



# **Clean Energy Manufacturing in California**

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**Apollo Alliance BlueGreen Alliance**

**Clean Energy Manufacturing Project**

San Francisco, CA

**Joel S. Yudken, Ph.D.**

*Principal, High Road Strategies, LLC*

*104 N. Columbus Street, Arlington, VA 22203*

*(703) 528-7896 (o) • (703) 980-8122 (c)*

*jyudken@highroadstrategies.com • www.highroadstrategies.com*

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## **1. Introduction**

The purpose of this report is to provide an overview of clean energy manufacturing in the state of California. California enjoys a unique place in the nation, if not the world, as a pioneer in the development and adoption of renewable energy technologies. It has a long history going back to the 1970s, at least, with both state and federal programs that have directly encouraged and fostered growth in clean energy systems—in areas such as solar, wind, advanced batteries and biofuels, in particular. This history has made California the premier state in the nation, and global leader, in clean energy production and manufacturing.

This report reviews the current state of clean energy manufacturing in California in particular, viewing it in the context of its huge manufacturing base—the largest in the nation—and its well-developed clean energy economy value chain. Primarily, however, the discussion centers an examination of the the principal federal and state policies and initiatives that have played—and continue to play—a critical role in spawning, developing, and sustaining the state’s considerable clean energy manufacturing sector. At the end, it touches on the challenges and barriers that need to be addressed to maintain and extend this sector, in the face of the worst economic recession—and highest unemployment—the state has faced in many decades, not to mention its severe budget crisis.

## **2. California’s Manufacturing Base**

California boasts the eighth largest economy in the world, with a Gross Domestic Product (GDP) of \$1.9 trillion (2009), a population of 37 million and labor force of 18.1 million. It also has the nation’s largest manufacturing sector in terms GDP and employment.

<sup>1</sup> In 2010, California’s manufacturing GDP was \$220.23 billion, approximately 14 percent of total U.S. manufacturing GDP. Its manufacturing sector employed 1.24 million workers, or slightly more than one out of ten manufacturing employees in the United States.<sup>2</sup>

Manufacturing is the second largest non-government sector in California, accounting for 11.6 percent of the state’s total GDP in 2010, which is equal in size to the government sector.<sup>3</sup> Real estate and rental and leasing is first, accounting for 16.0 percent of California’s GDP. The professional and technical services and information sectors rank 3<sup>rd</sup> and 4<sup>th</sup>, with 9.2 percent and 7.0 percent of the state’s GDP, respectively.<sup>4</sup> However, manufacturing was only the 5<sup>th</sup> largest employer in California in 2009, with 8.9 percent of the state’s total non-farm employment.<sup>5</sup>

Nevertheless, the large GDP shares of the manufacturing, professional and technical services and information sectors and their combined shares of the total state GDP and total employment—28 percent and over one quarter respectively—reflect the substantial role of both high-tech manufacturing and services in the state’s economy. Notably, the computer and electronic products manufacturing industry (NAICS 334) was by far the largest manufacturing employer—271,901 employees

or 22 percent of total California manufacturing employment—and had the highest GDP—\$54.4 billion or over one-quarter of the state’s total manufacturing GDP in 2009.<sup>6</sup>

Aside from high-tech, California’s manufacturing base is very diverse, with sizable petroleum refining, food product manufacturing (reflecting California’s large agribusiness sector), and metal bending (fabricated metal products and machinery manufacturing) industries. Other important sectors include chemicals and transportation equipment (aerospace and motor vehicles) manufacturing.<sup>7</sup>

***Manufacturing trends.*** As with the rest of the nation, California’s economy, and especially its manufacturing sector, took a beating the recent Great Recession and financial crisis. Total non-farm employment in California rose through the first half of the decade, but fell sharply over the second half—a total of 1.3 million jobs were lost, a drop of 8.4 percent, between 2007 and 2010. After a steady rise since 1998 of 39.3 percent, California’s real GDP declined by 3.7 percent between 2008-2009. This was a somewhat higher rate than the U.S. as a whole (2.5 percent). Yet, its recovery has been slower than the nation as a whole. Even though the state’s real GDP started to grow again, by 1.8 percent, from 2009-2010, total U.S. real GDP grew faster. The state’s unemployment rate rose to 12.5 percent in 2010, and remained higher than the national rate of 9.1 percent in May 2011, even after dipping below 12 percent in April.

California’s manufacturing sector also lost heavily due to the recession. After doubling the previous decade, the state’s manufacturing real GDP fell by 4.6 percent between 2008-2009. Manufacturing employment in California declined as well—183,000 manufacturing jobs were shed between 2008-2010. However, this sector had already lost nearly a quarter of its workforce—430,000 jobs—since 2000. A fifth of all manufacturing establishments (of all sizes) in California also shut their doors between 2001-2010—a net loss of 12,000.<sup>8</sup>

The computer and electronic products manufacturing industry was one of the biggest losers, which alone shed 122,000 jobs—a 29 percent drop—between 2000-2008, and another 25,400 jobs between 2008-2010. That is, California’s largest manufacturing industry lost over a third of its workforce over the past decade—belying an otherwise healthy GDP growth over the same period. A net of over 1,600 or 30 percent of establishments in this industry similarly were lost between 2001-2010.<sup>9</sup>

There was a similar pattern of employment and establishment declines for many of the other major manufacturing industries in the state. For example, machinery manufacturing lost 38 percent of its employment and a net 20 percent of its establishments. Similarly, fabricated metal products shed 34 percent of its jobs and 18 percent of its plants, and transportation equipment manufacturing lost 33 percent of its employment and 19 percent of its facilities.<sup>10</sup>

***California's manufacturing strengths.*** Despite these loses, California's large, diverse manufacturing base provides a strong foundation for developing a robust clean energy manufacturing sector. Most production of clean energy technologies is rooted in the design and manufacture of conventional technologies and products. For example, solar photovoltaic manufacturing is centered in the semiconductor and related device manufacturing industry—some of the largest producers of photovoltaic cells in California are semiconductor manufacturers—and the state's strong glass industry is an important supplier in the fabrication of solar cells and module. Storage battery manufacturing is part of the electronic equipment, appliance, and component manufacturing industry. Wind turbine manufacturing belongs to the turbine and turbine generator set industry within the machinery manufacturing sector.<sup>11</sup>

California's global leadership in technology, large pools of educated, high-skilled workers, major transportation and export hubs, and ready access to sources of venture capital, are some of the main advantages attracting innovative clean energy manufacturing to the state:

- By most measures California leads the nation in science and technology research, development and innovation:
  - It is a major center for the design of automobiles, furniture, apparel, software, electronics, telecommunication services, computers and semiconductors.<sup>12</sup>
  - Almost 25 percent of U.S. industrial R&D is performed in California.<sup>13</sup>
  - The state is home to over 40 federal laboratories and three of the ten NASA centers in the country—more than any other state in either category.<sup>14</sup>
  - It leads in several strategic high-tech industry segments, with between 20-60% of U.S. market share in electronic components, commercial aerospace, medical instruments, biotechnology and transportation.<sup>15</sup>
  - It leads the nation in patents—over 23,000 in 2009, more than any other state.<sup>16</sup>
- California's manufacturing, professional and technical services, and information sectors employ more workers in each category than any other state. It also a leading state in high-wage services. California has nearly 1 million high-tech workers—more than any other state and equal to one-eighth of all U.S. high-tech workers. It also has seven of the nation's top 20 engineering schools and possesses the highest concentration of engineers, scientists, mathematicians and skilled technicians.<sup>17</sup>
- California ranks first in venture capital; i.e., it gets more venture capital as a share of gross state product than the national average. For example, in 2009, the California companies received more than \$11 billion or nearly half of all VC invested in the United States.<sup>18</sup> The top sectors receiving VC funding include software, telecommunications, biotechnology, medical devices and semiconductors.<sup>19</sup>

- California has twelve cargo airports—carrying 3 million tons of freight per year—and leads the country with eleven cargo seaports.<sup>20</sup> A top exporter, it shipped merchandise totaling \$143.2 billion overseas in 2010. The largest exports include computers and electronic products—accounting for 29 percent of the state’s total merchandise exports in 2009, transportation equipment, machinery and chemicals. Twelve metropolitan areas exported over \$1 billion in 2008; the Los Angeles area led the state, with 39 percent of exports—the 3<sup>rd</sup> largest in the nation, followed by the San Jose-Sunnyvale-Santa Clara and the San Francisco-Oakland Fremont areas.<sup>21</sup>

### 3. California’s Clean Energy Economy

Another important advantage is California’s very large market for clean energy generation components, products, and systems. Spurred by the oil crises of the 1970s, federal and state tax credits—during the first administration of Governor Edmund G. Brown, Jr.—helped spawn new solar and wind industries. Solar companies producing and installing solar heating and generation equipment proliferated and wind turbine farms were built on the slopes of hills in three primary locations around the state.<sup>22</sup> California’s capacity for renewable energy generation is extensive. Its sunny southeastern deserts have a high potential for solar energy production (solar cells and solar thermal). And substantial geothermal and wind power resources exist along the coastal ranges and the eastern border with Nevada.<sup>23</sup>

***Clean energy production.*** California has since become home to the largest concentration of renewable energy production in the United States. Today, the state leads the country in electricity generation from non-hydroelectric renewable energy sources, including geothermal, wind power, fuel wood, landfill gas, and solar power, and ranks second behind Washington State in the generation of hydroelectric power:

- In 2009, 11.6 percent of all California’s electricity came from renewable sources including small hydroelectric facilities—compared to only 3 percent nationwide.<sup>24</sup>
- California tops the nation in solar energy generation, accounting for over 90 percent of total U.S. net solar electricity generation in 2007. Five of the top ten solar energy- producing utilities in the United States are located in California.<sup>25</sup> This includes the largest solar power facility in the world, located in the state’s Mojave Desert.<sup>26</sup>
- California is also a leading producer of wind energy, holding nearly 10 percent of nation’s capacity,<sup>27</sup> and is the nation’s top producer of geothermal energy, with 2500 MW of capacity—including the largest complex of geothermal power plants in the world.<sup>28</sup>

**Clean energy employment.** Estimating how many jobs there are associated with clean energy has proven to be difficult, largely because the sector cuts across a wide range of other traditional industrial activities and sectors, not to mention the problem of defining what a clean energy (or “green”) job is. Separating out the size and scope of manufacturing activity associated with clean energy as defined for purposes of the Apollo California Green MAP project is especially difficult. Manufacturing and energy generation are core parts of a large clean energy value chain that also includes supporting economic activities such as R&D, investment, commercialization, distribution, installation, workforce education and training, and final users (consumers/residents, government, business). (Appendix A provides a brief discussion of recent estimates of CEM employment in the state and their shortcomings.)

