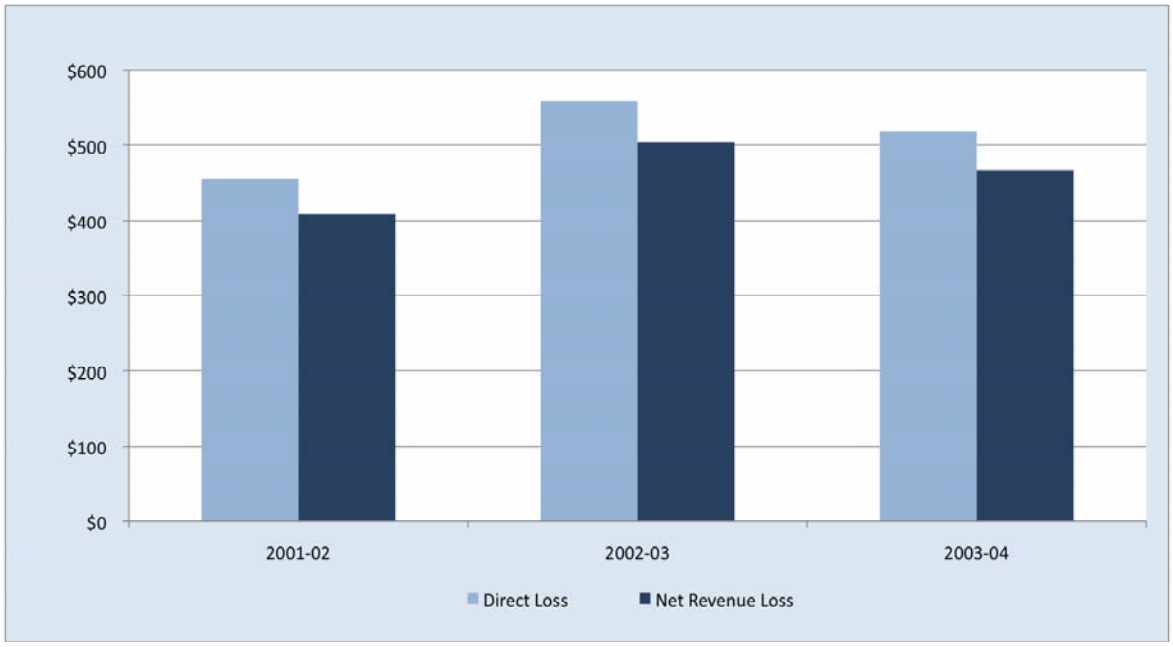

Figure 1. Direct and net revenue loss (dollars in millions) from California state R&D tax credit, FY 2001-02, 2002-03, and 2003-04. Source: LAO.

Establishing a firm rate of return for R&D tax credits is challenging for both federal and state governments alike. While the federal government analyzes it, such reviews are periodic at the state level. The California LAO last performed a comprehensive review in 2003. In this review, the LAO concluded that the evidence supporting the value of state-level R&D tax credits was not sufficient to justify continuing the program in California.[43]

However, other studies of state-level R&D tax credits indicate that state credits in general, and the California program in particular, bring substantial returns to the state, and have suggested that "… the establishment of state R&D credit programs is effective in stimulating more industrial R&D expenditure."[44]

[42] AB 1452, chaptered as Chapter 763, Statutes of 2008.
[43] California Legislative Analyst's Office, An Overview of California's Research and Development Tax Credit (Sacramento: 2003), p.2.
[44] Yonghong Wu, " The effects of state R&D tax credits in stimulating private R&D expenditure: A cross-state empirical analysis." Journal of Policy Analysis and Management 24: 4 (2004) pp. 785-802.

