APPENDIX 9

SILICON VALLEY:

Green Economic Potential

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INTRODUCTION

Since the 1970s Silicon Valley has been regarded as the world's leading center for technological innovation. But since the dot-com crash of the early 2000s, Silicon Valley has struggled to reinvent itself, first as a biotechnology center and a new wave of internet applications, Web 2.0, and most recently, as "a hotbed for clean technology" and green innovation (Joint Venture Silicon Valley Network 2009: 30-31). Regional leaders have sought to restore the economic vibrancy of the region by targeting industries with high growth potential to fuel the next wave of innovation. Will Silicon Valley be successful in innovating in the green economy? Will the assets that fueled innovation and growth in the information and communication technologies enable the region to position itself as leader in clean technologies as well? How is innovation in the green economy taking place in Silicon Valley at present? The goal of this report is to identify Silicon Valley's main historical assets with the potential to foster innovation in the green economy. It also aims at analyzing how innovation in green sectors is taking place at the moment.

This report uses quantitative and qualitative analysis to explore Silicon Valley from an economic development perspective. This report is divided into five sections. The first section provides main socio-economic indicators of the region. The second section gives a historical overview of Silicon Valley's economic history since WWII, with a focus on the evolution of its main industries and main economic actors. In the third part we analyze in more detail the economic structure of Silicon Valley of the last two decades through some economic indicators and a brief shift-share analysis. Part 4 is a review of key indicators of innovation in green sectors. Finally, section 5 looks at relevant green policies and regulations and examines the role of key regional actors in the promotion of the green economy. It also provides some insights on the characteristics of green innovation in Silicon Valley based on a series of interviews conducted with representatives of 15 organizations in the region.

For the purposes of this study we work with this definition of the green economy:

> "At its most basic level, the green economy is the clean energy economy, consisting primarily of four sectors: renewable energy (e.g. solar, wind, geothermal); green building and energy efficiency technology; energy-efficient infrastructure and transportation; and recycling and waste-to-energy. The green economy is not just about the ability to produce clean energy, but also technologies that allow cleaner production processes, as well as the growing market for products which consume less energy, from fluorescent light bulbs to organic and locally produced food. Thus, it might include products, processes, and services that reduce environmental impact or improve natural resource use." [1]

The definition of the geographical extension of Silicon Valley often varies. Some reports consider Silicon Valley to encompass Santa Clara and San Mateo counties (e.g. JV: SV's Index of Silicon Valley) while others take into account Santa Clara and San Benito Counties. Commute patterns bring in workers from San Francisco, San Mateo, San Benito, and Alameda counties. What is clear is that cities of Santa Clara County--San Jose, Mountain View, Cupertino and Sunnyvale--are central to the Valley's economy. Therefore, for the purposes of this report we focus on data for Santa Clara County except where indicated.

[1] Chapple, 2008.

Figure 1: Map of Santa Clara County

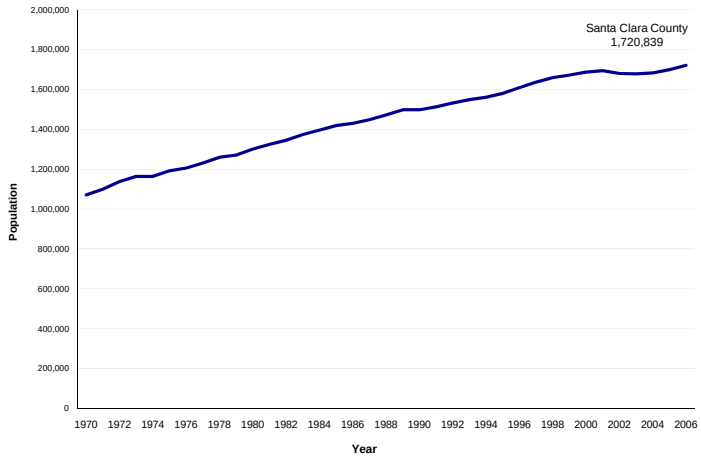
Source: www.siliconvalleyonline.org/images

DEMOGRAPHICS

POPULATION

As of 2006, the population of Santa Clara County was 1,720,839 people, a 4.7% of California's total population.

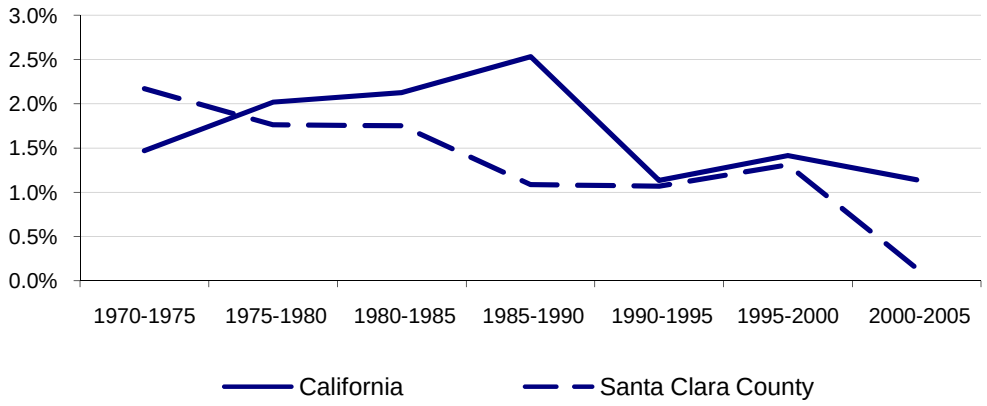
Figure 2: Total Population of Santa Clara County, 1970-2006



Source: Bureau of Economic Accounts, Table CA1-3 Population

Though it appears that Santa Clara County has experienced steady growth, Figure 3 below shows that Santa Clara County's population growth rate lagged California's from 1970 until 2005, except for the five-year interval of 1970 to 1975, coinciding with the rise of information technologies in Silicon Valley. The dot-com bust (2000-2005) accounts for the sluggish population increase in Santa Clara County.

Figure 3: Population Annual Average Growth Rate in California and Santa Clara, 1970-2005



Source: Bureau of Economic Accounts, Table: CA1-3 Population

RACE AND ETHNICITY

The racial/ethnic composition of Silicon Valley is highly diverse. Silicon Valley is no longer majority white, but is a majority minority region. Whites, Asians, and Latinos comprise the three largest ethnic groups in Santa Clara County (See Table 1).

Table 1: Race/Ethnicity in Silicon Valley, 2005-2007 (*)

	Santa Clara County		California	
	Number	**Percentage**	**Number**	**Percentage**
White	673,411	39.1%	15,593,822	43.0%
Black	43,318	2.5%	2,205,637	6.1%
Asian	510,285	29.6%	4,369,567	12.0%
Other	57,748	3.4%	1,140,906	3.1%
Hispanic	438,057	25.4%	12,954,535	35.7%
Total	1,722,819	100 %	36,264,467	100 %

(*) Represents the average characteristics over the 3-year period of time (2005-2007)
Other: American Indian and Alaska Native, NHOPI, some other race, 2 or more races

Source: US Census Bureau 2005-2007 American Community Survey

The percentage of foreign-born population residing in Santa Clara County is very high (37%), with a 22% coming from Asia, a 10% from Central America and a 3% from Europe. Together with San Francisco County, it has the highest percentage of Asian-born immigrants in the San Francisco Bay Area. Again, many observers suggest that the presence of an international community of high-tech workers improves the competitiveness in the region by connecting global knowledge, finance capital, and additional supply of workers.

EDUCATIONAL ATTAINMENT

As the population grew in the 1990s, it became more educated, showing lower rates of not graduating from high school and college, and higher rates of bachelor's and advanced degrees. These figures likely reflect the influx of high-skilled foreign workers during the dot-com boom.

Table 2: Educational Attainment in Santa Clara County, 1990-2000

	1990	2000
Less than 9th grade	8.0%	8.0%
9th-12th grade, no diploma	9.9%	8.6%
High school graduate (includes equivalency)	18.8%	15.9%
Some college, no degree	22.1%	19.6%
Associate degree	8.5%	7.4%
Bachelor's degree	20.5%	24.0%
Graduate or professional degree	12.0%	16.4%

Source: US Census Bureau 1990-2000

ECONOMIC HISTORY

1850S TO 1940S: FARMING AND AGRICULTURAL MANUFACTURING

Before the rise of the Silicon Valley, the Santa Clara Valley was home to some of the richest fruit growing land in the world. Turn-of-the-century boosters nicknamed the area, "The Valley of Heart's Delight," referencing the beauty of the orchards and the success of the agricultural economy. At the time, the region was home to the largest continuous area of fruit orchards in the world, 60 square miles of six thousand small, independent farms, mostly family owned (Sachs 1999).

But the arrival of the electronics industry and wartime and Cold War defense spending would trigger a radical transformation in the socioeconomic structure of the Valley. San Jose's population grew from over 57 thousand in 1930 to over 445 thousand in 1970 (Matthews 1999: 459-60). And while in 1960, the region was still home to over 200 fruit processing businesses like canneries and other agricultural light manufacturing, the agricultural sector would soon be replaced as the main driver of the region's economy.

1940S TO EARLY 1960S, THE MILITARY-INDUSTRIAL-RESEARCH UNIVERSITY COMPLEX: AEROSPACE AND TRANSISTOR RESEARCH, AGRICULTURAL AND AUTOMOBILE MANUFACTURING

The region did not boom in the same way that Los Angeles did during and after WWII, but the war laid the groundwork for the region's transformation that began in the 1950s. The area had suffered badly during the depression and a pro-growth coalition of local leaders sought to attract defense spending. Santa Clara County had received a naval base, Moffett Field, in the 1930s, and the agency that eventually became NASA established the Ames Research Center on the base's land. Food Machinery Corporation (FMC) and Handy Iron Works in the area were given wartime contracts and IBM built a punch card facility in San Jose during the war. Many of the veterans in the area stayed once the war was over (Matthews 1999: 460-61).

The wartime and Cold War research university was also an engine of economic development. Fred Terman, a professor of engineering at Stanford, had a unique relationship with the federal research and development monies and politics. He was able to attract federal defense funding from Washington through his contacts, notably Terman's former Professor at MIT Vaneevar Bush who had been recruited to run FDR's Office of Scientific Research and Development. Terman wanted to consolidate the Bay Area and Stanford's industrial and research base to match the dominance of the east coast defense-driven technology innovation and manufacturing that operated in MIT's orbit. He encouraged his graduate students, William Hewlett and David Packard, to commercialize an audio oscillator they built. HP, like other Silicon Valley firms that Terman supported, like Litton Industries and Varian Associates, expanded greatly under wartime defense contracts (Saxenian 1994: 20-21).

Terman also fostered ties between university and local industry actors through programs like the Stanford Research Institute, to do defense research in collaboration with business in the West, and the Honors Cooperative Program, which encouraged local engineers to enroll in evening courses. He also pushed for the creation of the Stanford Industrial Park that further encouraged collaboration between regional high-tech entrepreneurial activity and university research by housing firms on campus. Later, in the 1970s, Xerox put its Palo Alto Research Center (PARC) there. Terman succeeded in getting Lockheed to first put an R&D lab on the Stanford Park, and later convinced the company to put its missile facility in Sunnyvale, just to the southeast, complete with an agreement to share knowledge and resources between the university and the firm. Other firms that located in the Stanford cluster in the 1950s and 1960s include Westinghouse, Philco-Ford, Sylvania, Raytheon, ITT, and IBM. NASA set up its Ames Research Center at Moffett Field (Saxenian 1994: 24-25; Castilla et al. 2000).

Economic development in the region, then, emerged from a culture of open business development with Stanford's research institutions to promote local industry and services. These actors rolled out a unique town-gown, public private partnership that gave the Valley its special mixture of economic development with the fuel of federal defense spending and the motor of the research university's innovation and land use policies. (O'Mara 2005, see Chapter 3)

Local municipalities, notably San Jose, sought their slice of the pie. The San Jose chamber spent $1 million to sell land in the area to outside businesses, attracting the Ford plant from Richmond to Milpitas in 1953. Five years later, IBM upgraded its facility in the city to a much larger site. Local politicians got support from local voters for bond measures, and leveraged Sacramento and Washington for funding to build the infrastructure required for this new growth (Matthews 1999: 463). In all, during the period from the end of WWII to the early 1960s close ties were formed in Silicon Valley between an entrepreneurial research university, local defense facilities, and federal R&D, expanding private electronics and aerospace firms. Pro-growth municipalities played an important role in the process by through "business friendly" policies based on laissez-faire attitudes to land use and labor policies.

1960S TO EARLY 1980S: INTEGRATED CIRCUITS, SEMICONDUCTORS, MEMORY, AND PCS

By the 1960s, the aerospace and electronics industry was joined by semiconductor manufacturing. The semiconductor industry grew out of a rupture within Shockley Transistor in Palo Alto in the late 1950s. Several former employees founded Fairchild Semiconductor, which itself would spawn many well-known manufacturers. IBM was an early customer, but the firm generated major profits from contracts with the Air Force and NASA. Robert Noyce, Gordon Moore, and Andy Stern founded Intel from the ranks of Fairchild. Many of the semiconductor and venture capital firms that grew up in the region in this period drew a lineage to Fairchild (Castilla et al. 2000; Saxenian 1994: 25-26).

In the early 1970s, journalist Don Hoefler coined the phrase "Silicon Valley", based on the principal ingredient used in the material for semiconductors. By then, two major shifts were afoot in the Valley: a shift to semiconductor manufacturing as the major industry in the Valley (first to chips, then to high-value microprocessors), and a shift from federal defense contracting to consumer electronics. The recession of the early 1970s and cutbacks in Vietnam War spending caused the first major shift to consumer applications from defense-driven electronics (Collaborative Economics 2001: 9-12). Current and former scientists, engineers, and managers put their money to work investing in companies in the area. Stanford joined them in continuing its entrepreneurial activity with its own investment in local firms. The era of venture capital had begun, but the Valley would not officially wean itself from defense spending until major cutbacks following the end of the Cold War. The late Cold War decades in the 1970s and 1980s combined both large sums of federal defense spending that gave rise to the Valley's electronics industries in the 1950s and 1960s with a new breed of flexible entrepreneurialism that would come to characterize the venture capital-based high tech economy of the 1990s (Saxenian 1994, p.27).

One of the most noted technologies that grew out of this era was the integrated circuit, which evolved into the microprocessor, a transition that took from roughly the late 1950s to the early 1970s. Microprocessor innovations first grew out of the ranks of Shockley labs in the 1950s. The technology was drastically improved by Robert Noyce (founder of Intel) at Fairchild Semiconductor and Jack Kilby at Texas Instruments after semiconductors were made on silicon "chips." The process that is popularly now referred to as "Moore's Law" (after Gordon Moore, with Robert Noyce, co-founder of Intel, referring to the exponential increases in processing speeds) took over the industry. Year-by-year these increases in computing power made new revolutions in computing possible at the same time that production costs fell equally as drastically. With the invention of the microprocessor by an Intel engineer in the early 1970s, the process was well on its way to creating an industrial, cultural, and geographic paradigm shift in the Valley (Castells 1997: 40-41).