For example, a survey conducted by the California’s Employment Development Department (EDD) to estimate the amount and distribution of green jobs across the state’s industrial sectors, came up with a rough estimate of 88,810 workers in the manufacturing sector associated with some responsibilities tied to green activities.<sup>29</sup> This however is an overly broad definition, which does not allow estimates of clean energy manufacturing as defined here.

Other studies give far more modest estimates of CEM employment, though none are definitive. A Next 10 report, *2010 California Green Innovation Index*, estimated that in 2008, manufacturing accounted for 21 percent of all green employment in California. Within this number, only manufacturing jobs—over 5,200—within the energy generation, energy storage and transportation clusters can be directly associated with CEM in the Apollo definition.<sup>30</sup> Based on another study of green firms and employment in Silicon Valley, estimates that up to 550 firms with 7,000 employees in that area may qualify as CEM,<sup>31</sup> suggesting a somewhat larger number of firms and jobs may count as CEM, compared to the Next 10 estimates.

**Regional Overview.** A report by Next 10, *Many Shades of Green*, notes that since 1995 jobs in this clean energy cluster, or what it calls the “Core Green Economy,” expanded by 56 percent in the state, while the total employment grew only 18 percent.<sup>32</sup> The Bay Area and Sacramento area posted the greatest gains, followed by Orange County and San Joaquin Valley. Recent growth in this sector has been especially strong in energy generation, energy storage and clean transportation.<sup>33</sup> Although activities associated with the “core green economy” is present in every region throughout the state, each has its own areas of specialization.<sup>34</sup>

- The **San Francisco Bay Area**, accounts for an estimated 28 percent of the employment and 26 percent of businesses in California’s green economy. A global hub for solar and other energy generation technology, the Bay Area also accounts for 45 percent of California’s employment in energy storage. In addition, because of the high concentration in venture capital firms, it is the center of the state’s green finance and investment activity.<sup>35</sup>

- The **Los Angeles Area**, accounts for 23 percent of the employment and 22 percent of green economy businesses in the state. The energy generation segment has experienced strong growth over the fifteen-year period, 1995-2010, especially solar, wind and energy management. Employment related to wind power grew by 45 percent from 2008-2009, and energy storage (advanced batteries) employment has doubled since 1995. In addition, the region is a hot spot in clean transportation technology, including alternative fuels, reflecting its large number of motor vehicles and equipment jobs.<sup>36</sup>
- **Orange County** has experienced dynamic growth in energy generation, particularly in energy storage related to fuel cells. This segment represents 18 percent of green employment in the county; solar is a large and expanding portion, and wind generation is growing as well. Building on its expertise in its conventional auto industry, the area also is a leader in clean transportation and alternative fuels.<sup>37</sup>
- The **San Diego Region** has 11 percent of the state's green jobs. Clean energy generation is the largest employer with 39 percent of green employment in the area. Also strong in the region are hydro generation and accessory equipment and controls, and alternative fuels.<sup>38</sup>

**CEM sectors in California.** California not only has been a leader in clean energy generation, it also leads the nation in key areas of clean energy manufacturing, most notably solar PV manufacturing. It also hosts competitive manufacturing capabilities in other clean energy areas, such as wind, biofuels, and advanced energy storage (particular Li-ion batteries). Even though California has seen strong growth and remains a leader in installed capacity and use of these technologies, it faces strong competitive headwinds in attracting investment in manufacturing capacity from other states and globally (i.e., China, Europe and Japan). Brief overviews of these sectors in California are provided below, and more in-depth summaries appear in Appendix B of this report.

#### **a. Solar Energy**

Solar energy is the fastest growing energy technology, and one of the fastest-growing sectors in the U.S. economy. The U.S. solar market grew 67 percent in 2010, rising from \$3.6 billion in 2009 to a \$6 billion industry.<sup>39</sup> The U.S. solar photovoltaic (PV) market remains the industry's most attractive and stable growth market.<sup>40</sup> California leads the nation in solar power generation and manufacturing. It currently accounts for nearly half of all solar power in the United States. Its solar market continued to grow by 33 percent in 2009, despite the recession. California leads the nation in installation of PV systems<sup>41</sup> and solar heating systems,<sup>42</sup> and is one of six states with large-scale concentrating solar power (CSP).

Correspondingly, it has the largest number of solar businesses in the nation; it currently is home to about 30 percent of all solar companies and estimated solar jobs in the United States.<sup>43</sup> These range include contractors/installers, distributors,



manufacturers/suppliers and other service providers. Of 1,049 solar companies in California identified by the Solar Energy Industries Association (SEIA), 188 are either manufacturers or suppliers. The state especially excels in PV manufacturing, mainly centered in the Bay Area (and mostly in Silicon Valley). It is home to the largest share of 39 active facilities in the nation engaged in manufacturing PV components (polysilicon, wafers, cells, modules, inverters), spread across 17 states.<sup>44</sup>

Several factors have helped to make solar power the leading clean energy industry in the California. These include the state's large internal market for renewable energy, its large venture capital network, its global leadership in high technology, and favorable government policies going back several decades. Since the solar PV sector is rooted in the semiconductor industry, it has benefitted from Silicon Valley's technological preeminence.

At the same time, growing cost pressures and increasing low-cost international competition present significant challenges for the industry's future. For example, China's share of California's solar market grew from 1 percent to nearly 46 percent in the three years prior to and leading through 2009, while the U.S. share fell 27 percentage points.<sup>45</sup> China also dominates globally, with 85 percent of world's PV manufacturing capacity.<sup>46</sup> These pressures have also intensified the competition between U.S. states for attracting new solar PV manufacturing investments.

One area where the U.S. solar industry might be able to maintain its global competitiveness in the face of low-cost foreign competition is technology innovation. For example, Rob DeLine, VP of Marketing for Miasolé, a Silicon Valley PV firm, notes that his firm, along with other California companies, are trying to develop more advanced PV technologies (e.g., CIGS, or copper, indium gallium and selenium cell technology) which are higher performing at lower cost, in order to stay ahead of Chinese PV manufacturers.<sup>47</sup>

## **b. Wind Power**

Wind power capacity in the United States has grown steadily since the mid-1990s, especially between 2006-2009, increasing the market opportunities for U.S. manufacturing throughout the wind energy supply chain. Today, the U.S. has one-fifth of the installed wind capacity in the world, and although in 2010, wind power provided for only 2.3 percent of the nation's electricity mix it accounted for 25 percent of all new U.S. electric capacity in 2010. Over the past four years, wind power added 35 percent of all *new* U.S. electricity capacity, second only to natural gas, and more than nuclear and coal combined.<sup>48</sup>

The rapid expansion in wind power installations has attracted increased investments in both domestic and foreign businesses in U.S.-based manufacturing for the wind industry.<sup>49</sup> The U.S. wind power manufacturing sector has grown significantly over the past five years as a result. Foreign manufacturers dominated

in supplying components for U.S. wind turbines and wind power installations, and in 2004-2005, domestic content in wind turbines was only around 25 percent. By 2009, however, this share rose to approximately 50 percent. Compared to only a few dozen manufacturers in 2004, there were over 400 wind-related manufacturing facilities in 2010 making components for wind turbines, including towers, blades and assembled nacelles in every region of the country. Fourteen new wind-related manufacturing facilities were brought online in 2010, alone.<sup>50</sup>

The nation's first wind farms were built in California in the 1980s, and until 2000 California led the nation in wind power. Today 38 states have utility-scale wind installations, but California now only ranks third, behind Texas and Iowa, in installed utility-scaled wind power capacity.<sup>51</sup> It nevertheless remains a leading state in wind turbine and components manufacturing. At least 15 different facilities around the state are currently involved in manufacturing facilities. Most wind power manufacturing tends to be concentrated in Southern California, especially Los Angeles, Riverside, and San Diego counties, in proximity to the largest concentrations of wind power capacity in the state. Northern California has a somewhat smaller share of both wind power capacity and manufacturing.<sup>52</sup>

Rising market opportunities for increased utility-scale wind farms remain the likely future driver for new wind manufacturing opportunities in California. Federal and state clean energy policies, including the federal stimulus program, the American Recovery and Reinvestment Act of 2009 (ARRA), seem to have played a relatively small role in driving the growth in wind manufacturing in the state, in contrast to states like Michigan.<sup>53</sup> Government policies however could be critical for helping U.S. manufacturers remain competitive with low cost foreign producers in wind product manufacturing in the future.

### **3. Advanced Energy Storage**

Advanced energy storage (AES) technology, especially lithium-ion batteries, is not currently used to any great degree in energy electricity generation. Lithium-ion (Li-ion) batteries have emerged as an important technology for use in hybrid and electric vehicles, however. This market is expected to grow over the next decade, globally and domestically, generating potentially substantial manufacturing opportunities in California and other states throughout the nation.