An analysis published by the Federal Reserve Bank of San Francisco likewise concluded that state R&D tax credits do stimulate a relocation of R&D from states with less generous credits to states with more generous ones,[45] although it warned that the net effect of state R&D tax credits nationwide could be considered a "zero-sum game". Other analyses suggest that the effect of the credits is most effective in [biotech] industries.[46]

Unquestionably, other states perceive California's R&D tax credits as a competitive disadvantage. Early in 2008, Arizona pushed for expansion of its own version of the credits, passing legislation that specifically cited the need to remain competitive in the face of California's R&D tax credits.[47]

A Different Total

Taken at face value, the data gathered at the federal level suggest that the state spends approximately $347 million on R&D. Thanks to the recently initiated NSF survey on state R&D spending, this represents a substantially more complete picture of R&D funding than was available in previous years. However, while useful as a metric against other states' performance, it does not give policymakers a clear picture of the state's true commitments to R&D funding. The federal numbers suggest the CEC spends $30 million a year on unspecified programs; PIER actually represents an annual, sustained commitment of more than double the amount, focusing on specific areas of energy research that reflect California priorities in renewable energy and greenhouse gas emissions. The GGDISI collectively raise hundreds of millions annually for R&D focusing on four specific research areas selected by the state, but are represented in the budget by less than $5 million in operating costs, distributed through the UC. And the state's R&D tax credit, despite being scaled back by the state's budget woes, adds hundreds of millions to the total.

The state actually takes a substantially larger role in directing R&D funding in the state, but it is challenging to assess this role because it does not track these data as part of a comprehensive R&D strategy. With the rising importance of state-level policy in R&D and California's reliance on its high-tech sector, coordinating such a strategy seems a logical and beneficial approach.

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[45] Daniel J. Wilson, " Beggar Thy neighbor? The In-State vs. Out-of-State Impact of State R&D Tax Credits." Federal Reserve Bank of San Francisco Working Paper No. 2005-08, p.4.

[46] Lolita Paff, "State-Level R&D Tax Credits: A Firm-Level Analysis," Topics in Economic Analysis and Policy 5 (2005).

[47] Arizona Senate Bill 1434 and House Bill 2653.(http://www.azleg.gov/FormatDocument.asp?inDoc=/legtext/48leg/2r/bills/hb2653o.asp).

5. Building a New Understanding of California's R&D Spending

In order for California policymakers to effectively manage a comprehensive approach to R&D spending, it is necessary to clearly define the terms of what falls under the scope of its R&D strategy, and to build tools that will enable more effective analyses of the true impact of this spending.

Examining individual programs such as the UC Discovery Grant program and the GGDISI makes it clear that state R&D funding effectively leverages funding from other sources for California institutions and programs. However, establishing an overall measure of return is not feasible due to the variety of reporting methods and inconsistency of data availability between institutions. The UC Discovery Grant and GGDISI have succeeded in bringing in federal and industry dollars that not only match, but exceed the initial state expenditure by at least 30% (higher in the case of the GGDISI). And PIER, which uses economic benefits as a metric rather than matching R&D funds, estimates a similar rate of return to California residents. These programs and institutions are directing R&D dollars towards sectors deemed most likely to result in potential benefits to the state's economy (e.g. biotechnology, communications & networking, information technology, and nanotechnology).

State R&D funding is focused on areas of importance to California that may not be adequately supported by other sources.

CIRM is the single largest state-funded research program in the country, and its creation was a direct response to restrictions in federal R&D policies. PIER's focus on energy research was shifted in response to climate change concerns. California's R&D expenditures are often focused on fostering innovation in areas where applications may be years away. While federal funds have in recent decades funded most basic research in the United States, challenges in funding at the federal level have induced many states to take a more active role.

State R&D funding fosters collaboration and provides essential input into the innovation process.

The GGDISI were designed to be managed as regional centers of innovation, rather than specific to a given university; each is co-managed by more than one UC campus and is the nexus of a partnership that includes industry and the federal research community. The UC Discovery Grant program is designed to seed working relationships between academic and industry research communities. It is precisely this interconnectedness that is cited by the National Governor's Association and ASTRA as the key to generating and maintaining the health of the innovation process. R&D funding is only one input factor, but it is a critical one, and it represents one of the best opportunities for state policymakers to influence the process.

What does the state need to know?

A comprehensive list of R&D funding underway, not a representative sampling

The NSF survey did not reach every state agency in California (or other states), but concentrated on those that were deemed most likely to conduct R&D. Even with the assistance of state coordinators (in California, the Department of Finance) up to 40% of the surveys sent out reached agencies that did not actually conduct any. Other agencies may well have been missed. This provides state policymakers with a fragmented understanding at best of the state's overall R&D investment.