By the beginning of the 1980s, Silicon Valley had succeeded in wrangling national competitive advantage away from the older, traditional high-tech manufacturing center of Boston's Route 128 (Saxenian 1994). But by the 1980s Silicon Valley also faced new international competition, losing a share of the semiconductor memory market to Japan and South Korea. Once based on custom fabrication and short-run production, the Valley turned to price cutting and scale economies in its manufacturing. The Valley could not compete with Asia on predictable cost factors, and suffered in the long run from its investment strategy, ushering the loss in by having located manufacturing facilities in Asia and the Southern United States in the 1960s and 1970s (Saxenian 1994: 79-82). Though the Valley has maintained a high proportion of semiconductor manufacturing relative to the rest of the state through today, semiconductor manufacturing has seen a regional decline in employment numbers since the mid-1980s, never recovering from the blow to the memory market (Saxenian 1994: 2-9, 37-57).

Despite the decline of 200 thousand manufacturing jobs, foreign competition did not spell the end of the industry. Instead, new startups like Cypress emerged who had short run, custom fabrications for many specialized applications. They emphasized research and development and outsourced manufacturing when possible. This transition back to high value-added, short-run custom production operations brought the region back to economic health by the late 1980s. The Valley's manufacturing sector diversified and branched out into a range of other products, printers, hand-held devices, software firms, business services, disc drives, PCs, workstations, and customized chips (Saxenian 1994: 117-25). While Hewlett-Packard, Silicon Graphics, and Intel were major employers in the region, they increasingly looked to fragmenting their production processes to local contractors who enabled fast and flexible production runs, just-in-time inventory, and innovative input into the design process.

This economic and productive restructuring of Silicon Valley came along with another technological transformation. The microprocessor's invention led to the personal computer revolution from the mid-1970s to the early 1980s that spawned Apple Computer, Microsoft, and IBM's entry into the PC market. Apple's icon-based Macintosh came out in 1984, while Bill Gates' and Paul Allen's Microsoft came out in 1976, whose operating system would lead the market. This revolution would in turn laid the groundwork for the IT and internet revolution of the 1990s (Castells 1997: 41-42). According to Saxenian (1994, see Ch.6), the more advanced the electronics economy became in the Valley, the more it required and thrived on the blurring of boundaries between firms' production and design operations. Producers brought their suppliers to the table for designs, and encouraged them to find other customers to maintain autonomy and reduce risks that dependency on one customer threatened if that customer went out of business. Small firms stood to benefit from this networked contract outsourcing within the region, and startups proliferated in the 1980s.

Venture capital was increasingly a motor of the finance capital that made these processes happen in the 1980s. The culture of venture capital was pervasive in the Valley's semiconductor industry. Venture investors encouraged the companies in their portfolios to share ideas, to adopt similar technologies, and to invest in one another's companies (Saxenian 1994: 115). Former engineers became entrepreneurs. With their intimate knowledge of the technology and business, and their ready access to fast capital to invest, venture capital actors took an aggressive stance to promoting companies they created or with whom they partnered. They made suggestions into design, marketing, and management strategies. They acted as regional conveners for joint ventures. They were, in a sense, high-risk bankers who had intimate knowledge of the industry they were investing in, and who could make operational and strategic decisions about the direction that the company took (Saxenian 1994: 27-40).

1990s Boom: Information technology (IT), Semiconductor Manufacturing, Software Development and Biotechnology Research

The breakup of the Soviet Union and communist Eastern bloc countries brought with it a decline in the heyday of defense spending that characterized the Reagan years. The weaning of the Valley's reliance on defense spending accelerated in this period, notably with the consolidation and contraction of Lockheed (Lockheed-Martin after 1994). The firm's Bay Area employment declined from 24,800 in the mid-1980s when it was the largest private employer in Santa Clara County to 7,850 in Santa Clara and Santa Cruz Counties in 1999 (Quinn 1999; Herhold 1999). Other major federal defense contractors in the area saw similar declines: Ford Aerospace and Communications Corp., GTE Sylvania, FMC Corp. all saw huge decreases in their employment pools as defense spending declined to $2.8 billion in 1999 from a height of $5 billion in 1986 (Carey and Marshall 1999). The process of taking defense facilities, technology, and management and redeploying them for consumer electronics saw a major boom as the Valley shifted into high gear to maintain its competitive advantage. Yet, most of the employment was shielded because of the technology and skill transfer of defense manufacturing and services to that of consumer electronics and applications.

A volatile cluster of small internet-related firms comprised the majority of new economic activity during the 1990s. Small firm start-ups characterized the decade of the internet and software companies, and firms founded after 1990 accounted for all the economic growth in the region between 1990 and 2000. 29,000 new firms were founded in the decade, most of them with 0-4 employees. Many of these firms were start-ups, but many were also spin-off firms from existing medium and large firms; a high failure rate (up to 50%) prevailed (Zhang 2003). The region was undergoing a speeding up of the restructuring 20-year plus process of weaning itself from defense dollars to consumer-based electronics and related industries (Collaborative Economics 2001; Zhang 2003).

The 1990s were the era of the small-firm start up and wild speculation brought on by another major actor in the Valley, by then a traditional player: the venture capitalist. Venture capital funding took off in the 1980s and especially the 1990s with investments in internet-related industries (software, communications, consumer/business services), but also electronics, hardware, and the biotech industry. The internet boom was made up of many small start-ups of which many benefited from the local access to a network of VC firms that were themselves proliferating in number and significance. California, the Bay Area, and Silicon Valley (in ascending order of proportion) received larger proportions of venture capital when compared to other states, MSAs, and counties. With many local, small early-stage companies, VC had access to an array of opportunities (Zhang 2003: 32-37). When compared to other high tech regions around the country, VC and its firms were also exceptional in a number of other ways. VC-backed firms in the Valley got funding earlier, went through additional rounds of funding sooner, were more likely to be acquired or merge with a larger company, and were more likely to reach an IPO. Given the eventual dot-com bust, it is not surprising, however, that Valley VC-backed firms were less likely to be profitable when compared to other U.S. technology regions (Zhang 2003: 38-47).

Besides venture capital, the region increasingly boasted a host of business and professional services that played an important role in furthering the innovation capabilities of the region. The presence of large firms in accounting, legal, and financial services, some nationally-based (PricewaterhouseCoopers), some local (Wilson-Sonsini), have been recognized as an important asset in the capacity of the Valley to transform new knowledge and technologies into commercializable products and services (Castilla et al. 2000).

The rise of biotech, multimedia technology, and the internet that proliferated in the late 1990s drew on very similar regional assets to those that produced the rise of semiconductors and PCs. According to Manuel Castells (1997: 64-65), the region "learned by doing" through what others have called the Valley's "habitat" of multiple actors who have clustered together in a regional configuration that has produced waves of innovation (Collaborative Economics 2001). These actors include R&D facilities, research universities, high-tech companies, professional and business services, and venture capital firms. But while innovation in Silicon Valley relied heavily on its regional assets, local actors increasingly developed global synergies, establishing networks of capital and technological and business knowledge that transcended national boundaries and were sustained by its also increasingly global labor markets (Castells 1997; Saxenian 2006).

2000S BUST AND CRISIS: BIOTECH, WEB 2.0, AND HOPES FOR A GREEN FUTURE

The internet bust of 2000 to 2003 brought major restructuring in the economy of the region. Between 2001 and 2002, the region lost 127,000 jobs and saw unemployment climb from 1.7% in January of 2001 to 8.9% in October of 2002 (Zhang 2003; Collaborative Economics 2001). The bust also caused speculation about the competitive advantage of the region. Joint Venture: Silicon Valley Network produced a paper in which they promoted a new hybrid economy of collaborations between biotech, nanotech, and a variety of communications technologies. The paper posited that the downturn had been caused in large part by speculation that outran revenues in high-technology start-ups and suggested that the Valley build on its regional "habitat" of networked innovation and external economies, technology clusters to innovate around what it considered to be the next great wave of technological innovation: communications technology, including wireless applications; biotechnology, with applications that could be combined with IT; nanotech, also with combinatory technological possibilities for IT; and creative industries, though the Valley, the authors admitted, was not a hotbed of creative industries like design and architecture (Collaborative Economics 2001: 8-23).

And yet, biotech would not be the generator of jobs that IT in its various iterations had been—microprocessors, PCs, web applications. Biotech commands a lower market share of venture capital than IT-related industries, and has a much longer investment period and time-to-market. It exists almost exclusively in the orbit of the university, with a huge number of its entrepreneurs coming from research universities and holding PhDs in life sciences and related medical fields. It does not generate the same spillover effects for economic development that IT does, except with revenues generated from high salaries its employees earn. With these two combinations, an exclusive pool of entrepreneurs and limited spillover effects, its economic development effects do not translate into large shares for the employment market, thereby making it an important, but limited contributor to the region's economy (Zhang and Patel 2005).

The region had not, of course, lost many of the assets that created the possibility of such an extraordinary swell of innovation in the 1990s, even if it had lost most of the gains in jobs and investment from the early 1990s. The investors and entrepreneurs who survived the bust emerged to begin investing again in new opportunities, showing up alongside newcomers who were making it big in social networking websites like Twitter, Facebook, YouTube, Digg, and so forth (Rivlin 2005). By 2003, Santa Clara County, for example, had begun to bounce back from its weakened condition, and yet employment levels had only climbed back to 1995 levels by 2007 after they had reached a low for the years between 1990 and 2007 in 2004[1]. As the decade nears its close, it remains to be seen whether and how the regional economy will emerge from the decade of the dot-com bust and the mortgage crisis.

CHALLENGES TO ECONOMIC DEVELOPMENT: LAND USE, TRANSPORTATION, SOCIOECONOMIC INEQUITY

Though the region boasts many assets for a climate of innovation and entrepreneurial activity, it is faced with a number of challenges related to land use and infrastructure, especially housing and transportation; it is also faced with the challenge of income polarization and access to social and professional resources, like education. These issues grew in importance during the 1990s and continue to be issues for current economic development.[2] Indeed, among the top justifications provided by Joint Venture: Silicon Valley Network's 2009 outline report to launch its centerpiece green initiative, the Climate Prosperity Council, are lack of transit and congestion along with crowded land use that limits new business development (Joint Venture Silicon Valley Network 2009: 21-22).

These issues present challenges for firm location, both those existing or starting up in the Valley, and those companies outside who potentially could move to the Valley. The volatility of the region's economic growth in the 1990s meant the creation of numerous start-up companies that spun off from existing firms. Though these firms typically located in the region early in their life to make use of existing regional knowledge and networks and the region's external economies and assets, pressure on land use drove costs up for housing, office space, labor, and transportation. Quality of life suffered as a result, putting pressure on many firms to relocate. However, relocation out did not pose a threat in the near or short-term to employment numbers. More firms left the region during the decade than moved in, but this issue was offset by the creation of new firms (Zhang 2003: 53-72).

[1] Source: Bureau of Labor Statistics.

[2] See Joint Venture Silicon Valley, *Index of Silicon Valley,* which began in 1994 and has been released annually since. The Valley's labor policy and advocacy group, Working Partnerships, began releasing its own annual report on the state of the Valley in response to the business-driven *Index*. In response, Joint Venture began issuing social indicators as part of its *Index*. For a discussion of these organizations see Saxenian & Chinoy Dabby, 2004: 46-47.

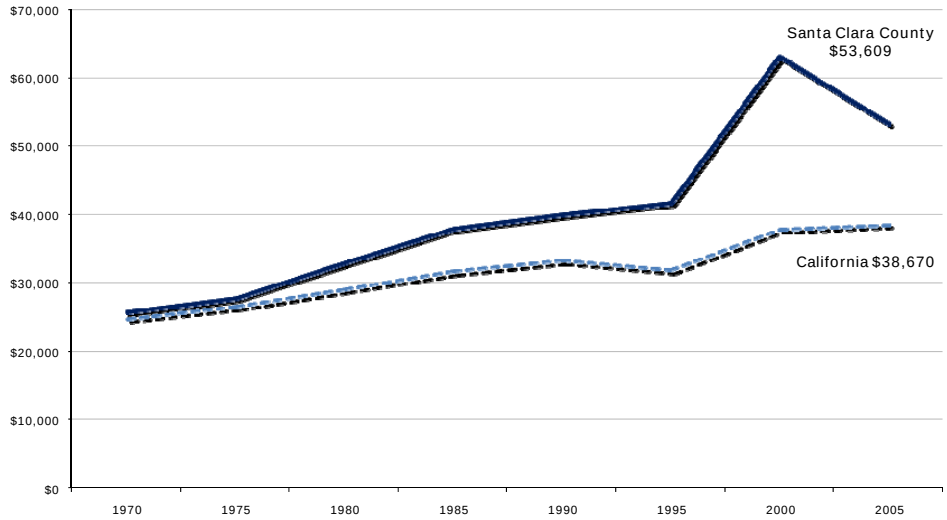
CURRENT ECONOMIC STRUCTURE

ECONOMIC INDICATORS

INCOME

Santa Clara County's electronics manufacturing and high-tech service industries produced overall high wages and incomes that grew well over California's figures (See Figure 4 below). State and county incomes (as a measure of total aggregate reported income) have consistently registered growth rates in the double-digit percentages through the 1970s and 1980s (for 5-year intervals 1970-1975; 1975-1980, and so on), in spite of the economy of "stagflation" during the 1970s and recession of the early 1980s. The income growth in Santa Clara County versus California from the 1970s through the 2000s is testament to the region's ability to generate personal wealth and to have weathered previous national economic downturns in the early 1980s and early 1990s. But the losses of the early 2000s also demonstrated that the Valley was not immune to instability. Income levels in the region were high, but they also took on big losses when the dot-com bubble burst. These figures however do not reflect the high cost of living or the lack of affordable housing and health care that continues to pose serious problems for the region. Joint Venture Silicon Valley and the Silicon Valley Leadership group both have struggled to identify policies that provide low cost health care and affordable housing to the region's workers.