The Duke University-based Center on Globalization, Governance & Competitiveness (CGGC) CGGC identifies China, Japan, South Korea and the United States as currently the largest major lithium-ion battery manufacturers for electric vehicles (EVs). Asia dominates however, capturing the overwhelming market share of Li-ion battery manufacturing: Japan leads with a 57 percent market share, followed by Korea (17 percent) and China (13 percent). The United State is far behind (about 2 percent of the global market), with only one U.S. company is near the top of the list of major lithium-ion manufacturers in the world.<sup>54</sup>

About 30 percent of total Li-ion manufacturing locations are in either California or Michigan, which are the two states with U.S. EV automakers, Tesla (California) and General Motors (Michigan). California has the most manufacturing locations (28), followed by Michigan (8), and Illinois (6). CGGC also reported 18 advanced battery startup firms in the United States, more than half located in California.<sup>55</sup>

As in the solar PV industry, high tech innovation also drives advances in the battery industry. Not coincidentally, the Bay Area—in and around Silicon Valley—is home to the largest concentration of Li-ion manufacturing and R&D locations, and especially start-up firms in the Li-ion industry in the nation.<sup>56</sup> Federal (including ARRA) and state programs and policies have helped drive growth both U.S. and California's Li-ion battery manufacturing capacity (see below). Indeed, much of the growth of a Li-ion battery value chain in the United States—which includes R&D, raw material search and mining, manufacturing of Li-ion batteries and cases, and assembly, as well as marketing, financing, shipping and customer services—has been attributed to this support.<sup>57</sup>

Continued government support is likely to be needed to help California (and U.S.) Li-ion manufacturers remain competitive with Asian companies whose governments have poured considerable funding for building a competitive supply chain of Li-ion batteries for vehicles. Most significantly, the Asian producers, which have become better established with government help, now invest more of their own funds in R&D, compared to U.S. Li-ion manufacturers.<sup>58</sup>

#### **4. Biofuels**

Biofuels use plant or animal feedstock to produce fuels that can be used in transportation, and also for providing heat and power for industrial processes and generating electricity. Biomass-based products can also be used as feedstock—substituting for petroleum or natural gas-based feedstock—in a wide range of manufactured products (e.g., plastics, solvents, chemical intermediates, lubricants, etc.). Most bio-industry activity, nationally and in California, has focused on providing low-carbon substitutes for petroleum-based transportation fuels, i.e., gasoline, diesel, and aviation fuels, rather providing sources of heat and power.

As a petroleum fuel substitute, biofuels can play a major role in reducing California's (and the nation's) dependency on petroleum imports and cutting GHG emissions. Transportation uses about half of all the energy consumed in California, 90 percent of which is supplied by petroleum. This sector also accounts for about 40 percent of the state's greenhouse gas emissions (GHG), the largest from any sector.<sup>59</sup>

California is a global leader in the development of alternative fuels mainly due to historic state policies and investment trends.<sup>60</sup> Although, petroleum is expected to continue to fuel at least three-quarters of California's vehicles over the next two decades, the alternative fuels market share also is expected to grow, with ethanol providing the largest contribution.<sup>61</sup> California currently has 6 ethanol plants, five

of which are corn-based, with a combined production capacity of 250 million gpy. Most of this capacity was built up just over the past decade.<sup>62</sup> Ethanol however has become a controversial fuel, as critics claim corn ethanol production to be an inefficient process, and some doubt its contribution to reducing GHG emissions.<sup>63</sup>

Biodiesel is expected to be a more important substitute fuel in California in the future. Biodiesel is produced from renewable resources such as vegetable oil, animal fats, or waste vegetable oil. Because it is less energy intensive than the production of ethanol from corn, it offers greater potential for reducing GHG emissions and environmental impacts.<sup>64</sup>

The National Biodiesel Board (NBB) identifies 16 biodiesel plants with combined annual production capacity of 84.5 million gallons per year. Crimson Renewable Energy, LP in Bakersfield, operates the largest facility, which opened its doors in 2009, with a capacity of 30 million gallons.<sup>65</sup> However, due to the industry's inability to compete with petroleum-based diesel prices, six plants representing one-third of the state's biodiesel production capacity have been idled. In 2010, therefore, that these plants were expected to produced far below their capacity.<sup>66</sup>

California is also developing biomethane production capacity. Biomethane, which is made by treating organic matter with heat and bacteria, has the lowest carbon intensity of readily available alternative fuels. It can be used as an energy source in transportation, power generation, and combined heat and power applications. The main sources for biomethane include dairies, landfills, wastewater treatment facilities, woody biomass from forest management activities, and municipal solid waste streams. Although biomethane has significant production potential, only a handful of biomethane or biogas projects are operating in California, so far.<sup>67</sup>

## **5. Clean Energy Policies in California**

California's considerable economic, technological, financial, human and natural resources endowments have played a key role in making it a leader in clean energy generation and manufacturing, nationally and globally. Federal and state policies have also been critical drivers of the growth of California's renewable energy capacity. California, in fact, has pioneered in enacting and implementing policies that made it an early leader in clean energy production, which was complemented by federal policies that drove the growth of clean energy at a national level.

Studies have shown positive trends in recent years and projected growth in California's green sectors, including manufacturing, services and support activities, despite the state's current economic difficulties.<sup>68</sup> Although the growth of renewable energy resources has been holding steady since 2002, over this period wind generation more than doubled. Between 2007-2008 installed solar capacity grew by four and a half times throughout California and by 14 percent from 2008-2009.<sup>69</sup>

Much of this growth is directly attributable to state and federal policies aimed at encouraging the development and use of renewable energy resources. The positive trends reflect in no small part the introduction of major clean energy policies such as AB 32 and the Renewable Portfolio Standard (RPS), as well as a number of other state and federal programs that have spurred growth in clean energy production and manufacturing (as well as other green activities, i.e., energy-efficiency and resource conservation, green buildings and energy infrastructure, etc.).

Over the past few years, in particular, the state has instituted several programs to incentivize and assist clean energy manufacturers, i.e., to build, expand, and/or modernize their facilities in California. These initiatives have received support from former Governor Schwarzenegger and Governor Brown, as well as California's legislature. They include financial incentives and energy-related tax credits specifically targeted to clean energy manufacturing. The state also has supported programs supporting R&D and innovation in clean energy technologies, and workforce development, among others.

Federal programs since the economic crisis, especially the ARRA, have also encouraged growth in clean energy generation capacity and clean energy manufacturing in California. These programs have either provided direct support to clean energy projects in the state, or provided funding that have been distributed through state programs. ARRA funding has been crucial in maintaining and/or bolstering the capabilities of existing state programs, both in California and across the country. In some instances, it also spurred new programs to dispense the ARRA funds, that otherwise might not have existed.

The combination of state and federal programs, bolstered by ARRA since 2009, has helped the growth of clean energy manufacturing in all the key clean energy sectors:

- They have helped California firms expand, modernize, or build substantial new solar power generation and manufacturing capacity in the state.
- Although state and federal programs only played a small role in driving recent growth in wind manufacturing, California's RPS and other demand-side incentives have spurred the growth of CEM in wind power technologies.
- As noted above, ARRA programs were instrumental in developing a Li-ion battery value chain in California over the past few years.
- Both the U.S. Department of Energy and the state have made biofuels a policy priority, especially to reduce reliance on petroleum fuels in the transportation. These include policies for driving biofuels demand (the federal Renewable Fuel Standard and California's Low-Carbon Fuel Standard)<sup>70</sup> and to promote biofuels manufacturing.

As the ARRA phases out—there still are a few ARRA programs distributing resources for clean energy projects, directly or through state programs—California, as with most other states, will be hard pressed to maintain the a level of

commitment to clean energy projects comparable to the past few years. Even though there exists substantial political support in the state for clean energy, California's budget crisis may put serious limits on new clean energy investments from the state, just as the national budget crisis could dramatically limit federal support for clean energy. Yet, to confront the growing low-cost global competition in clean energy markets, which also has intensified competition between the states for attracting clean energy investments, state and federal programs could be vital to the future growth of clean energy manufacturing, in particular, in California not to mention the nation as a whole.

### **a. California State Financial Incentives**

Over the past few years, the State of California has administered two major financial assistance programs—loans and grants—available explicitly to aid CEM manufacturers. In February 2010, the California Energy Commission established the Clean Energy Manufacturing Program, to provide \$90.1 million through a combination of state and federal stimulus funding for two initiatives—the *State Energy Program (SEP) Clean Energy Business Financing Program* (\$30.6 million) and the existing *Alternative and Renewable Fuel and Vehicle Technology Program* (\$59.5 million)—to support clean energy manufacturers in the state. Specifically, the program encourages the production and manufacture of energy efficiency and renewable energy components, systems, and technologies, alternative and renewable fuels, and vehicles and vehicle components.<sup>71</sup>

- *Clean Energy Business Financing Program (CEBFP)*—With a goal of promoting industrial job creation and retention, this program has provided low interest loans to private businesses for retooling, improving, modifying, or expanding renewable product manufacturing facilities. Using SEP funding from ARRA—CEC received a total of \$226 million in SEP funds from ARRA for a number of private and public energy projects<sup>72</sup>—the CEBFP will give up to \$30.6 million in 2.75 percent low-interest loans, to be paid back over 7 years.<sup>73</sup> It is estimated that this program will leverage from \$145 million to \$175 million in private capital.

Table I lists five solar photovoltaic manufacturers that have so far have received a range of \$750,000 to \$5 million in loans from this program. This includes a \$5 million loan to CaliSolar, leveraging \$20.7 million in additional financing, to build a new PV manufacturing facility and expand existing solar cell capacity. CaliSolar is the only U.S. supplier of multi-crystalline solar cells.<sup>74</sup> Similarly, a \$3.3 million CEBFP loan is helping Morgan Solar move a PV plant to a new site in Chula Vista, California. A key concern is whether this new program will be able to continue using state funds, once the ARRA federal funds are used up.

- *Alternative and Renewable Fuel and Vehicle Technology Program (AB 118)*—Established under Assembly Bill 118 (Nuñez, Chapter 750, Statutes of 2007), subsequently amended by AB 109, it directed CEC to develop and deploy alternative and renewable fuels and advanced transportation technologies. It has an annual

program budget of up to \$100 million, dispensed in the form of grants, loans, loan guarantees, revolving loans, and other mechanisms.<sup>75</sup> It supports projects that, among other things:

- develop and improve alternative and renewable low-carbon fuels;
- optimize alternative and renewable fuels for existing and developing engines;
- produce alternative and renewable and low-carbon fuels in California; and
- establish workforce training programs.