R&D funding by both program AND institution

Traditional statistics gathered by the NSB and NSF focus on funding distribution by institution and region. At a national level this makes sense, but for a state such as California with a limited number of mission-specific programs, these numbers fail to capture the true size of the state's investment. Both PIER and the Center for Information Technology Research in the Interest of Society contribute funding to energy related research; there is no ready way for policymakers to gauge the collective impact of these and other energy related R&D funding by the state, nor how they may impact California's greenhouse gas emissions goals.

How much of the state's total R&D funding is influenced by state spending

California's direct R&D spending is approximately one percent of the total R&D conducted in the state, but it is likely that a substantially larger percentage of the total is influenced, directly or indirectly, by the choices in R&D spending that the state makes and the areas it chooses to support, both through seeding programs and institutes and through its tax credit. As noted above, a cut of $2.5 million in funding for the IUCRP budget led to a corresponding reduction of $4.5 million in matching industry contributions. At present, it is not possible to fully understand the potential impacts of such decisions as the restriction of the R&D tax credit in the 2008-09 budget.

The state needs to collect these data in a consistent and centralized manner.

By taking a proactive role in defining what activities it considers R&D and requiring all stage agencies to report these expenditures in a consistent manner, California could significantly enhance its ability to make informed decisions about its overall R&D expenditures. Potential offices to collect these data include the Office of Planning and Research, the California Research Bureau, the Legislative Analyst's Office, and the Economic Strategy Panel. One model to consider is that of the Massachusetts Technology Collaborative, a quasi-public development agency that has worked with industry, academia, and the government to produce annual innovation indices since 1996.[48] While the MTC index does not focus on state R&D expenditures, it does provide important data on corporate and federal R&D within the state.

[48] http://masstech.org.

California has the right pieces, but it needs better data to focus optimally its R&D strategies. Other states are not standing still. While California remains a national leader in total federal and industry R&D expenditures, it ranked only third in the 2008 Milken index for R&D inputs, with a performance that remained "statistically unchanged" since the previous index, but nonetheless slipped as other states lobbied hard to attract federal research dollars and some succeeded on a per-capita basis.[49] As with any state program, long-term sustainability is important. Because the true effectiveness of state R&D funding depends upon leveraging funding from other sources, there is increasingly intense competition from other states seeking to attract the industry and federal R&D dollars that have been coming to California. It is not enough to tread water: California slipped in four of five categories tracked in the state science and technology index. Faced with potentially long-term budget limitations, the state needs to understand its R&D expenditures and priorities better in order to make the most of its finite resources. If it does not, other states certainly will.

[49] Milken Institute, *California's Position in Technology and Science*, p.6.

Appendix A: NSF Survey of State Research and Development Expenditures

The National Science Foundation provided funding to the U.S. Census Bureau to develop and conduct the FY 2006 survey, via a website survey. The survey was launched in November 2006 with a letter from the NSF Director, Dr. Arden Bement, to governors asking for each state's participation. The survey materials also included a letter of endorsement from the National Governors Association chair, Governor Janet Napolitano. Responses were collected through October 2007.

The survey covered state government departments, agencies, independent commissions, and other entities determined to be state-run. It excluded state-run colleges and universities, which are canvassed as part of the NSF Survey of R&D Expenditures at Colleges and Universities. The NSF surveyed a total of 416 state agencies nationwide, with a response rate of over 98%; of the respondents, 164 agencies, or 39.4%, reported no R&D activity.[50]

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NB that there are several caveats in comparing the results of the 2006 NSF survey with those of previous years, including those of CCST's previous reports. As the NSF notes, "Because of differences in the survey populations, definition of covered R&D activities, and collection methods, the results of previous NSF surveys on state government R&D are not comparable with the statistics collected on the FY 2006 Survey of State R&D Expenditures."[52] Further, it must be noted that this survey excludes academic institutions, which comprise the single largest group of institutions conducting R&D outside of private industry. The NSF survey is designed to assess total R&D conducted under the direct auspices of state agencies. This includes R&D conducted by a state agency but funded in whole or in part by federal funding.

[50] NSF, State Agency R&D Expenditures, Technical Table A-1. (http://www.nsf.gov/statistics/staterd/)
[51] NSF, State Agency R&D Expenditures, Technical Table A-1.
[52] NSF, State Agency R&D Expenditures, p.1.

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