Figure 4: Per Capita Real Income in Santa Clara County and California (in 2006 $)

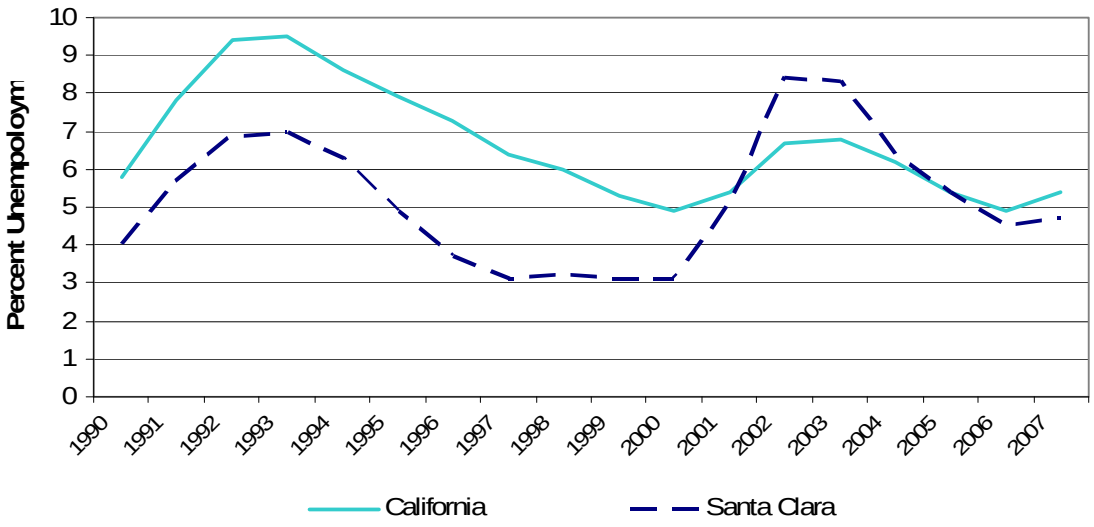


Source: Regional Economic Information System. Bureau of Economic Analysis, U.S. Department of Commerce

POVERTY AND UNEMPLOYMENT

Santa Clara County levels of poverty were significantly lower than California averages during the 1990s. For instance, while in 1999 Silicon Valley's poverty level was 7.6%, the rate for California was almost double at 14.2%. However, Santa Clara County shed jobs by the tens of thousands after 1999 and registered especially large losses after 2001. The peak of 958,642 jobs in 2001 dropped to a low of 824,247 jobs by 2005. Unemployment rates followed suit and Silicon Valley's job market was affected especially from 2001 until 2006 (See Figure 3). By 2007, before job losses hit the Bay Area due to the current economic decline, Santa Clara had only recovered to 1994 job levels, around 850,000 jobs.

Figure 5: Unemployment Rates in California and Santa Clara County, 1990-2007



Source: Bureau of Labor Statistics

SHIFT-SHARE ANALYSIS

Before addressing specific details of the green economy in Silicon Valley, it is important to establish a general understanding of the regional economy more broadly. In order to do so, this section uses two instruments widely used in regional economic analysis: location quotients and shift-share analysis.

- *Location Quotient* (LQ). This report calculated location quotients for all economic sectors in order to determine whether or not the regional economy (Santa Clara County) has a relatively greater (LQ>1) or lesser (LQ<1) concentration of that sector than California averages. Although LQ are useful for showing the sectors in which the region specializes, they do not explain the sources of change over time. They do not describe either how the performance of the regional economy differs from that of the state. Shift-share analysis indicators address some of these issues better.

- *Shift-Share Analysis* is a technique used in regional economics to measure the performance of a region compared to a larger geographic entity (state or nation for instance). For this report, we chose to compare the performance of the regional economy with that of California. The shift-share analysis featured in Table 4 below decomposes changes in employment levels in three categories in order to identify whether the sources of employment growth or decline in the region are specific to the state's overall employment growth trend (Economic Growth Factor), the sector performance (Proportional Shift), or the region's competitiveness (Differential Shift). Because sector effects and California growth rate are subtracted, the Differential Shift (DS) gives us a measure of the share of employment growth of every sector that can be considered specific to the region's competitive advantage.

Location quotients (LQs) and Differential Shifts (DS) are therefore indicators of the specialization and competitiveness, respectively, of the region in specific economic sectors (2-digit NAICS industries) or sub-sectors (3-digit NAICS industries).

Table 3: Total Employment and Wages in Santa Clara County by Economic Sector, 1990-2008

Economic Sectors (2-digit NAICS)	1990	2000	2008	% Change 90-08	Average Wage Bay Area (2006)
22 Manufacturing	260,399	241,190	**163,360**	-37%	$97,083
54 Professional and technical services	60,193	117,530	**114,054**	89%	$99,508
44-45 Retail trade	81,808	89,320	**83,176**	2%	$33,211
62 Health care and social assistance	49,068	61,598	**73,190**	49%	$52,755
72 Accommodation and food services	45,171	59,641	**63,994**	42%	$19,709
56 Administrative and waste services	46,214	75,541	**56,226**	22%	$39,781
23 Construction	35,502	44,158	**42,806**	21%	$56,528
51 Information	22,324	37,541	**41,481**	86%	$121,665
42 Wholesale trade	44,734	40,860	**40,027**	-11%	$73,264
81 Other services, except public administration	23,867	24,722	**31,804**	33%	$29,089
61 Educational services	21,270	22,630	**28,619**	35%	$45,680
52 Finance and insurance	22,338	18,641	**20,692**	-7%	$119,764
53 Real estate and rental and leasing	13,863	15,065	**15,797**	14%	$55,415
48-49 Transportation and warehousing	10,573	14,907	**10,993**	4%	$48,041
71 Arts, entertainment, and recreation	9,862	8,842	**9,659**	-2%	$35,875
55 Management of companies and enterprises	2,830	21,861	**9,440**	234%	$102,648
11 Agriculture, forestry, fishing and hunting	3,527	4,006	**3,239**	-8%	$27,447
99 Unclassified	N/A	N/A	**2,957**	N/A	N/A
22 Utilities	2,531	1,928	**1,872**	-26%	$83,383
21 Mining, quarrying, and oil and gas extraction	219	188	**254**	16%	$109,348
Total Employment	**756,293**	**900,171**	**813,641**	**8%**	

Source: Own calculations based on data from the US Bureau of Labor Statistics, US Quarterly Census of Employment and Wages, 2008.

In 2008, the largest providers of employment in Silicon Valley were Manufacturing (163,360 jobs), Professional and Technical Services (114,054), Retail Trade (83,176), Health Care and Social Assistance (73,190), and Accommodation and Food Services (63,994). One of the most remarkable aspects of the employment data in Silicon Valley is the importance of manufacturing. In the era of the service economy, manufacturing survives in the Valley, though it has declined significantly since 2000. The large number of manufacturing jobs speaks to the presence of IT manufacturing in the area (semiconductors, computer appliances, etc.). The fact that high-tech companies dominate the manufacturing industry, employing many engineers and highly qualified staff, might explain its high average wages ($97,083).

A shift-share analysis of Silicon Valley reveals more specific trends and dynamics of the regional economy. First, it confirms the decline of IT Manufacturing activities in the last ten years. Although still holding a high location quotient in 2008 (5.95), the DS of the sub-sector (3-digit NAICS) "Computer and Electronic Product Manufacturing" for the period 2000-2008 is -3.8% while the job growth for the same period is -32.2%. During 2009, numerous Silicon Valley chipmakers have announced substantial job cuts including National Semiconductor (1,725 jobs), Intel Corp. of Santa Clara (6,000 jobs), and Advanced Micro Devices of Sunnyvale (1,100 job cuts).

Table 4: Silicon Valley Economic Structure: Location Quotients and Shift-Share Analysis, 1990-2008

	Santa Clara Employment			Santa Clara Location Quotient			California Employment			Shift-Share 1990-2000				Shift-Share 2000-2008			
Industry Title (2-digit NAICS)	1990	2000	2008	1990	2000	2008	1990	2000	2008	Econ. Growth Factor	Prop. Shift	DS	Job Growth	Econ. Growth Factor	Prop. Shift	DS	Job Growth
11 Agriculture, forestry, fishing and hunting	3,527	4,006	3,239	0.18	0.17	0.17	280,936	319,020	306,727	11.6%	1.9%	0.0%	13.6%	5.7%	-9.6%	-15.3%	-19.1%
21 Mining, quarrying, and oil and gas extraction	219	188	254	0.08	0.12	0.16	37,455	22,025	25,678	11.6%	-52.8%	26.9%	-14.3%	5.7%	10.9%	18.5%	35.1%
22 Utilities	2,531	1,928	1,872	0.55	0.46	0.51	66,502	56,791	58,584	11.6%	-26.2%	-9.2%	-23.8%	5.7%	-2.6%	-6.1%	-2.9%
23 Construction	35,502	44,158	42,806	0.74	0.88	0.85	692,291	682,072	799,846	11.6%	-13.1%	25.9%	24.4%	5.7%	11.6%	-20.3%	-3.1%
31-33 Manufacturing	260,399	241,190	163,360	1.84	1.79	1.83	2,059,262	1,830,809	1,423,273	11.6%	-22.7%	3.7%	-7.4%	5.7%	-28.0%	-10.0%	-32.3%
42 Wholesale trade	44,734	40,860	40,027	1.05	0.87	0.90	618,668	636,648	709,499	11.6%	-8.7%	-11.6%	-8.7%	5.7%	5.7%	-13.5%	-2.0%
44-45 Retail trade	81,808	89,320	83,176	0.79	0.80	0.80	1,495,330	1,527,619	1,650,261	11.6%	-9.5%	7.0%	9.2%	5.7%	2.3%	-14.9%	-6.9%
48-49 Transportation and warehousing	10,573	14,907	10,993	0.46	0.46	0.41	330,565	438,163	429,401	11.6%	20.9%	8.4%	41.0%	5.7%	-7.7%	-24.3%	-26.3%
51 Information	22,324	37,541	41,481	0.79	0.98	1.43	412,306	519,849	463,001	11.6%	14.5%	42.1%	68.2%	5.7%	-16.7%	21.4%	10.5%
52 Finance and insurance	22,338	18,641	20,692	0.53	0.48	0.56	617,510	532,039	584,404	11.6%	-25.5%	-2.7%	-16.6%	5.7%	4.1%	1.2%	11.0%
53 Real estate and rental and leasing	13,863	15,065	15,797	0.77	0.79	0.92	259,926	259,876	274,938	11.6%	-11.6%	8.7%	8.7%	5.7%	0.1%	-0.9%	4.9%
54 Professional and technical services	60,193	117,530	114,054	1.19	1.74	1.68	733,850	918,781	1,079,218	11.6%	13.6%	70.1%	95.3%	5.7%	11.7%	-20.4%	-3.0%
55 Management of companies	2,830	21,861	9,440	0.88	0.90	0.73	46,728	329,758	207,230	11.6%	594.1%	66.9%	672.6%	5.7%	-42.9%	-19.7%	-56.8%
56 Administrative and waste services	46,214	75,541	56,226	1.05	1.08	0.94	636,334	950,818	949,066	11.6%	37.8%	14.0%	63.5%	5.7%	-5.9%	-25.4%	-25.6%
61 Educational services	21,270	22,630	28,619	1.83	1.52	1.67	169,118	202,073	273,063	11.6%	7.9%	-13.1%	6.4%	5.7%	29.4%	-8.7%	26.5%
62 Health care and social assistance	49,068	61,598	73,190	0.78	0.73	0.84	916,984	1,150,609	1,394,541	11.6%	13.8%	0.1%	25.5%	5.7%	15.5%	-2.4%	18.8%
71 Arts, entertainment, and recreation	9,862	8,842	9,659	0.71	0.56	0.63	202,532	216,414	243,156	11.6%	-4.8%	-17.2%	-10.3%	5.7%	6.6%	-3.1%	9.2%
72 Accommodation and food services	45,171	59,641	63,994	0.70	0.75	0.79	942,753	1,086,367	1,293,794	11.6%	3.6%	16.8%	32.0%	5.7%	13.4%	-11.8%	7.3%
81 Other services, except public administration	23,867	24,722	31,804	0.77	0.61	0.70	451,706	554,226	723,092	11.6%	11.1%	-19.1%	3.6%	5.7%	24.8%	-1.8%	28.6%
99 Unclassified	N/A	N/A	2,957	N/A	N/A	0.68	N/A	N/A	69,714	11.6%	N/A	N/A	N/A	5.7%	N/A	N/A	N/A
Total, all industries	**756,614**	**900,190**	**813,641**	**1.00**	**1.00**	**1.00**	**10,980,978**	**12,257,882**	**12,958,485**	**11.6%**	**0.0%**	**7.3%**	**19.0%**	**5.7%**	**0.0%**	**-15.3%**	**-9.6%**

Source: US Bureau of Labor Statistics, Quarterly Census of Employment and Wages, 2008. Calculations by UC Berkeley Center for Community Innovation

The IT industry began with the development of faster microprocessors, semiconductors, and personal computers, but it has increasingly shifted its focus to software and internet-related services. This fact is related to the globalization of the IT supply chain and the increasing competitiveness of East Asia in IT manufacturing. The employment data analyzed suggest that highly specialized IT Services, such as computer system design and other software-related industries, have remained in the Silicon Valley while manufacturing is being outsourced.

Apple's iPod provides an example of these trends. While the box that comes with every iPod has a proudly printed "Designed in California" label, the value of the parts actually manufactured in the US account for only $18 of the $299[1] retail price (Greg, Kraemer, and Dedrick 2007). The rest of parts are manufactured in China, Taiwan, Korea and Japan. However, Apple's gross profit per unit is $80 (out of $299), a profit greater than the price of any single input manufactured by any of its partners in Asia. Therefore, while iPods are not manufactured in Silicon Valley, Apple still keeps an important part of its staff in Cupertino working in issues related to IT Services like research and development, design, etc. In short, although Silicon Valley maintains its legacy in hardware development and manufacturing, the region has now a more balanced mix of IT manufacturing and IT service jobs.

The manufacturing sector has however rapidly been losing jobs since the 1990s and is the big loser of the economic restructuring process in the last decade. Our findings also indicate that income polarization poses a crucial challenge to the Valley's job market. Between 1990 and 2008, there has been rapid growth of those sectors with higher average wages (Professional and Technical Services [$99,508], Information [$121,665] or Management of Companies [$102,648]), and, at the same time, of those with lower average wages (Food Service [$19,709] or Other Services [$29,089]).