**Table I—Clean Energy Manufacturing Program  
Selected Loans and Grants California Manufacturers**

Program	Energy Technology	Company, Location	Project	Award/ Loan
<b>Clean Energy Business Financing Program (CEBFP)</b>	<b>Solar Power</b>	CaliSolar, Sunnyvale	Expand solar cell capacity production from 60 MW annually to 75 MW annually by December 2010	\$5 million loan
		Solar Power, Inc., Chula Vista	Purchase cell sorters and stringing machines for new PV plant, opening January 2011	\$5 million loan
		Quantum Solar, Irvine	Purchase products aimed at increasing the output of PV plant	\$4.5 million loan
		Morgan Solar, Chula Vista	Move PV plant from Canada to new site; purchase of assembly and injection molding machines; opening November 2011	\$3.3 million loan
		Solaria Corp., Fremont	Purchase glass scanners and module testers for PV plant	\$753,992 loan
<b>Alternative &amp; Renewable Fuel &amp; Vehicle Technology Program (AB 118)</b>	<b>Advanced Batteries</b>	Quallion LLC, Sylmar	Battery manufacturer will provide matching funds to create pilot scale manufacturing line to produce 10,000 one-kilowatt/hour Li-ion modules	\$1,026,072 grant
		Leyden Energy, Inc., Fremont	Manufacturer of lithium-ion batteries for consumer electronics, energy storage and EV markets, will produce 10 EV batteries per month	\$2.96 million in grants
	<b>Electric Vehicles</b>	Green Vehicles, Inc., Salinas	Help build 2,000 <i>Triac</i> electric vehicles a year	\$2,052,560 grant
		Electric Vehicles, Int., (EVI), Stockton	Modernize its primary U.S. manufacturing facility and supported decision to relocate headquarters and main manufacturing operations from Toluca, Mexico	\$3.9 million grant
		Wrightspeed, Inc., San Jose	Development of advanced clean energy transportation company's Digital DriveSystem retrofit kit for medium-duty fleet trucks	\$1.2 million grant
		Quantum Fuel Systems Technologies Worldwide, Inc., Lake Forest	Launch a new generation of innovative plug-in hybrid vehicles (PHEV) system.	\$1.37 million grant
	<b>Biodiesel</b>	RTC Fuels, Sacramento	Partner with InterState Oil Company to develop one-million-gallon a year biodiesel blending facility serving San Francisco, San Jose, Sacramento, Stockton	\$1,790,000 grant total
		RTC Fuels, El Cajon	Develop 800,000 gallon a year biodiesel blending facility service Ventura, Los Angeles, Orange, Riverside, San Bernadino, Imperial, and San Diego	

Sources: "ENERGY COMMISSION AWARDS \$12.6 MILLION FOR ALTERNATIVE VEHICLE TECHNOLOGIES." *States News Service*. October 6, 2010; "Electric Vehicles International Will Use California Energy Commission Grant to Expand Manufacturing Plant." *Business Wire*. May 26, 2011; "Leyden Energy Launches Next Gen Lithium-Ion Battery Line." *Manufacturing Close-Up*. May 26, 2011; "California Energy Commission Approves Wrightspeed's Electric Vehicle Manufacturing Plant Grant." *Energy Weekly News*. December 31, 2010; KIMBERLY S. JOHNSON and KEN THOMAS . "Ford, Nissan, Tesla's electric plans get \$8B jolt ." *AP Online*. 2009;

"SunPower's and Flextronics' New Solar Manufacturing Plant Creates Jobs, Economic Benefits and Clean Affordable Energy." [Benzinga.com](#). August 10, 2011; "Quallion Receives Intent From California Energy Commission to Provide Up to \$9M in Cost Sharing for Lithium Ion Battery Manufacturing Facility." [U.S. Newswire](#). May 28, 2009. "SunPower's and Flextronics' New Solar Manufacturing Plant Creates Jobs, Economic Benefits and Clean Affordable Energy." [Benzinga.com](#). April 12, 2011.

CEC provided \$59.5 million in 2010 to support projects in four areas: biomethane production (\$21.5 million), ethanol production incentives (\$6 million), vehicle and component manufacturing (\$19 million), and advanced biofuel production (\$13 million). Table I lists eight grants, ranging from \$1 million to \$4 million provided to companies engaged in the production of advanced batteries, electric vehicles, and biodiesel fuels. These include two grants using ARRA funds to Li-ion battery start-ups Quallion LLC in Sylmar and Leyden Energy in Fremont.<sup>76</sup>

***AB 118 battery and biofuels support.*** California's Alternative & Renewable Vehicle Technology Program has made advanced battery research and development and manufacturing a priority<sup>77</sup> For FY 2011-2012, the CEC under AB 118 is allocating \$8 million to fund projects that establish commercial-scale alternative fuel vehicle and component manufacturing facilities (including batteries) in California.<sup>78</sup> This includes \$7.5 million, including possibly loans and loan guarantees, to support new advanced diesel substitute production plants or plant expansion.<sup>79</sup>

CEC is also allocating \$8 million for FY 2011-2012 to continue the growth of methane production capacity to serve the transportation industry in California.<sup>80</sup> It previously has provided \$33 million in funds for nine biomethane projects.<sup>81</sup> Supportive government policies and additional incentives will continue to be needed to offset the high capital costs associated with this very young industry, to enable it to grow. Because of capital constraints and the uncertainty of how the economics of the industry would play out, a number of California biomethane projects were stalled in 2010.

***Other financial assistance programs.*** There are other potential sources of financing involving state programs that currently are not explicitly focused on helping clean energy manufacturing, i.e., there are few or no examples of assistance provided to CEM businesses that easily can be discerned, though it is possible that some have been helped. More significant, these programs are mentioned because of the potential of leveraging these capabilities, and targeting future investments to support CEM.

- ***Infrastructure and Economic Development Bank (I-Bank)***—The I-Bank is California's only general purpose financing authority and has extremely broad statutory powers to issue revenue bonds, make loans and provide credit enhancements for a wide variety of infrastructure and economic development projects and other government purposes. Since it began full operation in 1999, its capitalization has grown from \$6.0 billion to over \$31 billion in debt financing.<sup>82</sup>



The I-Bank's Industrial Development Revenue Bond (IDB) Program can provide tax-exempt conduit revenue bond financing—i.e., low-cost financing of up to \$10 million—for eligible small- to mid-size manufacturing companies, for the acquisition, construction, rehabilitation, and equipping of the businesses. IDBs are payable solely from the revenues generated by the privately-owned business, are neither backed nor guaranteed by either the State or the I-Bank and do not involve the use of state funds. They were first issued by I-Bank in 1999, and as of November 2010, I-Bank has issued 50 IDBs totaling approximately \$245 million to businesses located throughout the state.<sup>83</sup> A new bill, AB-700, would make important changes in the I-Bank's structure, allowing the I-Bank and its board to more fully control its own budget, and provide a great deal more flexibility that could enable it to more easily target its resources, such as to new CEM facilities and projects. This bill has attracted significant support from business and economic development organizations throughout the state.<sup>84</sup>

- *The Environmental Investment Initiative (aka "Green Wave") of the California Public Employees' Retirement System (CalPERS) and California State Teachers' Retirement System (CalSTRS)*—This initiative, which draws on CalPERS and CalSTRS, the nation's largest the third largest public pension funds, with combined assets of \$250 billion—has delivered strong returns compared to other investments in its portfolio while at the same time producing energy savings through greater energy efficiency.<sup>85</sup> The "Green Wave" initiative was launched in 2004 with the purpose of committing \$1.5 billion in cutting-edge technologies and environmentally responsible companies. This includes investing a combined \$500 million for targeted investments in clean technologies.<sup>86</sup> Since 2006, CalPERS has committed \$500 million to external managers in its Global Equity asset class who restrict companies with a negative environmental footprint. CalPERS has committed more than \$1.5 billion to its private equity Environmental Technology Program.<sup>87</sup>

## **b. California State Tax Incentives**

California offers a variety tax credits, ranging from credits for equity investments in low-income communities, home-buyers, and hiring workers to R&D. Only one tax credit, the *Sales and Use Tax Exclusion (STE)* was specifically designed to aid CEM firms. The state's *Enterprise Zone (EZ) Program*, established to help attract businesses to economically distressed communities in the state, has no explicit clean energy focus. However, it could be used as a vehicle for attracting investments in clean energy generation and manufacturing projects, along the lines, for example, of Michigan's Renewable Energy Renaissance Zones.<sup>88</sup>

- *Advanced Transportation and Alternative Source Manufacturing Sales and Use Tax Exclusion (STE) Program (SB 71 Program)*—The California Alternative Energy & Advanced Transportation Authority (CAEATFA) administered the *Advanced Transportation and Alternative Source Manufacturing Sales and Use Tax Exclusion (STE) Program (SB 71 Program)*.<sup>89</sup> Under this program, CAEATFA provides solar, wind, and other clean energy technology firms an exemption from the state's 8.25

percent sales tax for the purchase of property (qualified property purchases) used for the design, manufacture, production, or assembly of advanced transportation technologies or alternative energy source products, components, or systems. The applicants are evaluated according to fiscal, environment, and employment benefits that the projects would provide to the state and local jurisdictions, produced by the manufacturing facilities and purchases from related suppliers. Approved applicants must make at least 25 percent of the qualified property purchases within the first year of approval, and have up to three years to complete all their approved property purchases and receive the STE. Waiver..