Table 5: Top 5 Economic Sub-Sectors (3-digit NAICS) in Silicon Valley by Total Employment, 1990-2008

Economic Sub-sectors (3-digit NAICS)	1990	2000	2,008	% Change 90-08
Professional and Technical Services	60,193	117,530	**114,054**	**89%**
Computer and electronic product manufacturing	173,503	164,985	**111,928**	**-35%**
Food services and drinking places	37,850	51,535	**55,570**	**47%**
Administrative and support services	44,864	73,576	**54,358**	**21%**
Specialty trade contractors	23,847	32,885	**30,253**	**27%**

Source: US Bureau of Labor Statistics, US Quarterly Census of Employment and Wages, 2008

[1] Price for a 30 GB iPod in 2007

Table 6: Top 10 Economic Sub-Sectors (3-digit NAICS) in Silicon Valley by Total Employment, 1990-2008

	Total Employment Silicon Valley			Silicon Valley Location Quotients			Shift-Share 2000-2008			
Industry Title (NAICS 3-digit)	1990	2000	2008	1990	2000	2008	Econ. Growth Factor	Prop. Shift	DS	Silicon Valley Job Growth
541 Professional and Technical Services	60,193	117,530	**114,054**	1.19	1.74	**1.68**	5.7%	11.7%	**-20.4%**	-3.0%
334 Computer and electronic product manufacturing	173,503	164,985	**111,928**	5.29	5.37	**5.95**	5.7%	-34.0%	**-3.8%**	-32.2%
722 Food services and drinking places	37,850	51,535	**55,570**	0.74	0.78	**0.82**	5.7%	15.5%	**-13.4%**	7.8%
561 Administrative and support services	44,864	73,576	**54,358**	1.08	1.09	**0.95**	5.7%	-6.7%	**-25.2%**	-26.1%
238 Specialty trade contractors	23,847	32,885	**30,253**	0.82	1.00	**0.92**	5.7%	11.6%	**-25.3%**	-8.0%
611 Educational services	21,270	22,630	**28,619**	1.83	1.52	**1.67**	5.7%	29.4%	**-8.7%**	26.5%
423 Merchant wholesalers, durable goods	27,974	30,262	**27,830**	1.20	1.14	**1.26**	5.7%	-8.3%	**-5.5%**	-8.0%
621 Ambulatory health care services	21,351	25,819	**26,292**	0.85	0.77	**0.74**	5.7%	17.3%	**-21.1%**	1.8%
622 Hospitals	11,448	17,729	**24,176**	0.58	0.74	**0.98**	5.7%	14.6%	**16.1%**	36.4%
445 Food and beverage stores	13,324	15,654	**15,433**	0.66	0.71	**0.74**	5.7%	5.4%	**-12.5%**	-1.4%

Source: US Bureau of Labor Statistics, Quarterly Census of Employment and Wages, 2008. Calculations by UC Berkeley Center for Community Innovation

Other sub-sectors at the 3-digit NAICS level with high location quotients in 2008 include: “Professional & Technical Services” (1.68), “Educational Services” (1.67), and “Merchant Wholesalers, Durable Goods” (1.26). All of the top 10 sub-sectors by employment in Silicon Valley however have negative differential shifts. Declining sub-sectors in the region, apart from “IT Manufacturing”, include “Administrative and Support Services” and “Merchant Wholesalers”. These three sectors represented a total of 194,116 jobs in 2008 (24% of total employment). In contrast, five sub-sectors showed a positive performance including Hospitals, Other Information Services, Food Services and Drinking, Educational Services and Ambulatory Health Care Services. They also confirm the tendency towards the polarization of wages in Silicon Valley, as both IT Services (one of the highest average wages) and Food Services (lowest average wage) are on the rise.

THE GREEN ECONOMY IN NUMBERS

GREEN EMPLOYMENT AND ESTABLISHMENTS

This report provides figures on green employment and establishments in Silicon Valley for 1990, 2000, and 2008. For each year, employment levels, average annual growth rates (AAGR), and location quotients (LQ) are presented for six different green sectors: energy research and services, environmental services, green building, green transportation, green manufacturing, and recycling/remediation. This section considers Silicon Valley as the sum of Santa Clara County and San Benito County.

Table 7: Green Economy Summary for Silicon Valley, 1990, 2000, 2008

	Green Employment								Green Establishments							
	1990	LQ	2000	LQ	2008	LQ	Region AAGR 90-08	State AAGR 90-08	1990	LQ	2000	LQ	2008	LQ	Avg. Est. Size, 2008	Region AAGR 90-08	State AAGR 90-08
Energy Research and Services	133	0.1	233	0.2	246	0.2	3.5%	1.7%	20	0.5	38	1.4	44	1.3	5.6	4.7%	4.7%
Environmental Services	842	0.4	1,211	0.6	1,367	0.6	2.7%	3.9%	82	1.2	181	1.0	175	0.9	7.8	4.6%	5.9%
Green Building	1338	2.2	2,044	3.2	2,411	2.8	3.3%	2.3%	46	1.7	36	1.1	67	1.5	36.0	2.2%	1.4%
Green Manufacturing	939	0.6	887	0.5	868	0.7	-0.4%	0.0%	52	1.4	44	1.2	58	1.5	15.0	0.6%	2.0%
Green Transportation	178	0.1	365	0.1	473	0.2	5.6%	0.8%	10	0.2	38	0.9	51	0.8	9.3	10.1%	5.8%
Recycling / Remediation	721	0.3	805	0.3	756	0.4	0.3%	1.1%	91	1.5	97	0.8	122	0.9	6.2	1.7%	3.3%
Total Green	4,151		5,545		6,121		2.2%	1.6%	301		434		517		11.8	3.2%	4.2%

Source: NETS

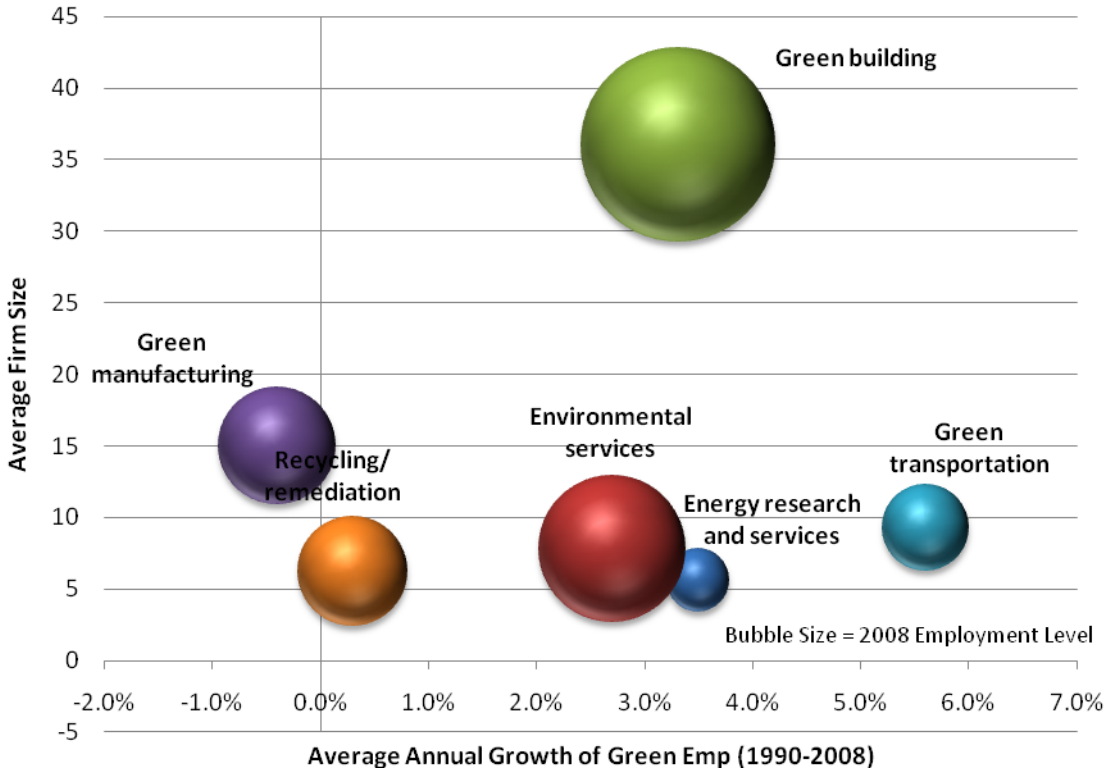
In 2008, there were over 500 green businesses in Silicon Valley.[5] Green sectors employed in that year a total of 6,121 people in the region.[6] This represents 3.7% of all green employment in California. Silicon Valley has had higher growth rates than the state as a whole in green employment. The region has a significant high concentration in Green Building activities (employment location quotient equals 2.8 in 2008). Green Building is the sector that provides the most jobs in Silicon Valley, with a total of 2,277 jobs in 2008. This represents 37% of all green employment in the Valley in that year.

In general terms, Green Transportation, Green Building, and Energy Research and Services are the sectors with the highest growth rates in employment in Silicon Valley, followed closely by Environmental Services. Green Manufacturing and Recycling/Remediation are essentially stagnant. However, it should be noted that many existing manufacturing companies in the Valley are shifting into green products, but may not be captured by our data if they have not changed their industrial classification. Figure 7 below offers a glimpse into the relationship between firm size, total sector employment and the growth of each green sector from 1990 to 2008.

[5] Data compiled from multiple databases including the National Establishment Time Series (Dun & Bradstreet) database and the Build it Green directory

[6] National Establishment Time Series (Dun & Bradstreet) data

Figure 7: Silicon Valley Green Manufacturing Growth and Firm Size by Sector, 1990-2008



Source: National Establishment Time Series (Dun & Bradstreet) data. Calculations by UC Berkeley Center for Community Innovation

GREEN INNOVATION AND INVESTMENT INDICATORS

Silicon Valley accounts for 31% of all clean tech investment in the United States and 55% in California (Joint Venture Silicon Valley Network 2009). The availability of venture capital and angel investors willing to invest in promising high-growth sectors is one of the most defining assets of Silicon Valley. In the face of the decline of IT and semiconductor manufacturing in the Valley, there has been a remarkable diversion of venture capital to clean technologies in recent years. For example, in the webpage of an important VC firm headquartered in Silicon Valley, investment in clean tech is regarded as a "burgeoning opportunity":

> "We have nearly $5 billion of committed capital and since our inception in 1996, we have made substantial investments in Information Technology and Healthcare. We recently made a serious commitment to Asia with teams in Hong Kong and Beijing. Our expertise in these arenas give us a foundation of knowledge that is transferable and complementary to new industries like clean tech. We were the first large venture capital firm to recognize the opportunity here and have since committed $1 billion for this burgeoning opportunity"
>
> Source: Vantage Point Venture Partners webpage (http://www.vpvp.com/about_us) (Accessed March 30th 2009)

From 2000 to 2008, the region was the preferred destination in California of clean tech venture capital investment with a total of 827 million dollars. The patent activity of the Valley is remarkable. With a

population of less than two million people, Silicon Valley accounts for more than 50% of all the state patents. Yet, it accounts for only 23% of clean tech patents in California, showing how the innovation capacity of Silicon Valley is not mostly focused in clean tech but rather include a broad range of areas. According to the composite innovation ranking elaborated for this report, the region ranks second in green innovation in California after Los Angeles.

Table 8: Silicon Valley Green Innovation and Investment Indicators, 2000-2008

Patent Activity, 2000-08[1]			Venture Capital Investments 2000-08 ($millions)[2]			SBIR/STTR Grants, 2000-08[3]			Green Startups, 2000-07[4]			Green Gazelles 2008 [4]		
Clean-tech	% of State Overall	% of State Clean-tech	Clean-tech ($)	% of State Overall	% of State Clean-tech	Clean-tech Grants	% of State Overall	% of State Clean-tech	Green Start-ups	% of State Overall	% of State Green	Green Gazelles	% of State Overall	% of State Green
245	51.8	23.2	827	36.1	30.7	5	12	11	315	5.0	4.4	168	5.0	4.6

Sources: 1) USPTO, 2) VentureExpert; 3) US Small Business Administration, 4) NETS. CCI Calculations

THE GREEN ECONOMY ON THE GROUND: INSTITUTIONS, NETWORKS, AND INITIATIVES

SILICON VALLEY'S KEY ACTORS IN THE GREEN ECONOMY

Just as in previous waves of innovation, Silicon Valley hosts a rich array of institutions, networks and initiatives focusing on building regional capacity to compete in the green economy.

JOINT VENTURE: SILICON VALLEY NETWORK

Joint Venture: Silicon Valley Network (JV:SV) is a public-private partnership founded in the early 1990s in response to the downturn in the national and regional economy that resulted from the decline in defense spending. The organization was established following a venture capital model of creating initiatives principally around economic development projects. The internal management of the initiatives operated as flexible, networked projects that had relative autonomy, and were funded or dropped based on their performance. Initiatives were created out of member interest, and were fostered through collaborations that networked outside the walls of the organization, directed only in part by JV:SV staff (Saxenian and Dabby 2004: 34-36). JV:SV was successful in bringing together actors from education, government, and business. These cross-jurisdictional and cross-sector initiatives comprised innovative solutions to regional economic development problems. While these actors were often suspicious of one another in other regions, they successfully collaborated through JV:SV on projects that included educational programs, permit streamlining, expanding computer, internet, and wireless access, health care, workforce development, a defense and aerospace consortium, livability and environmental projects, incubator and business development projects, and the annual meetings at which the *Index* is presented (1995 to present) (Saxenian and Dabby 2004).

The organization succeeded in establishing itself as a crucial regional influence, establishing the organization as a credible "command and control" actor that could convene and facilitate regional initiatives across jurisdictions and sectors. This process accomplished several goals: the creation of a regional identity legitimated Silicon Valley as a place with a coherent identity; its members and participants benefited from gains in social capital through the networks it provided in its initiatives; and the JV:SV *Index of Silicon Valley*, a research report of economic and social indicators, commented on the region's health and drew broad regional and international interest. The report established JV:SV as a brand synonymous with the Valley, and standardized and increased economic research as a reference tool for the region's nonprofit, business, government actors. An annual conference where the document is unveiled draws hundreds of the Valley's main players (Saxenian and Dabby 2004: 14-16; 23-24, 54). The organization has struggled in recent years, but continues its annual meeting around the *Index*, and has a full program of initiatives, now placing a strong emphasis on the emerging green economy.

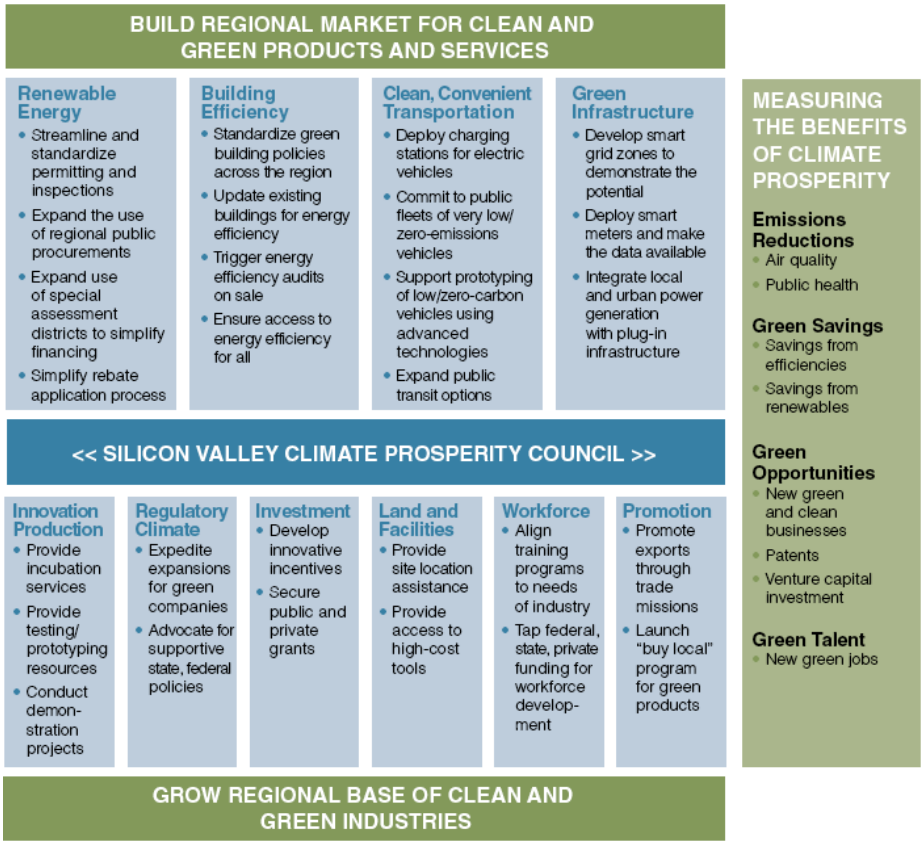
Following Morgan's departure, the organization struggled to put together initiatives from 1998 to 2001, and lost the business allegiances that drove its funding, managerial, and network support through the 1990s. In 2001, Russell Hancock took over the lead of the organization, and has made an effort to return to some of the organization's original emphasis on business, but adding in initiatives that included equity, livability, and the environment (Saxenian and Dabby 2004: 43-45). Its current set of programs mirrors its strategy in the 1990s of a wide-ranging set of initiatives based on a venture capital model of management and execution: an autonomous project emerges through a diverse board and is developed through a network of regional actors. Some of these projects are, California Competes, a state-wide innovation promotion project; improving cell phone coverage; Climate Protection, a project to help regional public agencies to identify greenhouse gas lowering technologies and to implement them;

Disaster Preparedness; Grand Boulevard to develop the El Camino as a vibrant thoroughfare; New California Network, a project to reform the state's public revenue streams; Silicon Valley Economic Development Alliance, a project to share best practices and to promote the region outside the area; Smart Health, a project to improve the information systems in health care; Smart Valley, a project to build local communications infrastructure; and Wireless Silicon Valley, a task force collaborative between local IT managers and public officials.[7]

CLIMATE PROSPERITY COUNCIL

The 2009 version of the State of the Valley Conference, where the annual *Index of Silicon Valley* was released, also showcased a new document, "Climate Prosperity: A Greenprint for Silicon Valley" (Greenprint). The document provided a companion to the longer *Index*, laying the groundwork for a JV:SV-led initiative called the Climate Prosperity Council, itself led by a working group consisting of leaders in manufacturing, university research, local government and utilities, R&D, and management. The initiative plan establishes two central goals—building a regional market for products and services and growing a regional base of industries--and takes stock of regional assets and current programs under way that will support these goals.

Figure 12: Joint Venture Silicon Valley and Climate Prosperity Council Strategic Framework



Source: Climate Prosperity: A Greenprint for Silicon Valley (2009)
http://www.jointventure.org/programs-initiatives/climateprosperity/climateprosperity.html

[7] http://www.jointventure.org/aboutus/overview.html (accessed April 10, 2009).

The *Climate Prosperity Report: A Greenprint for Silicon Valley*, unveiled at the 2009 State of the Valley Conference, claimed that Silicon Valley "was blessed" with a long list of assets to lead the world in developing the green economy. Among those they included (Joint Venture Silicon Valley Network 2009):

- A thriving, diverse clean tech cluster supported by entrepreneurs and venture capitalists
- Major corporations that are diversifying to serve the clean and green markets (e.g. Google or Applied Materials) and others that are introducing world-changing clean tech products (Nanosolar, Better Place or Tesla Motors for instance)
- Research programs at Stanford, UC Santa Cruz, UC Berkeley, Lawrence Livermore and Lawrence Berkeley National Labs and the Electric Power Research Institute
- Utilities that are leading the way in reducing the use of fossil fuels for electricity generation
- Local government agencies that are developing innovative policies
- Numerous nonprofits and volunteers that are championing the case of environmental protection, recycling, energy and water conservation
- Community colleges, labor unions, and workforce development programs that are already helping people prepare for a full range of clean and green jobs

SILICON VALLEY LEADERSHIP GROUP

The Silicon Valley Leadership Group's (SVLG) regional mission approximates that of JV:SV, causing some popular confusion between the two. Because they both adopt and phase out projects with some frequency, and work on initiatives having disparate themes and missions, some of which are closely linked and similar, the confusion is understandable. Where JV:SV's initiatives arise primarily out of collaboration between business, government, and education, the SVLG's agenda arises out of its constituency primarily of private-sector allies and members. This has led some observers to suggest that the SVLG's mission has historically taken a narrower set of interests. According to Saxenian and Chinoy Dabby (2004: 44-46) SVLG was historically focused primarily on physical projects: housing and transportation infrastructure primarily. At the founding of JV:SV, to limit overlap, the organizations agreed that the mission of the SVLG (called the Silicon Valley Manufacturers' Group until 2001) would focus primarily on transportation and housing. However, at present the SVLG's agenda covers all major public policy issues, from economic vitality, workforce development, and education to energy, environment, health, housing, and transportation. And while its constituency is composed by principal officers and senior managers of member companies, they work in a collaborative effort with government officials at all levels in order to address problems affecting economic health and quality of life in Silicon Valley.

In relation to the green economy, the two organizations compete with one another for resources and certain aspects of their programs, and it remains to be seen if the organizations will coordinate or double-count their work in this area. The Leadership Group's major initiatives around the green economy fall under the rubric of "Clean and Green: Alternative Energy Action Plan," which includes several projects. Carl Guardino, SVLG CEO, was instrumental in passing the Bay Area Climate Change Compact, an agreement between the mayors of San Francisco, Oakland, and San Jose to form public-private partnerships to address climate change, and to hold up a list of ten principles for greening their city, including green workforce development, citywide energy use, information availability and planning shifts, transportation and infrastructure projects, and green building practices (Bishop 2009). Other projects include Cool Commutes, a competition among the employees of large regional corporations to reduce greenhouse gasses; Green Building, to streamline cities' practices and standards for green

building; a celebrity, CEO bike-to-work day; market creation for Plug-In Hybrid Electric Vehicles (PHEVs) and Electric Vehicles (EVs); SolarTech, a business association for the solar industry; energy efficient data centers; BART to San Jose; California High Speed Rail; Supply Chain Efficiency; Sustainable Silicon Valley, a nonprofit that promotes voluntary energy efficiency among small and medium sized businesses; and Energy Watch Partnership between SVLG and PG&E to offer free energy audits and to outline retrofit project cost-benefit analysis and facilitate rebates and incentives (Silicon Valley Leadership Group 2009). The SVLG played a major role in advocating and lobbying for BART to San Jose, winning the passage of sales tax hikes in both 2000 and 2008. They were also successful in lobbying state voters for the passage of the California High-Speed Rail Act. The Leadership group has played a major role in not only convening regional actors, but also in using the clout of the "association" to convene state and federal officials. They played a role in shaping the AB32 legislation, and also have relationships at the federal level.

CITY OF SAN JOSE

The City of San Jose has a checkered past with regard to its environmental history. It is home to the largest number of Superfund sites in the nation, due to groundwater pollution from semiconductor firms, belying the notion that high tech is automatically clean tech. Though manufacturing has cleaned up its act since the mid-1990s with groundwater pollution, the Environmental Protection Agency (EPA) reports that air pollution has showed little improvements in the Valley. The Silicon Valley Toxics Coalition has reported that a majority share of the electronics products produced in the Valley will end up in landfills, posing significant environmental hazards (Evans 2004; Pellow and Park 2002).

Under Mayor Chuck Reed, the city has taken on some ambitious goals to make the city a role model for the kinds of clean and green firms it hopes to attract and keep. Reed was a signatory of the recent "Mayors' Compact" between San Francisco, Oakland, San Jose and major regional policy actors: the Bay Area Air Quality Management District (BAAQMD), JV:SV, the SVLG, the Bay Council, and Association of Bay Area Governments (ABAG). Using San Jose as an example, the Public Policy Institute of California has found that California cities that adopt these partnerships are more likely to put enough resources behind the rhetoric to enact concrete programs and policies (Hanack et. al. 2008). The Mayor's "Green Vision" outlines some ambitious goals for reducing global greenhouse gasses and for attracting and keeping investment. The idea, similar to that offered in JV:SV's Greenprint, is that there is a close relationship between local market culture and consumer practice and the industrial export base. The 10-point plan approximates the Mayors' Compact, and outlines 15-year goals for the city:
"The City of San José in tandem with its residents and businesses will:[8]

1. Create 25,000 cleantech jobs as the world center of cleantech Innovation
2. Reduce per capita energy use by 50 percent
3. Receive 100 percent of our electrical power from clean renewable sources
4. Build or retrofit 50 million square feet of green buildings
5. Divert 100 percent of the waste from our landfill and convert waste to energy
6. Recycle or beneficially reuse 100% of our wastewater (100 million gallons per day)
7. Adopt a General Plan with measurable standards for sustainable development
8. Ensure that 100 percent of public fleet vehicles run on alternative fuels
9. Plant 100,000 new trees and replace 100% of our streetlights with smart, zero-emission lighting
10. Create 100 miles of interconnected trails"

[8] San Jose's Mayor's Green Vision.
http://www.sanjoseca.gov/mayor/goals/environment/GreenVision/GreenVision.asp Accessed April 17, 2009.

ANGEL AND VENTURE CAPITAL INVESTMENT

As mentioned in section 4 above, Silicon Valley is the region with highest levels of venture capital investment, with increasing levels of that investment going to green/clean technologies. The shift of the investment community towards green/clean technologies presented in the quantitative data section is confirmed by the findings of the interviews conducted in the region. Our interviews reveal that the investment community in Silicon Valley is shifting its attention from information and bio technologies to clean tech.

> "I think the most successful VC firms in the world are here in Silicon Valley. I think out of the top 10 VC firms in the world, almost 2/3 of them have embraced clean tech. So there's a significant amount of capital available for venture funded clean tech companies here in Silicon Valley."
>
> Executive of a Clean Tech Venture Capital Firm

Similarly, the angel capital community has been moving swiftly to take advantage of the emerging opportunities in the green economy. The Keiretsu Forum, the world's largest angel investor network operating in eighteen chapters in three continents and with 750 accredited investors, installed the Clean Tech Investment Committee in 2006. This committee aims at funding companies with a focus on recycling, environmental clean up, renewable energy production, energy storage, and energy efficiency techniques. Members of this committee have also been active participants in the national steering committee of the Clean Economy Network, a national advocacy association for the clean tech and green business community based in Washington D.C.

> "Keiretsu Forum is a membership-driven organization. Typically investors invest in things that they understand or have passion about. And my personal passion for many years in my professional life has been in regards to clean technologies and sustainability. So there is a personal passion of mine, … the membership has really choose this new space (clean tech) because a lot of us were following it personally, but we didn't have a formal channel to express that investing interest and participation interest. That's why I think it gained so much momentum so quickly."
>
> Angel Investor

However, the transition to clean technologies has not been simple or straightforward. The expertise required to make investment decision in the green economy is very different from the one required in previous technologies. According to an angel investor, the technical proficiency required to invest in clean technologies was initially a limiting factor in investing in this business sector,

> "Yes, initially it was a very big limiting factor. Clean tech covers so many different things, chemistry, physics, logistics, finance, etc. So it really is a very, very broad spectrum of intellectual knowledge you need to master in order to be a proficient investor."

To address this challenge the investment community is taking a number of steps to inform themselves about clean technologies and acquire the necessary technical expertise.

> "The nice thing about our organization is that it is so robust in terms of the size of the network and also from the background of the membership. So, for instance, the former director emeritus of Lawrence Livermore National Labs is a member of our organization and he is someone that I have spoken with in many occasions, about various clean tech fields. His science expertise has been very helpful for me, he also serves as an advisor to one of my startups. So, leveraging the infrastructure (the members) itself is very important, but also we do educational seminars. We've done several "clean tech 101", "clean tech 102" type of events which is broad overviews of this field in general, describing the different sectors, solar, wind, biomass, hydro, geothermal,

> etc. But more knowledge is always very helpful, so I have been involved with the Clean Tech Open which is a really great academy system, it has been very helpful. But any educational forum is great for us, people attend, they are very active, they love to learn. These are very successful people, if they see the opportunity and also if it meets their passion, they are going to get smart as fast as they possibly can."
>
> Angel Investor

Investors are acquiring the necessary knowledge through each other, from educational courses organized by their networks, and through the interaction with external organizations like clean tech-focused business associations, non-profit organizations and universities and research institutions.

Our interviews also reveal that even in the present economic downturn, lack of capital might not be a factor restricting innovation in the green economy. In fact, there is probably much more interest and capital looking at clean tech than viable companies to invest on.

> "What they were finding is that people who had money, either venture capitalists or angel investors which had made a lot of money creating companies - in the 1990s essentially or before that - they had this money and they wanted to invest it in clean tech. They could see that clean tech was going to be the next big thing, but there were no companies to invest on. So they were trying to figure out where they should put their money. And there was not so much innovation going on and they were trying to sort it out. So they founded groups like Power Lunch."
>
> Executive Director of a Silicon Valley Environmental Non-profit

However, the perceived lack of opportunities for investment might not be caused so much by the lack of ideas, technologies, or even companies in the green sector, but the result of the capital requirements and investment time frames involved in clean technologies, which make them less attractive for investors. Accordingly, investors are being very selective with their investments and looking carefully at all the factors that might affect their potential returns,

> "Software has short commercialization time frames. Renewables are bigger investment plays, $1000s of millions and longer paths to market. If you look at how VC has done it, they are putting lots of money into solar for more innovation, but you have to be very strategic with solar. The CPUC has a mandate of 30% by 2020. So there's a need for renewables by 2020, but we need to understand what that means. … Policy meets finance, with CPUC, if there's a mandate for 50 megawatts, any investor needs to know that that's the output we are looking for."
>
> Executive of a Clean-Tech Incubator

RESEARCH AND DEVELOPMENT (R&D) FACILITIES

Silicon Valley is particularly well endowed with top-level R&D facilities. Key R&D organizations in the region include: NASA Ames Research Center, Stanford University, SRI International, Palo Alto Research Center (PARC), and Electric Power Research Institute (EPRI) among others. The region also benefits from the talent and research capacity of institutions located in the San Francisco Bay Area, such as UC Berkeley and Lawrence Berkeley National Laboratories.