To-date (through May 1, 2011), CAEATFA has approved 28 projects located in 11 counties, with total anticipated sales and use tax exclusions (STE) of \$87.4 billion on qualified property purchases of \$961.0 million, estimated fiscal benefits of \$88.9 million, environmental benefits of \$52.9 million, and a net 602 jobs created from SB 71. As Table II shows, solar PV manufacturing projects received by far the largest number of approvals (11). Santa Clara County firms were largest recipient of approvals (9), eight for solar PV manufacturers, and one for solid oxide fuel cell manufacturing. Alameda County received the second largest number of awards (5), two for solar PV manufacturers, one for lithium battery manufacturing, and two for alternative fuel production projects (landfill gas capture and production and hydrogen fuel production).<sup>90</sup>

**Table II—SB 71 Program Approved Projects, May 1, 2011**

Type of Project	No. of Projects
Biogas Capture and Production	3
Biomass Processing and Fuel Production	1
Demonstration Hydrogen Fuel Production	1
Electric Vehicle Manufacturing	1
Landfill Gas Capture and Production	7
Lithium Batteries Manufacturing	2
R&D of Solar Fuel Generator Systems	1
Solar Photovoltaic Manufacturing	11
Solid Oxide Fuel Cell Manufacturing	1
<b>TOTAL</b>	<b>28</b>

Source: CAEATFA, 2010 Annual Report to the California State Legislature, March 2011.

- *California's Enterprise Zone (EZ) Program*—The EZ program was established in 1984 to stimulate business investment in economically depressed areas of the state and create job opportunities for Californians. Legislation currently allows for 42 EZs. Each EZ is administered by its local jurisdiction working with local agencies

and business groups to promote economic growth through business attraction, expansion and retention. EZ businesses are eligible for substantial tax credits and benefits, including hiring credits, sales tax credits, up-front expensing of depreciable property, among others.<sup>91</sup> The effectiveness of the program for creating jobs and generating economic gains for EZ communities has been the subject of debate, and some have called for reforming the program.<sup>92</sup>

### **c. Federal Support for CEM in California**

The American Recovery and Reinvestment Act of 2009 was the primary form of federal assistance available for clean energy projects at the state level in recent years. It included a number of programs, many administered through state agencies, which supported the development of renewable production resources and promoted the adoption of energy efficiency and conservation measures throughout the state. It provided billions of dollars nationally in grants, tax credits, loans and loan guarantees, energy conservation and clean renewable bonds, and workforce training initiatives. ARRA pumped a total of \$2.6 billion into California for 582 Department of Energy Recovery Act projects.<sup>93</sup> This represented 8 percent of the total loans and grants allocated by the DOE Recovery program in the nation.

**ARRA CEM Projects.** ARRA support for clean energy manufacturing and related projects amounted to \$282 million plus a portion of the \$226 million ARRA grant to the DOE's *State Energy Program* (SEP) that was used for clean energy projects (e.g., \$30.6 million administered by the CEC for the CEPFB program discussed above). Created by Congress in 1996, the SEP provides a wide variety of financial and technical assistance to the states through formula and competitive grants. The states usually add their own funds and leverage private investments for energy projects. ARRA provided a total of \$3.1 billion for SEP formula grants with no matching fund requirements.<sup>94</sup>

Table III shows direct awards to CEM projects, including 10 grants for solar PV systems development projects, 2 wind power projects and 2 biofuel projects. ARRA handed out only two grants for wind power manufacturing technologies. In addition, it provided a \$465 million loan for Tesla Motors, in Fremont, under the DOE's Advanced Technology Vehicles Manufacturing Program and a \$535 million loan guarantee (DOE/Treasury Section 1705 program) for Solyndra, Inc. in Fremont, to finance construction of a new solar PV manufacturing plant.<sup>95</sup>

Using ARRA funding, the state government in 2009-2010 also gave out AB 118 grants to biodiesel manufacturing and infrastructure projects, including grants to RTC Fuels in Sacramento and El Cajon for biodiesel blending facilities (see table I). ARRA also gave grants for biodiesel and ethanol technology projects.

**Table III—ARRA Awards to California Clean Energy Manufacturing Projects**

Program	Energy Technology	Company, Location	Project	Award/Grant
<b>PV Systems Development Grants</b>	Solar PV	Silicon Genesis Corp., San Jose	Accelerate development of a silicon wafering tool	\$3 million
		Sierra Solar Power Inc., Fremont	Accelerate development of a high-volume manufacturing silicone epitaxy growth system	\$3 million
		Solar Junction, San Jose	Move PV incubator technology from prototype to full-scale manufacturing	\$3 million
		Alta Devices, Inc., Santa Clara	Move PV incubator technology from prototype to full-scale manufacturing	\$2.9 million
		XeroCoat, Inc., Redwood City	Develop and commercialize a low-cost novel glass antireflective coating that enables higher energy output from any glass PV module	\$1.3 million
		Tetra Sun, Saratoga	Move PV incubator technology from prototype to full-scale manufacturing	\$854,000
		Crystal Solar, Santa Clara	Develop thin crystal silicon solar cells on ceramic substrates	\$500,000
		Banyan Energy, Kensington	Develop a flat Aggregated Total Internal Reflection (ATIR) optic for moderate concentrating PV systems	\$500,000
		Palo Alto Research Center, Palo Alto	Expand and accelerate PV awards that can be made under current competitive funding opportunity	\$150,000
		Solar Red, San Jose	Develop and all-AC building integrated, thin-film cadmium telluride PV system for asphalt shingled sloped roofs	\$150,000
<b>Wind Power Grants</b>	Wind Power	Alpha Star Corp., Long Beach	Demonstrate the ability of the GENOA advanced structural residual strength and life analysis software to predict the state load	\$457,000
		Analatom, Inc., Sunnyvale	Demonstrate company's structural monitoring artificial intelligence software to identify problems in wind turbines and components	\$172,000
<b>Loan Guarantee Program</b>	Solar PV	Solyndra/ Fremont	Finance construction of the first phase of a new solar manufacturing facility	\$535 million
<b>Advanced Technology Vehicles Manufacturing Program</b>	EVs and Advanced Batteries	Tesla Motors, Fremont	Repurpose a manufacturing facility, to produce electric drive trains, electric vehicles and battery packs	\$465 million loan arrangement
<b>Modified Integrated Biorefinery Solicitation Program</b>	Biofuels	Amyris Biotechnologies, inc., Emeryville	Pilot plant to produce a diesel substitute through the fermentation of sweet sorghum, as well as co-producing lubricants, polymers, and other petrochemical substitutes	\$24.3 million
		Logos Technologies, Inc., Visalia	Convert switchgrass and woody biomass into ethanol using a biochemical conversion process	\$20.5 million

Source: DOE, *Recovery Act State Memos, California*.

**ARRA Advanced Energy Manufacturing Tax Credits (48C).** Established by ARRA, this measure provides a 30 percent tax credit for investments in new, re-equipped, or expanded advanced energy manufacturing facilities designed to make equipment to produce renewable energy equipment and technologies. Credits worth a total of \$2.3 billion were approved for 183 manufacturing facilities for clean energy products across 43 states.<sup>96</sup> Although the ARRA federal tax credits were expected to retire in 2010 they were extended through 2011.<sup>97</sup>

Under the 48C program, DOE approved tax credit requests by seven California companies for 9 CEM projects worth \$235.5 million—about one tenth the total tax credits DOE provided to firms across the nation. As shown in Table IV, awards were given to two advanced battery projects in Monrovia, CA, two solar water heating projects in Chico and Fontana, and five solar PV projects in Santa Clara County. To-date no awards or tax credits have been given to wind power companies.

**Table IV—ARRA Advanced Energy Manufacturing Tax Credit (48C) Awarded to California CEM Projects**

Energy Technology	Company, Location	Project	Award
Solar Power	Miasolé, Santa Clara	Manufacture Solar PV Cells and modules based on an innovative thin-film production technology	\$91.4 million
		Manufacture Solar PV cells and modules based on an innovative thin-film production technology	\$10.5 million
	CaliSolar, Inc., Sunnyvale	Build a new manufacturing facility to process silicon feedstock into finished solar cells	\$51.6 million
	Nanosolar, San Jose	To factory produce tools for the manufacturing of low-cost, low-GHG emission solar cells, using nanotechnology-enabled roll-to-roll processes	\$43.5 million
	Stion Corporation, San Jose	Manufacturing high efficiency (11-12%+) CIGS thin-film photovoltaic modules on glass;	\$37.5 million
	SunEarth, Inc., Fontana	Manufacture liquid flat plate solar thermal collectors for medium-temperature domestic water heating and industrial processes	\$289,000
	FAFCO, Inc, Chico	Develop a next-generation low cost, polymer-based solar water heating system for homes	\$215,000
Advanced Batteries	Aeroenvironment, Inc., Monrovia	Purchase equipment for manufacturing 25kWh LiTiO advanced battery packs and battery management systems	\$370,000
		Manufacture a patent-pending Mobile Charge that combines a battery pack with a Level 3 DC connector, for on-road service trucks	\$311,000

Source: DOE, *Selections for Section 48C Manufacturing Tax Credit* (Excel database).