Our interviews reveal that all of these institutions have taken important steps to support research and development aimed at reducing environmental impact and supplying future energy demand. As an example, Stanford launched in 2002 the Global Climate and Energy Project (GCEP), aimed at supporting fundamental research on technologies that will permit the development of global energy systems with significantly lower greenhouse gas emissions. GCEP's sponsors, ExxonMobil, General Electric, Schlumberger, and Toyota, will invest a total of $225 million over a decade or more as GCEP explores

energy technologies that are efficient, environmentally benign, and cost-effective when deployed on a large scale. In 2006, Stanford also founded the Precourt Energy Efficiency Center (PEEC), an initiative that draws upon the entire intellectual resources of the university in order to promote energy efficient technologies, systems, and practices, emphasizing economically attractive deployment. PEEC works to understand and overcome market, policy, technology, and human behavioral barriers to economically efficient reductions of energy use and to inform public and private policymaking. Other examples of initiatives to support R&D in the green economy are SRI International's Center of Excellence in Technology or PARC's clean tech research focus area.

But the strength of Silicon Valley to generate the scientific knowledge needed to support innovation in the green economy stands not only from its large and diverse pool of research institutions, but also from the synergies that can be produced from the different research orientations of these institutions. On the one hand there are research centers like Stanford's GCEP that is focused on fundamental research aimed at producing breakthrough ideas that might take 10 to 50 years to reach the marketplace. On the other, institutions like SRI International, that does both basic and applied research but still with long application time frames. And a third model is organizations like PARC that focus on research that is very close to the marketplace.

> "For us, we have to work pretty close to the market just because it is hard to monetize anything if you are more than three years away from the markets. You know, we either have to pay for ourselves, which is very risky, or you have to go to the government. SRI it is mostly government funded, a lot of their work means they are looking further down, because that is where the government… it is the only entity that funds that really 5, 10 years, 20 years timeline. We ought to look really 3-5 years, and if we can get somebody that can leverage technology that we did 5 years ago that's great, but what biz dev looks at is sort of, what kind of work can come now that we can get IP protection on, that can make an impact for somebody that has current pain, and we can tell a story about a solution to that pain in say a three year window."
>
> Business Development Executive at PARC

MAJOR CORPORATIONS

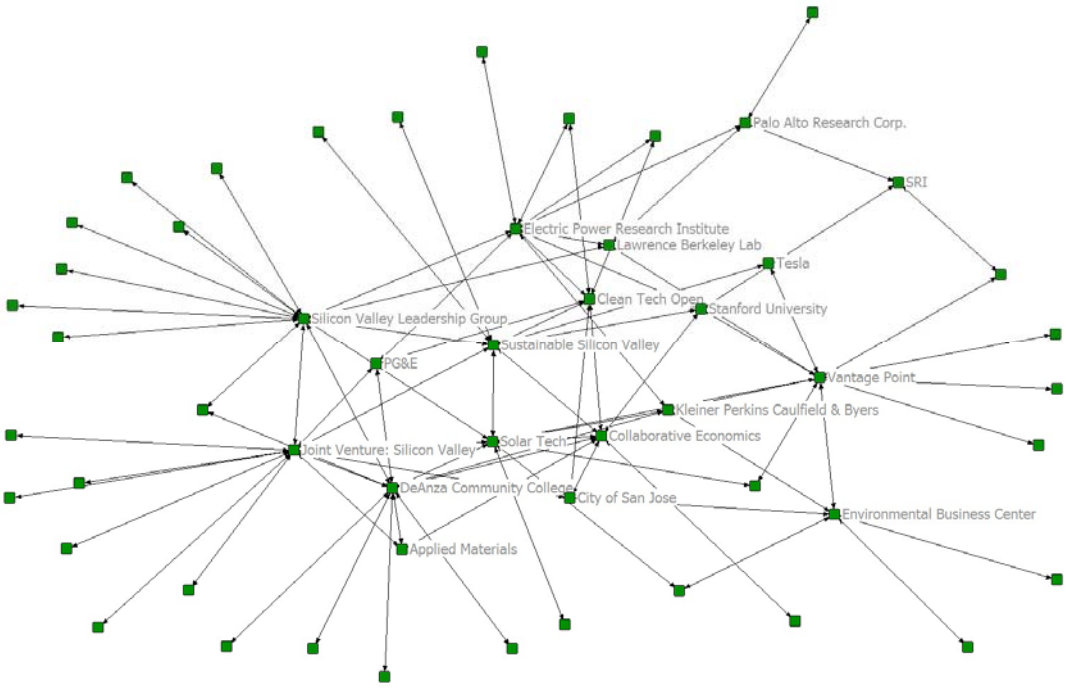
Many of the region's major corporations have taken up green initiatives. For instance, Intel has a recognized program for water reclamation in its U.S. and international facilities (Joint Venture Silicon Valley Network 2009: 32). Google and Intel started a program to get computing companies to produce and consume products that have low carbon emissions. The program, Climate Savers Computing Initiative, has dozens of members (Joint Venture Silicon Valley Network 2009: 33).[9] Google's foundation has created projects to fund research on creating alternatives to coal for electricity generation (RE<C, Renewable Energy Cheaper Than Coal), and to promote plug-in hybrids (RechargeIT).[10] Hewlett Packard has taken up corporate practices to reduce carbon emissions such as making data centers more energy efficient, videoconferencing, and providing carbon emissions product information to consumers (Joint Venture Silicon Valley Network 2009: 33). Applied Materials is one of the most active firms pushing regional partnerships towards a shift towards clean tech, in part because of its own transformation into a clean energy company. Applied Materials recently donated a $300,000 grant for the establishment of the Climate Prosperity Council in Silicon Valley.

[9] See also Climate Savers Computing Initiative. http://www.intc.com/intelProxy2009/proposal_7/index.html
[10] See http://www.google.org/rec.html Accessed April 17, 2009.

GREEN INNOVATION NETWORKS

Figure 13 below maps networks of social relationships among relevant persons and organizations in the region's green economy. The social network map is based on the names of individuals and organizations that came up in the different interviews conducted for this project. Among the six regions analyzed, Silicon Valley's social network map has the greatest extent. Our interviews confirm that the emerging clean tech cluster in Silicon Valley is benefiting from the rich existing networks of relationships between public entities and private companies and investors in the Valley. As a partner of an important VC firm in Silicon Valley puts it, "now we've seen a wave of clean tech companies get funded, the next wave is coming with better management teams; people who are 'expats from Silicon Valley' in its related industries, semiconductor industries and the biotech industry being the two most relevant. Those people who are leaving those industries, which they feel they're maturing, are adapting their talent, both personal and network talent, to a fluffy mix of ideas that are coming in the clean tech."

Figure 13: Social Network Map of the Green Economy in Silicon Valley



Source: UC Berkeley Center for Community Innovation based on responses of interviewees in this project

GREEN POLICIES AND REGULATION

State-level policy has been a clear push factor in motivating cities to adopt climate change programs. In the 2000s, a number of state laws led to the passage of AB 32 and SB 375. These laws created the Climate Action Registry (CAR) to track greenhouse gas (GHG) emissions, to limit vehicle emissions, and to boost the amount of clean energy procurement by the state. The governor signed an executive order that was eventually passed into state law (AB 32) that established the benchmark goal of reducing the state's carbon emissions to below 1990 levels by 2020. This policy put the California Air Resources Board in charge of overseeing the bill's implementation. The AB 32 Scoping Plan, passed in late 2008, laid out how the state would reach these goals, primarily through five program areas: emissions standards for passenger vehicles, energy efficient programs, a renewable energy portfolio standard, transportation fuels, measures to reduce emissions of gases that emit large amounts of green house gases (GHG). The bill also recommends that California adopt a "cap and trade" market system for reducing GHG emissions. Municipalities are encouraged to reduce GHG emissions 15% by 2020. SB 375 provides a roadmap for reducing local and regional transportation emissions standards, an requires metropolitan planning agencies to develop target goals for 2020 and 2035 (Hanack et. al. 2008).

The energy crisis of 2000 and 2001 spurred new programs and development for energy efficiency in state programs and policy. The program Flex Your Power, promoted by a partnership of California's utilities, residents, businesses, institutions, government agencies and nonprofit organizations, created a public relations campaign to provide information on energy efficient practices and financial incentives to the public, private, nonprofit sectors and the public as a whole. The Renewable Portfolio Standard Program set goals to increase the amount of renewable sources for energy use with investor-owned utilities (IOUs). The Clean Cars Law of 2002 (AB1493) required lower emissions passenger vehicles and light trucks. These laws set precedents for other states, many of whom have either adopted similar legislation—including AB 32—or are following California carefully (Next 10 2009: 11). AB 32 and SB 375, come in a long line of California environmental regulations that suggest that California will be a national leader in implementing global warming regulations. The 1970s OPEC oil embargoes and popular environmental movement established California as leader in energy regulation and creating incentives and market solutions to efficient energy use. The establishment of the California Energy Commission in 1974 and the federal Lawrence Livermore Laboratories clean building program were major steps in creating more efficient state and national standards in energy use (Next 10 2009: 10). In 1978, Title 24 set energy efficient standards for buildings and appliances, while the California Public Utilities Commission set policy that divided private utility investment and revenues for natural gas and electricity, set to begin in 1982 (Joint Venture Silicon Valley Network 2009: 15). This separated utilities' profits from their sales, giving them incentives to innovate efficient energy production and delivery.

As a result of these policies, economic analysis by the consortium Next 10 finds that California is a leader both nationally and internationally in terms of planning and implementing policies that made the state economical and efficient. Next 10 claims that California is more energy efficient and has lower GHG emissions than the rest of the United States, the UK, Germany, and Japan. The state registers lower per capita emissions than 15 years ago in spite of its high GDP. State utilities use low rates of energy compared to the rest of the country, offsetting energy needs even as the population rises (Next 10 2009: 5-6, 16-17, 20-21). Next Ten also reported that the California public has great faith in the capacity of the government and residents to address climate change, while growing the economy by innovating technology. Consumer behavior and home use follow these attitudes, and more Californians are installing solar panels and are buying energy efficient products and appliances. Innovation and product development in the state is following suit with clean and green patents, venture capital investment, and business and job creation.

Our interviews show that regional actors are carefully watching the unfolding of both AB32's and SB375's provisions to direct their policy and business strategies. In the meantime, many of our interviewees are working directly with state officials and regulators to influence the outcomes of the bills' enactment and enforcement, to make themselves known for future applications for state-level funding, and to lobby for their own interests, as well as the interests of their partners and constituents.

> "AB 32 is an incredible vision and it sets ambitious goals. When we get into the cap and trade program it's going to have teeth. So we are really going to have to achieve these goals or it's going to be very expensive for the polluters. . . . . 375 is kind of the long range investment strategy because it is all about land use and transportation . . . . both of them indirectly create markets for these products and the cities are saying alright we've got to get our greenhouse gas covered, businesses that are covered are saying we've got to get our emissions down. So they're looking for solutions, consultants, they are spending money trying to figure out how to do it. It's good business."
>
> Executive of a Regional Trade Association

> "The decision is to put a price on the cost of carbon – whether is through tariff, tax, carbon-trade system . . . . Governments, through policies, are affecting the market"
>
> Executive from a Venture Capital Firm

> "We bring the solar industry executives in the room with the governor and they talk so we develop connections. We brought the California Air Resources Board director, Mary Nichols, in a room with several large solar companies. She loves it because she needs to talk to the industry one-on-one. So that's what we provide, the networking and the hundred thousand foot policy support."
>
> Executive of a Regional Trade Association

Our interviews also reveal that the federal level actors are playing a major role in pushing changes toward the green economy. All eyes are pointed at the Obama administration and the potential for the American Recovery and Reinvestment Act (Stimulus Package). Several of our interviewees are directly involved in applying for stimulus package money. Several others communicated that they are aware of the funds' influence on the competitive advantage of the regional economy, and that it will be awarded on a competitive basis.

> "$700 million is going to flow through in California in the green area although we still not sure how. But it wasn't there six months ago."
>
> Director of an Economic Development Consulting Firm

THE GREEN ECONOMY IN THE MAKING: AN EMERGING GREEN CONSENSUS

This section explores how innovation in the green economy is actually taking place in Silicon Valley. The findings are based on 15 interviews conducted in the region between April 7 and May 4, 2009 with representatives of key organizations in the promotion and development of technologies, policies, and support programs to advance green innovation. These organizations include academic and research institutions, the city government, business associations, public-private regional coalitions, business incubators, venture capital firms, angel capital networks, non-profit associations, and economic development consulting firms. The interviews yielded 4 main findings:

1. While concerns about energy and the environment have been floating around for quite a while, recent economic and political developments have helped solidify a consensus around the concept of the green economy. The interests of many different actors, located at multiple levels, seem now to be aligned around a common goal: innovating in products and services that reduce environmental impact and solve the energy needs of society. And while there is no agreement about some of the

specific objectives or the strategies to be implemented, a diverse group of regional actors share now the same overall goal and are developing new initiatives and mobilizing resources to achieve it.

2. At first sight it might appear that the green economy is just a relabeling of existing economic activities, a branding effort to respond to current environmental and political concerns. But while the green economy is embedded in existing disciplines and economic activities, innovation aimed at addressing the present environmental and energy challenges requires existing actors to interact in new and different ways.

3. While green innovation relies heavily in regional actors and resources, the complexity and interdependence involved in bringing clean technologies to the marketplace are yielding supra-regional actors a more prominent role relative to previous waves of innovation. The innovation capabilities of regional actors seem to be increasingly reliant on interactions and coordination with actors operating at the state, national, and global levels.

4. The case of Silicon Valley suggests that regional advantage in the green economy will be largely determined by the capacity of regional actors to organize and establish a supporting infrastructure to both promote new intra-regional interactions and to establish the extra-regional linkages required to innovate. Far from being the result of spontaneous action, the interactions needed to sustain innovation in the green economy require a supporting organizational and institutional infrastructure. Local organizations in Silicon Valley are already creating the necessary structures to support these interactions at many different levels. And while extra-regional actors seem to be playing a more prominent role in this new economy, the capacity of regional actors to coordinate and interact does seem to be crucial to tap into the resources located at these extra-regional levels.

These findings are further developed in each of the following sub-sections: An Emerging Green Consensus, Characteristics of Innovation in the Green Economy, the Role of Regional Assets in Green Innovation, and Regional Advantage in the Green Economy.

AN EMERGING GREEN CONSENSUS

Our interviews reveal that concerns about energy and the environment are not new and have been floating around for quite a while. California in particular has an established tradition of environmental movements and a host of policies for energy use and clean air going back to the 1950s and 1960s. As put by a business development executive at a private research institution in the region when asked about whether the green economy was a new concept:

> "I have to think that this is something it's been around a long time and will continue to be around a long time. Because we have to use our resources more effectively and efficiently and that is inherently some piece of clean tech. Sometimes I think people are trying to throw foxes around clean tech like is something that is new, and maybe aspects of it are, but water issues, and using less energy, and having adequate resources, and having concerns about health, at some level, lots of this has been happening for a long time."

However, the 2008 spike in oil prices, the present economic recession, and the recent change in the federal administration seem to have solidified a consensus around the concept of the green economy. As expressed by a manager of a non-profit organization supporting the formation of clean-tech start-ups when asked if she perceived any changes in the markets, the political environment, or the regulatory framework that supported the development of their activities,

> "It is the current government administration that has really shifted a lot of people's viewpoints. … I think that with Obama's understanding of what is happening with our global climate it's really pushing a lot of people into the sector that might not have gotten there in the past."

The change in the federal administration has already produced significant changes in the economic landscape, opening up new opportunities for green economic activities. In words of the director of an economic development consulting firm located in the region, referring to the provisions of the stimulus package,

> "$700 million is going to flow through in California in the green area, although we still not sure how. But it wasn't there six months ago."

Changes in the economic and political landscape might not result in an automatic shift towards sustainable practices or green businesses and jobs. Rather, actors are finding their niche within these emerging conditions:

> "Just because it's hot and exciting, and stimulus money is going after it, doesn't necessarily mean that we are in. We need to find our space (in the market for clean tech)."
>
> Business Development Executive at a Private Research Center

Our interviews with representatives from a wide range of organizations suggest that their interests are now aligned around a common goal: innovating in products and services that reduce environmental impact and solve the energy needs of society. All of the interviewed organizations - including community colleges, private universities, for-profit and non-profit private research institutions, local governments, regional public-private partnerships, business associations, angel and venture capital investors, business incubators, non-profit organizations, and consulting firms - are currently implementing initiatives to promote and develop green economic activities. And while some of the organizations interviewed had a green mission since their inception, like a non-profit organization devoted to the support of clean tech start-ups, some others have only recently shifted their attention towards green activities. When asked about what type of investors are investing in clean technologies, a business development executive from a private research institution mentioned, "just about every VC is clean tech-focused now, it wasn't the case two years ago."

The coincidence of goals is also reflected in the numerous initiatives to foster green economic activities promoted by the city governments of the region, and by the resulting synergies among them. When asked about the role of city governments in supporting green innovation, the director of an economic development consulting firm located in the region mentioned,

> "San José has been at the forefront for a long time. The mayor of San José, Chuck Reed, envisioned this plan (San Jose Green Vision), so the city is using it to move in this direction. It's a great example. But when you look across all the cities, whether Mountain View or Palo Alto, they are all moving on that direction. You also have that the Bay Area, San Francisco, Oakland have a very strong commitment. The three mayors of the cities of San José, San Francisco, and Oakland signed this agreement a couple of weeks ago to work together on a series of green goals. There's an incredible amount of collaboration here going on at the local level."

Current environmental and energy concerns cut across multiple government levels,

> "I think that city, county, state, federal government, all have to be looking at this. Because you are not competitive as a quality of life location unless you are looking at sustainability and renewable energy. That's

my feeling. Because it affects security, it affects prices, it affects healthcare, and it affects so much of our lives that without a strong and progressive renewable energy portfolio and strategy the city, county, state, federal governments all become less attractive to bringing the best and brightest to their location."

Angel Capital Investor and Member of an Angel Capital Network

However, sharing the same overall goal does not always translates into smooth cooperation and often results in disagreements about specific objectives and implementation strategies,

"The challenge you have when going green is that each trade association wants to make its own mark. They want to sell their own car. They don't want to build part of the car. They want to be king. They want to carve out a niche. They want to show value to their members so every organization is coming up with their green project, their green vision… So we're all working in our own sandbox instead of pouring the sand into one big box. That's the challenge of doing these initiatives. How are you relevant? What are you doing different? Why should you fund this trade association instead of another? So a lot of the nonprofits are struggling for attention and struggling for their share of the solution. We all want to work together but we want to be kings."

Executive of a Regional Trade Association

In other cases, the different initiatives operate at different levels and complement each other,

"We don't want to interfere with city plans. This is a regional plan. Any and every city is going to be encouraged to have their own climate action plans, their own green vision, do their own programs. We are not trying to get in the way or take that away. We are trying to add value where collaboration results in a higher value added, where you stand political boundaries. Transportation systems don't stop when you get to the border of Sunnyvale. That's where we come in. … We're going to be working at the regional level."

Executive of a Regional Trade Association

CHARACTERISTICS OF INNOVATION IN THE GREEN ECONOMY

At first sight it might appear that the green economy is just a relabeling of existing economic activities, a branding effort to respond to current environmental and political concerns.

"In a lot of times clean tech is sort of a label that I think captures some vague ideas, you can have headlines around, sort of like nanotechnology, it's another one that I'd put in that category."

Business Development Executive at a Private Research Center

This perception is reinforced by the fact that some industries/businesses have transitioned to green products and services without much changes in their core activities or technologies,

"For specific clean tech things, semiconductors translate extremely well to solar. So that's a no-brainer. You know how the electricity markets are now, IT is going to transition very well into the (smart) grid. And there are numerous comparisons of how the Internet developed, and how networking in companies like Sun and CYSCO, how that will translate to the evolution of the smart grid."

Business Development Executive at a Private Research Center

"Some of this builds off. I mean if you look at our solar industry or if you look at biotech industry, many of the technologies we are talking about are sort of natural evolution whether it would be in the bio-fuel area or the relationship between semiconductors and solar"

Director of an Economic Development Consulting Firm

But upon closer inspection, transition into clean technologies is not straightforward in all cases, and it is often times difficult,

> "Because solar manufacturing and computer chip manufacturing companies use the same material, same technology, and you have the same outsource relationship… But it's not the same when you're doing biofuel for instance, where you have a physical process, all these chemicals... It's a totally different thing. People are actually finding it very hard to switch from high tech to clean tech."
>
> Executive Director of an Environmental Non-Profit

And while some sectors of the green economy might be embedded in existing disciplines and economic activities, innovation aimed at addressing the present environmental and energy challenges requires existing actors to interact in new and different ways.

> "You just cannot call out and hire a smart grid expert to know all that stuff, so looking within our organization we have a lot of these pieces, we have people that know about fiber security, we have people that know about renewables, we have people that know about connecting distributive resources, but they don't know about each other. Figuring out a way to get these parties in the room, to help define the problem, think about how each of their pieces of expertise can help solve it, where are the gaps, these are some of the things that I am doing. So that we can be prepared to work in this opportunity."
>
> Program Director at a Non-Profit Research Institute

> "Clean tech is really not an industry, it is sort of an overlay on a lot of industries, so, even here (at our research center) we don't have a clean tech lab, we have more of a clean tech coordinated effort, so that we can solve problems that are brought on by climate change, and that is where a lot of the funding and attention is."
>
> Business Development Executive at a Private Research Center

Our interviews revealed that many actors in Silicon Valley, from research institutions, investors, public-private regional partnerships, clean-tech non-profits, etc., are focused in addressing long-term and complex environmental and energy problems with the potential to produce disruptive innovations and with significant societal impacts and/or large economic returns. These efforts are organized around loosely defined projects, such as the smart grid, the electric car, carbon capture, or renewable energies, for which innovation is highly interdependent on the knowledge, skills, and resources of many different actors.

> "The energy system is very, very complex. So even if I have a perfect photovoltaic I need to have a good electricity transmission system. I need to have a storage system to deal with the intermittency. There are a lot of other things that I need to think about that need to work for this to be successful. So I think that the size and the complexity of the energy systems, and the integration of energy systems are so large that you can't turn it around on a dime."
>
> Project Director at a Private Research University

Furthermore, innovation in the green economy is not only complex and characterized by high interdependencies, in many cases it is also much more capital intensive,

> "The only thing is that the economics of the dot.com business, or even computer IT businesses, are very different from the economics of clean tech industry. For instance, a biofuel company, you're actually manufacturing. It's like going back to the old days when you were making computers and semiconductors here in Silicon Valley"
>
> Executive Director of an Environmental Non-Profit

"(clean tech) is much more capital intensive than an internet start-up, you need to build your solar fields or whatever it is, so it takes so much money."

Program Manager at a Clean-Tech Non-Profit

Not only the initial investments tend to be larger compared to information technologies, but returns on investment also seem to take longer, particularly in sectors where new technologies compete against existing ones. As expressed by a project director at a private research university when asked about the factors that are limiting the adoption of energy efficient and clean technologies,

"I would say that it's probably the legacy infrastructure. I would say that we can come up with new solar photovoltaics, or lots of new technologies, but generally, in the energy field it takes a long, you know, these are big investments. So if you are investing in a coal power plant you want to have that plant running for 50 years. So, the turnover time for energy systems tend to be very, very long. And I think we are beginning to come up with technologies that are still not economically competitive quite, but even if they are economically competitive with incentives and whatever, it still got to compete against an established infrastructure. So in terms of electricity generation it would be power plants, in terms of transportation it would be combustion engines, a hundred years of investment on that type of engine. So it is not going to happen overnight, to just change one energy technology to another. So I think that is something that is holding up moving new technologies into the marketplace."

So even when the green economy is embedded in existing disciplines and economic activities, and at first glance it might appear as if the green economy is just a branding effort, innovating in clean and energy-efficient technologies does seem to require existing knowledge and actors to interact in new and different ways. Innovation in the green economy, in at least some sectors of it, is complex and highly interdependent on the knowledge and decisions taken by numerous actors. And compared to innovation in information technologies, bringing clean and energy-efficient technologies to the market place seem to require larger initial capital investments and longer investment returns.

THE ROLE OF REGIONAL ASSETS IN GREEN INNOVATION

Our interviews reveal that Silicon Valley is particularly well endowed with resources to innovate in the green economy. The region possess a unique mix of talent, research capabilities, and financial resources that combined with an entrepreneurial-driven population with progressive, pro-environment attitudes provide a solid foundation to maintain a leadership position as innovation center in the green economy. This view was expressed by several of our interviewees when asked about the assets that the region possess to innovate in the green economy:

"That's a no-brainer, I think it's the access to equity capital sources, VCs, Angels, entrepreneurial savvy people, who know how to start companies that are based on technologies. There are world class research institutions where you just get a lot of leveraging of bright people who, you know, graduated from Stanford, a PhD, and didn't leave. You know, it is a nice place to live so the stay. And you see this talent pool of people that are just passionate about solving climate problems and somewhat altruistic so that passion is leveraged by their business side. So you got capital, you got technology, you got people… I think… part of it is past successes, and part of it is appetite for risk."

Business Development Executive at a Private Research Center

"Clearly when you put together Stanford and Berkeley, you got two of the world leading engineering and science universities in close proximity to each other. Then you throw into that the Lawrence Labs, you know, the Berkeley labs, the National large labs, particularly, because they have a focus in energy. Then, we have NASA down the street here. So when you put together all this, we have an incredible research capacity in this

region, the Bay Area, and Silicon Valley benefits from that. Also, from a training point of view, we are fortunate, not just Berkeley and Stanford but also San José State and Santa Clara University. It's a very strong asset and it's always been a plus for this region."

Director of an Economic Development Consulting Firm

"The other thing quite frankly, trying to steer clear off politics here, but when you look at San Francisco, San Jose and the larger communities you have a higher density of people but you also tend to have a more liberal viewpoint versus the Central Valley or northern California, and so I think that there is more of a demand for the green technologies, more of an interest, and quite frankly more of a policy push."

Program Director at a Non-Profit Research Institute

"I think the Bay Area is very supported by the local venture capital network. Palo Alto specifically there is a lot of money there, it is easy to interact with the VC at networking events, much more than, say Fresno."

Program Manager at a Clean-Tech Non-Profit

"You don't necessarily get that in other places… (and since) you have that cycle of, you know, your kid plays soccer with somebody who just sold his company for a hundred million, you get free advice! And you get free mentorship. And then they feel some obligation too. Because of their own success, to extend that helping hand to somebody else. Not to mention that they now have some interest in investing and continuing the cycle. Once you get in that cycle, it's much more sustainable."

Business Development Executive at a Private Research Center

One of our interviewees also recognized the diversity of industries and economic activities that Silicon Valley possess as a foundation to innovate in the emerging green economy,

"What people don't completely appreciate is the diversity also. It's not as mono-culture as many people see it. When you look here at the industries is not only semiconductors and IT, it's not really about software of computers, we have bio and a whole range of industry… the convergence of them is really interesting. And some of the green technologies are convergent. For instance, bio-fuels research on Berkeley Labs is coming out of previous bio-medical research that is now applied fuels."

Director of an Economic Development Consulting Firm

Given the technical complexity and the capital requirements of innovation green sectors, the regional research infrastructure represents a particularly valuable asset for companies initiating new clean ventures.

"We do have a lot of infrastructure here that quite frankly small companies can't handle on their own. We have a small fab in the back, we have an MRI unit, and we are open to companies that may be interested in using some of those, to prove their concepts, to answer technologies further, so that they can attract the type of venture capital that is required for spin-off."

Program Director at a Non-Profit Research Institute

"When you get downstairs into the lower two floors (of our research center), it is offices, but also it harbors labs, wonderfully equipped labs, that you may share with other research projects, but ultimately you would not be able to duplicate that as a start-up, even a start-up on venture funding, just because you wouldn't want to buy the metrology tools, and the lab… the chemical equipment that our research center can use over and over and justify it."

Business Development Executive at a Private Research Center

"One area specifically where I'd like to work with Stanford is in the grid, the smart grid at the Precourt Institute, they are doing a lot of work with smart meters . . . The Precourt Institute is doing research on the impact of smart meters on behavior and how you can design the interface between the smart meter and the

user to help them change home behavior and make good decisions. It would be great to work with them. They are already working with PG&E to do smart meter deployments and testing here in the Silicon Valley. Could also really help create new products and jobs, things you could plug into your smart meter, new interfaces and web-based interfaces."

Executive of a Regional Trade Association

But while the strength of their regional assets position Silicon Valley in an advantageous position to innovate in products and services that reduce environmental impact and address our present energy needs, our interviews also reveal that the complexity and interdependencies involved in green innovation are yielding supra-regional actors a more prominent role. The innovation capabilities of regional actors seem to be increasingly reliant on interactions and coordination with actors operating at the state, national, and global levels. This multi-level interdependency results from multiple factors. First, innovation in the green economy seems to be largely influenced by policies and regulations that are defined well beyond the region.

"If you're going to be successful in the green industry you need to understand the regulations and policies that are affecting the industry from a public policy standpoint, you know, utilities, regulations, etc. So this is a tricky industry, it's not that you can just jump on… it's not like starting a dot.com or something, it needs an understanding of a more complicated regulatory environment"

Director of an Economic Development Consulting Firm

"Energy has been a policy-driven market since its inception. So renewable energy looking for some sort of policy advantage or policy assistance, it's nothing new for the energy sector. The coal industry it's been subsidized for years, the oil and gas businesses have been subsidized for years. And in very big numbers, in significant ways. So this is nothing new for energy. Renewable energy is a very, very important part of the sustainable future obviously. I think Washington is taking some very, very good steps towards a couple of things. First, it's putting a tax on carbon, whether it's cap and trade or whether it is a straight tax, it's not yet seen. I also think that the RES is very, very important, which is a national Renewable Electricity Standard, and that's very important. And I mean, some very interesting and new financing techniques that are supported by the federal government could be interesting like the stimulus package. But even go beyond that, to new public-private partnerships that could potentially be happening in the next several months. So I am quite excited by what I have seen not only on RES but also on the cost of carbon being applied and leveling the playfield against fossil fuel generation. So I think that all of this has to come together with the Obama administration."