ARRA 48C has been a popular program within the business community, reportedly oversubscribed by ratio of 3 to 1. For FY 2012, the Obama Administration has requested an additional \$5 billion for the program.<sup>98</sup> U.S. Senator Sherrod Brown attempted to extend the tax credit through the Security in Energy and Manufacturing (SEAM) Act in 2010 but the bill did not make it through Congress. The legislation will be reintroduced in 2011 and is expected to seek another \$5 billion for the program.<sup>99</sup>

**DOE Section 1705 Temporary Loan Guarantee Program.** Under ARRA, The DOE also allocated \$1.9 billion in loan guarantees for renewable energy manufacturing projects located in the United States.<sup>100</sup> ARRA has appropriated \$2.45 billion<sup>101</sup> to cover credit subsidy costs for all projects, potentially leveraging from \$17 to \$50 billion of loan guarantees.<sup>102</sup> However, there are no new funds proposed in the FY 2012 budget request.<sup>103</sup> At least four projects in California, totaling about \$2.5 billion, have received loan guarantees from this program. These include \$535 million for Solyndra Inc. to help finance a new solar manufacturing facility in Fremont; \$1.3 billion for Brightsource Energy to construct three utility-scale concentrating solar power (CSP) plants in California's Mojave Desert in San Bernadino Cointy; and \$681.6 for the Genesis Solar Project in Riverside.<sup>104</sup> The CSP projects in San Bernadino and Riverside are expected to double the nation's current CSP capacity and displace 40 percent of the output of a typical 500-megawatt coal-fired plant. These projects are expected to create about 1,630 construction jobs and 114 operator jobs.<sup>105</sup>

**ARPA-E and SBIR/STTR Programs.** Several federal R&D programs, administered by the DOE, support the development of advanced clean energy technologies. As noted above (i.e., regarding PVs and Li-ion batteries), technology innovation is critical for maintaining and enhancing U.S. competitiveness in clean energy markets, globally and domestically. It remains one of America's most important advantages over low-cost clean energy product manufacturers in Asia and elsewhere.

ARRA gave a boost to programs such as the *Advanced Research Projects Agency-Energy* (ARPA-E) and *Small Business Innovation Research/Small Business Technology Transfer* (SBIR/STTR) program.<sup>106</sup> Not funded under the Bush Administration, ARPA-E was given initial funding of \$400 million from ARRA that supplemented FY2009 funds of \$15 million.<sup>107</sup> Under ARRA, California clean energy projects received 30 ARPA-E grants worth \$83 million and 25 SBIR/STTR awards worth \$18 million.<sup>108</sup>

Established in 2007, and modeled on the Defense Advanced R, ARPA-E supports transformational energy technology research projects. Funding for ARPA-E dropped to zero in FY2010, but the Administration has requested \$300 million for FY 2011 and \$550 million for FY 2012. The SBIR/STTR programs within the major federal R&D agencies are designed to increase participation of small, innovative companies in federally funded R&D. Extended several times, these program require a set percentage of each agency's applicable extramural R&D budget.

**DOE R&D and Technology Innovation Programs.** Long before ARRA, however, the DOE's Office of Energy Efficiency & Renewable Energy (EERE) has been sponsoring R&D programs to promote the development of advanced clean energy technologies. For example, its *Solar Energy Technologies Program (SETP)* focuses on the developing cost-effective solar energy technologies (photovoltaics, CSP). The EERE's *Wind and Water Power Program* seeks to improve the

performance, lower the costs, and accelerate the deployment of innovative wind and water power technologies. Other EERE R&D initiatives focus on biomass, vehicles and fuels, geothermal, hydrogen and fuel cells, buildings, and industrial efficiency among others.<sup>109</sup> While no comprehensive list of project recipients is readily available for purposes of this report, California clean energy firms undoubtedly have benefitted from these programs.

For example, under a three-year agreement initiated in 2007, the DOE's SETP has given up to \$24 million of federal funding to Silicon Valley-based SunPower to implement improvements across its value chain, reducing solar system costs through improvements in the design and manufacture of integrated solar power systems. The result is the opening a new solar panel manufacturing facility in Milpitas, in partnership with contract manufacturer Flextronics.<sup>110</sup>

#### **d. California Demand-Side Policies**

All policies designed to encourage private investment in CEMs, aside, CEM businesses ultimately are concerned about the size and location of the markets for their goods. Hence, policies that promote the installation of clean energy systems (e.g., solar PV and CSP installations, wind farms) in California have been vital to attracting the growth of CEM firms and their suppliers, to be in relative proximity to their markets. Indeed, California has led the nation in enacting and implementing such policies.

From 1998 through 2006, the California Energy Commission's (CEC) Renewable Energy Program provided market-based incentives for new and existing utility-scale facilities powered by renewable energy and consumer rebates for installing new wind and solar renewable energy systems.<sup>111</sup> Meanwhile, the California Public Utilities Commission (CPUC) funded larger self-generation projects for businesses. Begun in 2007, CEC's \$400 million *New Solar Home Partnership* program offers incentives to encourage solar installations and the CPUC's new *California Solar Initiative (CSI)* offers a variety of solar programs through publicly owned utilities, and consumer rebates for existing homes.<sup>112</sup> These and other important programs that are driving clean energy demand in California are described below:

- **AB 32**—Assembly Bill 32 (AB 32) (Nuñez, Chapter 488, Statutes of 2006), the Global Warming Solutions Act of 2006, signed into law 2006, established a goal of reducing 2020 greenhouse gas (GHG) emission reductions to 1990 levels, followed by an executive order which set a target to 80 percent further reductions by 2050. Governor Jerry Brown actively supports AB 32, including its policies specifically to reduce GHG emissions in the transportation sector. The defeat of Proposition 23, which would have repealed AB 32, in November 2010, highlighted the strong support within the state for addressing climate change and the need for switching to cleaner forms of energy.

- Renewable Portfolio Standard (RPS)—AB 32 bolsters support for California’s Renewable Portfolio Standard, which has been key driver of increased clean energy production over the past decade. The RPS was first established in 2002 with the goal of increasing the percentage of renewable energy in California’s electricity mix to 20 percent of retail sales by 2017. In November 2008, Governor Arnold Schwarzenegger signed an executive order increasing the RPS level to 33 percent by 2030.<sup>113</sup> In 2011, Governor Brown codified this goal, signing SB X1-2 extending the RPS to all electricity retailers in the state, including publicly owned utilities, investor-owned utilities, electricity service providers, among others.<sup>114</sup>
- California’s Feed-In Tariffs Program—These agreements would enable small facilities (1.5 MW or less) to sell up to 480 MW of renewable generating capacity to utilities at predefined terms and conditions, without contract negotiations. The CPUC established the feed-in tariff program in 2008, with the goal of helping utilities meet their RPS goals, contributing to California’s ambitious climate mitigation and renewable energy goals. Eligible renewable generation technologies include solar, wind, geothermal, biomass, biogas, small hydro and fuel cells that use renewable fuels.<sup>115</sup>
- California Solar Initiative (CSI) and New Solar Homes Partnership (NSHP)—The CSI is a comprehensive statewide solar program, overseen by the CPUC, which provides incentives for solar system installations to customers of the state’s three investor-owned utilities (IOUs): Pacific Gas and Electric Company, Southern California Edison, and San Diego Gas and Electric. This includes upfront incentives for solar systems installed on existing residential homes, as well as existing and new commercial, industrial, government, non-profit, and agricultural properties within the service territories of the IOUs. The NSHP is part of the CSI. It provides financial incentives and other support to home builders, encouraging the construction of new, energy efficient solar homes that save homeowners money on their electric bills and protect the environment.<sup>116</sup>
- Low Carbon Fuel Standard (LCFS)—Although California does not have a mandate for producing biodiesel, its Low Carbon Fuel Standard (LCFS) requires a 10 percent reduction in carbon intensity in diesel and gasoline fuels by 2020. Refiners, blenders and importers therefore can look to biodiesel as one of their primary options for meeting this goal. In addition, California’s *Bioenergy Action Plan* (BAP), established in response to Executive Order S-06-06 in 2006, it includes maximizing the contribution of bioenergy toward achieving the state’s petroleum reduction, climate change, renewable energy and environmental goals. It set a target of a minimum of 20 percent of biofuels to be produced within in California by 2010 and 40 percent by 2020.<sup>117</sup> Meeting these targets will require a substantial expansion in biodiesel production capacity. To reach 2020 BAP goals and support the California Air Resources Board LCFS objectives, California will need to expand current production to at least 700 million gallons.<sup>118</sup>



## **e. California R&D and Technology Innovation Programs**

California has long been a technological powerhouse, and has become a global leader in clean energy technology innovation. However, as noted above, U.S. clean energy manufacturers are confronting competition from low-cost foreign clean energy manufacturers, mainly from Asia, whose governments have also been investing in advanced clean energy R&D. In addition to the Federal R&D programs, California has also been sponsoring R&D and technology innovation programs, that may be the most ambitious and largest in the nation.

- Public Interest Energy Research (PIER)—Created in 1996 by AB 1890, the PIER Program required that \$62.5 million be collected annually from the IOUs, via the Public Goods Charge, by the California Public Utilities Commission (CPUC), and provided to the CEC for investments in energy-related research, development and demonstration (RD&D) projects. In 2006, SB 1250 reauthorized funding for the program from 2007 to 2011, and sharpened its research focus, to develop and help bring to market clean energy technologies, greater electric power system reliability, and lower system costs. PIER is the nation's largest state energy R&D effort.<sup>119</sup>

Although much of the PIER program is oriented towards electricity generation-related R&D and energy-efficiency, a major area of research is to support proof-of-concept R&D in the renewable resources area (solar, wind, biomass, biogas, and landfill gas, geothermal, hydro, ocean). These include projects designed to support the development of new technologies in the proof-of-concept stage, and/or develop promising new scientific concepts. Most are exploratory efforts designed to help determine new areas for larger scale-research. While some of this work will be applied directly to clean energy projects, much also would spur innovations in renewable energy products produced by CEM manufacturers.<sup>120</sup>

- R&D Tax Credit—The R&D tax credit is an important incentive for spurring long-term investments in research and manufacturing. Currently, the state allows companies to receive a 15 percent credit against their bank and corporation tax liability for qualified in-house research expenses, and a 24 percent credit for basic research payments to outside organizations. The California business community is concerned that California has been losing a growing number of R&D facilities to other countries and states. In response, the Silicon Valley Leadership Group has proposed the raising the California R&D tax credit level to 20 percent, matching the federal R&D tax credit level. It believes that this would encourage the state's clean energy manufacturers to invest in cutting-edge technologies, including in high-tech areas such as solar photovoltaics, advanced batteries and biodiesel fuels.<sup>121</sup>