Angel Capital Investor and Member of an Angel Capital Network

When asked if any local or national policies had affected their involvement in the green economy, a program director at a non-profit research institute mentioned,

"It helps to find some of the problems that researchers are looking at and funding organizations are willing to spend money on. So for example, we do a lot of work about carbon capture and the only thing that allow us to do that is if somebody, say, a government is going to fund this or make it an important enough problem that industry will fund it. Because no matter how important we think a problem is we can't self-fund it, we have to have support to be able to do that kind of work."

"The policy side is really an important driver. It's the interaction between policies, standards, and incentives that we think began to have a broad impact on the private sector. One of the reasons we are seeing such an increase in venture capital funding today is, I believe, that companies here in Silicon Valley and across California believe that there's a possibility of markets developing in terms of investment and business. … it is policy, influencing private behavior… it's a combination of all three (policy, businesses, and consumers)."

Director of an Economic Development Consulting Firm

Policies and regulations are playing an important role in providing new funding mechanisms and developing markets. When asked about any regulations affecting green innovation, a business development executive at a private research center remarks,

> "The investment tax credit for solar, that was part of the stimulus package signed last year, extended this tax credit for eight years. And then the recent stimulus, I think allow you to take a cash. That was tax credit, and then now, they allow you to take, I think a grant for 30% of the installation which I think is a huge thing. Tax credits is great but you have to wait to get it, you need to make the investment, you need to borrow money, you can't borrow money these days, so it was great, a carrot hanging out there over a chasm that you couldn't get across. Now, if you can get a 30% grant, you can get across the chasm a little easier. That is primarily for solar. There is another one for wind that I am not too well versed on."

Policies and regulations also seem to be playing an important role in the establishment of technical standards that are fundamental for the development and diffusion of new technologies,

> "Permitting is a big issue. Every city has their own permitting standards. So integrators don't know what the rules are . . . . You've got to meet in person. Everyone has different rules, so it is very difficult to roll out your product when you don't know with certainty when it's going to come. They are trying to work with the city to develop best practices."
>
> Executive of a Regional Trade Association

At present, some actors perceive the lack of consistency across standards and regulations as a big obstacle in the diffusion of new technologies. When asked how local governments and regulations have affected their involvement in the green economy, a business development executive at a private research center remarks,

> "They are standing in our way, essentially, California has got the CPUC (California Public Utilities Commission), state efforts, national efforts, every state is different. So imagine being a company and saying, we have this great solution, it works in New Mexico, because New Mexico's regulations and the way they manage their utilities. But you cannot start a business that works in one state. … it would be nice to get some consistency."

Supra-regional actors are acquiring more relevance not only in defining policies and regulations affecting green innovation, but also in providing direct funding. Even within a region with wide access to private investment resources, the investment community in Silicon Valley recognizes the importance of public resources located at other levels,

> "In today's market if you do not have some sort of knowledge of, or making steps to access the capital available at the federal level, the state levels, or the city levels, you are not competitive! That is just the bottom line in the hour of the market right now. Before, in many prior businesses, call it IT, call it the Internet, call it whatever you want it, was always businesses saying: out of the way government!, we'll take care of everything! And there were many great successes from doing so. In the energy market (the government) it is part and parcel, as I started this conversation by saying: energy has always been a policy-driven business. So every, every clean tech investment must have a (financial) sustainability strategy or risks not being competitive."
>
> Angel Capital Investor and Member of an Angel Capital Network

Furthermore, access to financial resources by itself is no guarantee of success in the green economy. The interdependencies between policies and financial resources is captured in the following quote of the director of an economic development consulting firm, when asked about the role of funding in the green economy in Silicon Valley,

> "It's very important but if you didn't have a market and if you didn't have a policy, finance by itself wouldn't do it. We saw it with the dot.com, that if you have a lot of venture capital going into an area and there is no market, it blows up"

The national and global scales are also fundamental for pooling knowledge and talent to complement the resources available in the region.

> "When we are going after these large, important problems to solve, we are also going after the best and the brightest in their respected fields and we bring them on board. … We are working with folks from MIT, and Stanford, from different organizations, primarily in the U.S. because it is a U.S.-based program. … We are not afraid to go and look outside. We may be the prime, for instance, in a particular government program, but a lot of that money quite frankly flows quite right back out of our research institute so that we can engage the best and the brightest. We are not interested in maximizing our revenue, we are interested in maximizing the return for our client."
>
> Program Director at a Non-Profit Research Institute

> "This has become somewhat of a practice here at our research center, at least. When we turn to a specific domain like solar, we are not solar experts, you know. We don't have 20-30 years in the solar industry, so we go out and find somebody that does, and bring him here at our research center either as an entrepreneur or executive in residence, or in many cases, as a visiting technologist. So we brought in a guy who was 20 years at BP solar, well known operations guy in the industry, now it has a company, a start-up for cell manufacturing in Atlanta. He worked here for more than 6 months, really as a researcher to help us lay out all the things that could improve efficiency in solar and for the first couple of years we just started checking off that list. It is a kind of a market-focused lens we apply to our research and say, what capabilities, what tools do we have to solve these problems, and what is the best, the most cost-effective way to leverage some of the capabilities that we have."
>
> Business Development Executive at a Private Research Center

Partnerships with supra-regional actors play an important role in creating the conditions for the adoption of new technologies,

> "We would have never been able to put it (a solar installation) on our own, without the bond money and without a partnership with PG&E, Chevron, and the Energy Commission. That's been critical. The Energy Commission has provided funding for curriculum development and so on. Chevron has provided ways that we can actually put in solar and get a cost savings back. Heat our pools, reduce our overall costs. Our bill is $4 million a year in energy alone, electricity alone. PG&E are providing the energy management technicians that need to go out and work in industry. Everyone gets something out these partnerships."
>
> Chancellor of a Community College District

Our interviews offer evidence that suggests that innovation in the green economy involves research and development that interacts closely with financial resources, policies, and regulations that are defined at many scales in order to reach commercialization and implementation. The innovation process may start more or less organically at the local level, based on the region's knowledge base and in the interests of local actors, but full deployment and commercial success, say several of our interviewees, will require interaction with actors and resources located at the state, national and global levels.

REGIONAL ADVANTAGE IN THE GREEN ECONOMY

Far from being the result of spontaneous action, the interactions needed to sustain innovation in the green economy seem to require a supporting organizational and institutional infrastructure. Accordingly,

regional actors are making explicit efforts to promote and coordinate these interactions both within and across organizations.

> "We have 5 divisions at our research institute. And it was recognized that big problems require big solutions and it's just unlikely that solving these big problems at one research center, working alone in a laboratory, is going to be able to do that. And, at our research institute, part of our reason for existing is to solve important problems. Energy is on that list, it's big, and we felt that to make a real impact we needed to be able to tap in the diverse resources that were available in our organization. So I was brought in to do three things: 1) To bring in information about the outside world, so that we can understand what the industry needs; 2) To represent our capabilities to the outside world. Until I took this position there was no single point of contact to energy activities here, you had to call everybody up one by one. And 3) to make sure that although we have these five divisions, for administrative reasons, to get people knowing about potential opportunities to work collaborative on big projects."
>
> Program Director at a Non-Profit Research Institute

> "It was 2005, it was probably 2006, when we put a clean tech…, a sort of a virtual center at our research center where we tried to coordinate activities so that the outside world knows that we do have some concentration on clean tech."
>
> Business Development Executive at a Private Research Center

In the case of some organizations, identifying and connecting the different actors relevant to green innovation is part of their core activities. This is the case of a non-profit organization devoted to the support of clean-tech startups,

> "So for instance, we have our matching event that is coming up, so all of the innovation partners (large research centers in the area) will be attending that matching event, they will be giving brief presentations on the technologies they are working on currently on their labs and saying, we have this sort of technology but it needs someone to take it to market, we have this water treatment technology but it needs the finishing touch and we are looking for a technical expert, that kind of thing. The innovation partners will be making those presentations. On this side, we'll have anyone who is an entrepreneur and who wants to join a team, or find a team, or start a company, and they will say, hey! I am the biz person that you are looking for, let's match up. Or, I am looking for a team to join and this team has this technology over here, so let's join up here. So, you have a great little melting point of all different talent and technology that you need to create an actual start-up company."
>
> Program Manager at a Clean-Tech Non-Profit

Public-private partnerships in the region are also developing plans to achieve a coordinated effort among all different stakeholders in the green economy.

> "So there was a purposeful decision in this case bringing together people from industry, venture capital, business community, education, and create what we called a Greenprint. So that's what it was being unveiled at the Joint Venture Silicon Valley event."
>
> Director of an Economic Development Consulting Firm

Regional actors are organizing to remove the barriers hindering the full deployment of new technologies,

> "We are removing barriers for solar companies at the local level, for the development of standards and best practices. So for us it's all about accelerating time to market. The way we are doing that is, with our member companies we're developing best practices, whether it's trying to streamline applications, paperwork with finance, more consistency in training workforce, more predictable applications, its day to day issues at the

local level. We have relationship with the California Energy Organization, also CALSEIA (California Solar Energy Industries Association). We get feedback from our members and from private-public partnerships."

Executive Director Solar Business Association

"We put together projects. We're not a body of experts. We don't do consulting. We put together teams around a specific project idea . . . . On renewables the solar installation industry is unhappy because almost every city in Silicon Valley has different rules and regulations for installing solar. What we would do is put together a team with the cities to standardize on the permitting process for solar installations. In this case, we work with Solar Tech which is already doing work on that, but we could bring more clout to that, to bring in more cities, more players, like the head of Applied Materials, the mayor of San Jose, others, so we could develop a template where you could say here's the way, this is going to be the Silicon Valley way of permitting renewables for homes and businesses, streamlining the process, the industry that would help homes and businesses get permits and help cities not have to do their own independent investigations."

Executive of a Trade Association

Another example of an effort to channel the resources of multiple organizations towards the promotion and development of green economic activities is the Climate Prosperity Council being promoted by the Joint Venture: Silicon Valley Network (JV:SVN). This Council aims at implementing a series of strategies developed in the report *Climate Prosperity: A Greenprint for Silicon Valley*, released in spring 2009 at the organization's annual meeting. The report outlines a regional plan to create an export base around green and clean energy and technology, and to create a local market for clean and green products and services. The projects proposed in the plan include creating initiatives to standardize development and production practices by creating templates and model ordinances for the permitting process for solar and building efficiency. Other initiatives include adopting technology and procurement practices in building and facilities management. The Climate Prosperity Council will be integrated by major figures from the rankings of regional business associations, research, government, and management.

From the evidence obtained in the interviews Silicon Valley seems to be well positioned in terms of regional assets to make the transition into the green economy. At the same time, our interviews reveal that innovation in the green economy relies heavily in extra-regional actors and resources as well as on macro-level structures, regulations, and resources. But while extra-regional actors seem to be playing a more prominent role in this new economy, the capacity of regional actors to coordinate and interact does seem to be crucial to tap into the resources located at these supra-regional levels. Accordingly, our analysis concludes that successfully innovating in the green economy will rely in the capacity of a region to engage actors and organizations at multiple levels and geographies, as much as on capitalizing regionally-based assets and fostering intra-regional interactions.

Regional actors in Silicon Valley have been putting in place the organizational and institutional infrastructure to enable the interactions required to introduce green products and services into the marketplace. The case of Silicon Valley suggests that regional advantage in the green economy will be largely determined by the capacity of regional actors to organize and establish a supporting infrastructure to both promote new intra-regional interactions and to establish the extra-regional linkages required to innovate. Our interviews, however, could not yield evidence on the effectiveness of these coordination efforts. But while it might be too soon to assess the results of the organizational and institutional infrastructure that it is being put in place, the complex and interdependent character of the innovation processes in green sectors suggest that this infrastructure provides a fundamental support to the uncertain process of developing and commercializing the technologies aimed at addressing the present environmental and energy challenges.

CONCLUSIONS

In the 2009 annual conference of Joint Venture Silicon Valley, the green economy was featured as the savior of the current economic malaise. The Valley's leaders—San Jose Mayor Chuck Reed, SVLG CEO Carl Guardino, JV:SV CEO Russ Hancock, among others—echoed the warning of observers that the United States as a whole has lost ground in the emerging green technology industries to places like Sweden or Germany. The message was that the green economy is the current wave of economic development, and the Valley needs to devote all its resources to boosting its competitive advantage in this emerging area. As the decade nears its close, it remains to be seen whether and how Silicon Valley will emerge from the decade of the dot-com bust and the present financial crisis. Job losses from the dot-com bust never recovered much above 1994 levels and Santa Clara County recorded a 35% loss in manufacturing employment between 2000 and 2008. A more recent wave of high tech manufacturing job-losses hit the semiconductor industry in the first months of 2009. For instance, National Semiconductors – one of the Valley's leading firms in the semiconductor industry – recently laid off one-fourth of its workforce. Still, Silicon Valley has proved historically resilient in rising out of economic downturns by retooling and revising its assets and strategies for innovation and economic development.

Will Silicon Valley be successful in innovating in the green economy to overcome the present economic decline? Will the assets that fueled innovation and growth in the information and communication technologies enable the region to position itself as leader in clean technologies as well? How is innovation in the green economy taking place in Silicon Valley at present? Based on quantitative and qualitative data this report showed that Silicon Valley seems to be particularly well endowed with resources to innovate in the green economy. The region possess a unique mix of talent, research capabilities, and financial resources that combined with an entrepreneurial-driven population with progressive, pro-environment attitudes provide a solid foundation to maintain a leadership position as innovation center in the green economy. But the region is also faced with a number of challenges related to land use and infrastructure, especially housing and transportation, as well as with the challenge of income polarization and access to social and professional resources like education. Lack of transit and congestion along with crowded land use place important limits for firm location, either those existing or starting up in the Valley, and those companies outside who potentially could move to the Valley.

This report also found that while the green economy might be embedded in existing disciplines and economic activities, innovation aimed at addressing the present environmental and energy challenges requires existing regional actors to interact in new and different ways. Furthermore, while green innovation relies heavily in regional actors and resources, the complexity and interdependence involved in bringing clean technologies to the marketplace are yielding supra-regional actors a more prominent role relative to previous waves of innovation. And far from being the result of spontaneous action, the interactions needed to sustain innovation in the green economy seem to require a supporting organizational and institutional infrastructure. This report showed that an extensive set of initiatives between firms, industry associations, nonprofits, educational and government institutions have already been put in place in Silicon Valley to support the required collaboration. The case of Silicon Valley suggests that regional advantage in the green economy will be largely determined by the capacity of regional actors to organize and establish a supporting infrastructure to both promote new intra-regional interactions and to establish the extra-regional linkages at the state, national, and global levels required to innovate.

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