- California's Innovation Hub (iHubs) Program. Launched in early 2010, the Governor's iHub initiative seeks to spur public-private partnerships, economic development and job creation around specific research clusters throughout the state. The iHubs are operated by local partnerships of local government entities, universities, businesses, venture capitalist networks, economic development

organizations and non-profits. They target young innovative companies that have been in business less than eight years in a technology cluster identified by the consortium.<sup>122</sup> To-date there are a dozen designated iHubs throughout the state. Although any kind of advanced technology cluster is allowed (e.g., biotechnology), emerging clean energy technologies are a leading focus for most of the iHubs.<sup>123</sup>

For example, the San Jose/Silicon Valley Emerging Technology Innovation Hub will forge stronger relationships among San José and local and eventually national and international partners to nurture and accelerate the commercialization of clean and emerging technologies. The Clean Tech Los Angeles iHub is a partnership between the City's business, academic, and government institutions focused on developing a world class clean technology cluster. The Sacramento iHub focuses on medical and clean technologies.<sup>124</sup>

## **f. California Workforce Development Policies**

California has sponsored several workforce programs designed to train workers in the skills needed by emerging clean energy businesses. However, most of the occupations and jobs targeted by these programs are in the construction and services side of the industry, with only a relatively small focus on manufacturing related workforce development. Some of the most important programs include:

- *Clean Energy Workforce Training Program (CEWTP)*—Established In 2009, the CEWTP is a multi-agency initiative to identify clean energy workforce needs, build regional capacity in clean energy sector development, and deliver industry-relevant training for displaced workers and new workforce entrants. The program is a partnership of California's Employment Training Panel (ETP) and the California Energy Commission, along with the California Employment Development Department (EDD), the California WIB, and the Green Collar Jobs Council.<sup>125</sup> \$75 million was initially allocated for the program to support what is believed to be the nation's largest green job workforce development program. The program's main focus is on training for jobs in the service sector, including designing, installing, retrofitting, operating and maintaining green technology systems. Training also is provided for manufacturing jobs in firms primarily engaged in the production of green technology products. Funding primary came from the federal ARRA program, and to a lesser extent the AB 118 program.<sup>126</sup>
- *Alternative Renewable Fuel Training Program*—The ETP also administers the workforce grants for the AB 118 program. For FY 2011-12, the ETP will disburse approximately \$4.5 million in *Alternative Renewable Fuel Training Program* state funds, in partnership with the CEC, for AB 118 projects to training incumbent and unemployed workers.<sup>127</sup> While the AB 118 employment training program continues to receive funds, the ARRA share of the funding for the CEWTP has ended.

- *Regional Industry Clusters of Opportunity Grant (RICOG) Program*—As part of the CEWTP, \$3 million was given for RICOG, a partnership between the CA WIB, CEC and California Economic Strategy Panel to provide grants to regions for identifying and developing clean energy industry clusters. Several kinds of partnership programs also were supported, such as a \$3.5 million *California Solar Workforce Partnership* and \$8.5 million *California Smart Grid Workforce Partnership*, among others.<sup>128</sup>
- *Other Training for Green Jobs*—Since July 2006, the ETP has approved more than \$68M in over 200 green/clean technology related contracts for more than 60,000 California workers. ETP provides financial assistance to California businesses to support customized worker training. It is entirely funded by a tax on employers, collected alongside the Unemployment Insurance tax.<sup>129</sup>

#### **g. Assistance to Small and Mid-Sized Manufacturers**

The National Institute of Standards and Technology's (NIST) Hollings Manufacturing Extension Partnership (MEP), in the Department of Commerce, works with small and mid-sized (under 500 employees) manufacturers to help them create and retain jobs, increase profits, and save time and money. The MEPs nationwide network of over 400 centers, field offices and partners, provides a variety of services, such as helping firms adopt innovation strategies, make process improvements, and introduce green manufacturing practices

California has two MEP affiliates: the Corporation for Manufacturing Excellence (Manex) in San Ramon, CA and California Manufacturing Technology Consulting (CMTC), in Torrance. Manex, founded in 1995, provides high-value consulting and business advisory services that help manufacturers in Northern California. It also holds a significant contract with California's Employment Training Panel (ETP) to assist manufacturers in enhancing the skills of their workforces. In addition, CMTC provides consulting and technical services for improving organization, industry productivity and global competitiveness of manufacturers in Southern California.

These MEP centers have provided assistance to companies in a wide range of manufacturing industries, but very few in the clean energy sector. To support California's CEM supplier chains, however, some consideration should be given to encourage these centers to broaden their focus to include to a larger number of clean energy manufacturers, and become more directly involved in the state's clean energy manufacturing program.

### **5. Challenges and Opportunities for CEM in California**

Building on California's powerful economic base, large advanced manufacturing capabilities, global technological leadership, highly educated and skilled workforce, and its vast natural resources, the state has become a global leader in both clean energy generation and clean energy manufacturing. California's history as a clean energy leader goes back decades—as far back as the first Jerry Brown

administration, which first put into place institutions (such as the CEC) and programs that helped give rise to the renewable energy industry in this country.

The summary above of CEM in California, and its major sectors—solar, wind, advanced batteries and biofuels—shows generally positive growth trends for these emerging industrial sectors, especially much of the last decade. Despite the Great Recession and financial crisis that decimated so much of the nation's and California's economy, not to mention its manufacturing sector, clean energy generation and manufacturing in sectors such as solar and wind, and even batteries, actually saw growth, though there are recent signs of slowing momentum.

Although this feat ultimately rests on the entrepreneurial and technological prowess of California's manufacturers, the report also demonstrates that state and federal policies and programs were essential to spawn new industries and spur the growth and expansion of the state's clean energy sector. Demand side initiatives, including financial and consumer incentives for clean energy generation, most recently AB 32, and especially the RPS, are critical to attracting investment in CEM to provide the products and technologies used in clean energy production. Manufacturers prefer to be near their customers, especially to avoid the costs associated with transporting heavy items, such as wind towers and turbines or solar panels over any appreciable distance. But direct forms of assistance to manufacturers such as grants, tax credits, and loans, provided by both federal and state agencies, have been crucial in supporting the growth and expansion of California's clean energy manufacturing in all its different segments.

***Clean energy sectors.*** The solar industry, especially photovoltaics—because it is rooted in semiconductor-based technology—has benefitted greatly from being centered in the advanced technology and innovation cauldron of Silicon Valley and in proximity to the rich vein of venture capital located in the Bay Area. As a result, the majority of solar startups and large-scale solar manufacturers in the state have chosen to locate in the region. As some of the industry members of the Apollo taskforce have suggested, technology innovation is vital for the design, development and manufacture of low-cost, highly energy efficient solar PV cells that are competitive with the low cost products of China and other nations.

ARRA programs at the federal level, and state programs like the Clean Energy Business Financing Program (CEBFP) and the Sales and Use Tax Exclusion for Clean Tech Manufacturing (SB 71) program have provided substantial support for the construction of new or expansion of existing solar manufacturing facilities in California. However, clean energy R&D and technology demonstration and commercialization programs, such as ARRA-E, SBIR/STTR and other DOE R&D programs also are important.

The wind industry has not received as extensive support from ARRA or state programs as the solar industry in California. Demand side support, especially the RPS, has been more important in encouraging wind power installations and new

manufacturing capacity to supply domestic wind power projects. There appears to be general agreement among industry experts that the United States could become a major center for manufacturing wind turbines and their components. But to make this a reality, a strong, long-term policy commitment to using more renewable energy is required. This would give turbine and components manufacturers the confidence they need to invest capital in building production facilities in the United States.<sup>130</sup>

Advanced battery (Lithium-ion, in particular) manufacturing has also grown, again helped by state and federal policies. ARRA programs in particular has helped California's battery firms, and the state's AB 118 has made advanced battery R&D and manufacturing a priority. ARRA in particular has been credited with underwriting the development a clean energy battery supply chain in California and elsewhere.

At the same time, various state and federal laws have set targets for increasing the development of clean substitutes for petroleum-based gasoline and diesel fuels, as vital to meeting the state's GHG emissions reduction goals in the coming decades. These include biofuels—ethanol, biodiesel, and biomethane—which also are being produced in California. Unfortunately, the recession apparently hit this sector hard, and because of related price and cost issues, much of the biofuel capacity in California has been idled over the last couple of years. The expectation is that when new fuel standards required by the state kicked in—i.e., the Bioenergy Action Plan and California's Low-Carbon Fuel Standard—biofuel manufacturing investments will revive.

***CEM challenges.*** Overall, regardless of the optimistic clean energy and clean energy manufacturing trends in these sectors, clean energy manufacturers face serious obstacles that could slow if not stop significant investment in clean energy manufacturing capacity. First, ARRA funding has all but dried up, which means that resources that were available for supporting or establishing cost-shares with state programs—as well as providing direct forms of assistance to manufacturers—is no longer there. Second, as several Apollo taskforce members noted, California's budget crisis has “taken the air out of the room.” This makes it difficult to push for current or higher levels of state funding for existing programs, much less for new programs, that support clean energy manufacturers.

Third, some are concerned about California's “business climate,” which they believe could discourage new CEM investments in the state. Business climate refers to how well a place supports economic growth and business development. Rhonda Mills of the Center for Energy Efficiency & Renewable Technologies (CEERT) and member of the Apollo California GreenMAP task force, identified six issues that she identifies as main challenges confronting companies considering locating their operations within the states. These include high property taxes, high payroll obligations, higher taxes across the board, higher energy prices, higher water prices, and stricter

environmental regulations. Transportation costs are another factor influencing CEM location and investment decisions.

**CEM options.** While some of these challenges cannot easily be mitigated—e.g., high water prices—policies that help reduce the costs of capital and financial risks associated with investment in the State, are probably the most important measures to consider. The state has several programs, such as CEBFP, SB 71, and AB 118, which provide grants, loans, and tax credits targeting clean energy production and manufacturing projects in the state. But there may be additional financing measures that could be called on to support CEM investment projects. For example, the California Infrastructure and Economic Development Bank (I-Bank, is the state's only general purpose financing authority with broad statutory powers to issue revenue bonds, make loans and provide credit for a wide variety of infrastructure and economic development projects and for other government purposes.

Other possible measures worth exploring, include expansion of enterprise zones to encompass more clean energy production and manufacturing projects, use of California pension funds and endowments for economically targeted investments, strengthening and broadening the state's clean energy workforce training programs, tying local content requirements to state grants, loans and tax credits, extension of the state's R&D tax credit, support for expanding the state's regional clusters grants program and centers of energy excellence, and establish local revolving loan funds to help small manufacturers, among others.

The challenges confronting the state in moving to the next level of clean energy production and manufacturing in the coming years are substantial. On the other hand, the political environment in California is generally supportive of going down the low-carbon path. In addition, the state has enormous economic, technological, human, and natural resources to draw upon. It also has strong legacy to build on, for creating an environmentally sustainable and economically prosperous future.

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## ENDNOTES

- <sup>1</sup> GDP data is from the Bureau of Economic Analysis (BEA) ([www.bea.gov](http://www.bea.gov)). GDP by state is the value added in production by the labor and capital located in a state. It is derived as the sum of the gross domestic product by state originating in all industries in a state. In concept, an industry's GDP by state, referred to as its "value added", is equivalent to its gross output (sales or receipts and other operating income, commodity taxes, and inventory change) minus its intermediate inputs (consumption of goods and services purchased from other U.S. industries or imported). Thus, GDP by state is the state counterpart of the nation's gross domestic product (GDP). Population and labor force figures are from U.S. Energy Information Administration (EIA), *U.S. States, California*. (<http://www.eia.gov/state/state-energy-profiles.cfm?sid=CA>).
- <sup>2</sup> All employment data is from the U.S. Department of Labor, Bureau of Labor Statistics (BLS) online database for the Current Employment Statistics (CES), State and Area Employment (SAE) tables, i.e., [BLS, CES SAE]. Texas and Ohio are a somewhat distant second and third—accounting for about 9 percent and 5 percent of U.S. manufacturing GDP, respectively, and 7 percent and 5 percent of U.S. manufacturing employment, respectively.
- <sup>3</sup> Nearly 80 percent of the government sector is for state and local government. Source is the BEA.

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- <sup>4</sup> The GDP share of the health care and social assistance sector is 6.6 percent; of retail trade, 5.9; finance and insurance, 5.6 percent; and wholesale trade, 5.3 percent. The top eight sectors together account for two-thirds of the total state GDP. Source is BEA.
- <sup>5</sup> Government accounted for the largest share (17.5 percent), followed by professional and business services (14.9 percent), education and health services (12.9 percent), retail trade (10.9 percent), and leisure and hospitality services (10.7 percent). Source is BLS, CES SAE.
- <sup>6</sup> Sources BEA and BLS, CES SAE.
- <sup>7</sup> Petroleum refining and coal production manufacturing industry is the second largest industry terms its share of manufacturing GDP (14.3 percent), followed by chemicals (12.1 percent), and food products (10.6 percent). Miscellaneous manufacturing (6.7 percent), other transportation equipment (6.4 percent), fabricated metal products (5.4) and machinery (3.5 percent) round out the top eight manufacturing industries which together account for 86 percent of all manufacturing GDP in California. In terms of manufacturing employment, the food products industry ranks second, with a 11.8 percent share, followed by fabricated metals (9.3), transportation equipment (8.4 percent; aerospace products and parts the largest share), miscellaneous manufacturing (6.5); chemicals (5.9), and machinery (5.4). Sources: BEA and BLS, CES SAE.
- <sup>8</sup> Each manufacturing establishment refers to a facility where manufacturing activity occurs. Each can have anywhere from one to over 1000 employees. The establishment figures reported here refer to the total establishments for an industry regardless of employment size. Source is the BLS, Quarterly Census of Employment & Wages (QCEW) (<http://www.bls.gov/data/#employment>).
- <sup>9</sup> Sources: BLS CES SAE and BLS QCEW.
- <sup>10</sup> Ibid.
- <sup>11</sup> Collaborative Economics, *Clean Technology and the Green Economy, Growing Products, Services Business and Jobs in California's Value Network*. Prepared for California Economic Strategy Panel, Sacramento, CA. March 2008: 7, 17.
- <sup>12</sup> Governor's Office of Economic Development (GoED). *California Investment Guide, An Overview of Advantages, Assistance, Taxes & Permits*, Sacramento, CA, November 2010: 4.
- <sup>13</sup> GoED, *The California Economy*. Website: (<http://www.business.ca.gov/WhyCA/TheCaliforniaEconomy.aspx>).
- <sup>14</sup> Ibid.
- <sup>15</sup> GoED, *California Investment Guide*, 4.
- <sup>16</sup> GoED, *The California Economy*.
- <sup>17</sup> Ibid.; GoED, *California Investment Guide*, 4.
- <sup>18</sup> GoED, *The California Economy*.
- <sup>19</sup> GoED, *California Investment Guide*, 5.
- <sup>20</sup> Ibid., 6.
- <sup>21</sup> Other major areas include San Diego-Carlsbad-San Marcos, Riverside-San Bernadino-Ontario, and Sacramento-Arden-Arden-Arcade-Roseville. GoED, *The California Economy*.
- <sup>22</sup> The California Energy Commission (CEC), *California Renewable Energy Overviews and Programs*. April, 21, 2011. (<http://www.energy.ca.gov/renewables/>).
- <sup>23</sup> EIA, *U.S. States, California*.
- <sup>24</sup> Large hydro plants generated 9.2 percent of electricity in the state. This compares to about half of California's generation coming from natural gas-fired power plants and 17 percent for the state's two nuclear power plants. EIA, *U.S. States, California*.
- <sup>25</sup> As of May 2010. Next 10, *2010 California Green Innovation Index*. Prepared by Collaborative Economics: 34.
- <sup>26</sup> Two new solar plants have been proposed for central CA, covering 12.5 square miles, and providing 800 MW of power. If permits are approved, they would generate 12 times as much electricity as the Mojave Desert plant. EIA, *U.S. States, California*.
- <sup>27</sup> EIA, *U.S. States, California*.
- <sup>28</sup> The facility, known as "the Geysers," is located in the Mayacamas Mountains north of San Francisco. It has more than 700 MW of installed capacity. EIA, *U.S. States, California*.
- <sup>29</sup> This survey of 15,200 employers concluded that more than 263,000 people spend at least half their time on jobs engaged in the production of green products or services. It found that another 170,000 jobs are held by employees who spend at least part of their time on green activities. Hence, the two groups together represent nearly half-a-million jobs in California with green activities across all industries. Next 10, *Many Shades of Green*, 6.

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- <sup>30</sup> Next 10; *2010 California Green Innovation*, 50.
- <sup>31</sup> BW Research Partnership, Green LMI, and Center for the Continuing Study of the California Economy, *Emerging Industry and Technology Sectors in Silicon Valley's Green Economy: Workforce Implications*. Conducted for work2future and NOVA. Carlsbad, CA, March 2011.
- <sup>32</sup> Next 10, *Many Shades of Green, Regional Distribution and Trends in California's Green Economy*. Prepared by Collaborative Economics, 2011 ([www.next10.org](http://www.next10.org)): 8.
- <sup>33</sup> Next 10, *Many Shades of Green*.
- <sup>34</sup> Ibid, especially 13-35.
- <sup>35</sup> Next 10, *Many Shades of Green*, 14-15. The San Francisco Bay Area includes Alameda, Contra Costa, Marin, Napa, San Benito, San Francisco, San Mateo, Santa Clara, Santa Cruz, Solano, and Sonoma counties. About 60 percent of energy generation-related jobs in the region are in solar power. In the area's energy generation sector, more than half the jobs are in advanced batteries, approximately a quarter is in fuel cells, and the remainder is in battery components and accessories and other segments.]
- <sup>36</sup> Ibid., 16-17. The Los Angeles area includes Los Angeles and Ventura counties.
- <sup>37</sup> Ibid., 18-19.
- <sup>38</sup> Ibid., 19-20. The San Diego Region includes Imperial and San Diego counties. Other important areas included the Sacramento Area (El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba counties), which has a high concentration of employment in energy generation, especially solar, but also wind, hydroelectric, and geothermal energy, and the Inland Empire (Riverside and San Bernadino Counties), which has had strong growth in energy generation employment (mostly solar, with increasing wind) and growing strength in clean transportation, including alternative fuels. Although the merger of two locally-based electric vehicle companies resulted in job losses in the 1990s, new jobs were created in 2008 following the formation of a new electric vehicle company. Ibid., 21-24.
- <sup>39</sup> Solar Energy Industries Association (SEIA), Research, Industry Data. [http://www.seia.org/cs/research/industry\\_data](http://www.seia.org/cs/research/industry_data)
- <sup>40</sup> Wendy Koch, "U.S. solar power industry booms, gain globally," *USA Today*, June 16, 2011.
- <sup>41</sup> Ibid. See also SEIA and GTM, *U.S. Solar Market Insight*, 2. Of the top 10 states with PV installations, California leads with 258.9 MWdc, almost twice next largest state, New Jersey with 137.1 MWdc.
- <sup>42</sup> SEIA and GTM, *U.S. Solar Market Insight*, 2. CSP projects uses sunlight to heat water or another fluid that generates steam to power a turbine.
- <sup>43</sup> The Solar Foundation, *National Solar Jobs Census 2010*. Washington, DC. October 2010: 5, 63. California ranks 1<sup>st</sup> on top ten states for solar jobs—an estimated 1,072 solar firms and 36,000 solar jobs.
- <sup>44</sup> The Solar Foundation, *National Solar Jobs Census 2010*.
- <sup>45</sup> "China Invades California Solar Market," *CalFinder*. Solar Blog. January 25, 2011. <http://solar.calfinder.com/blog/news/china-invades-california-solar-market/>. Aside from the lower costs of Chinese competitors, trade policies are also important factors in encouraging the sale of U.S.-made products.
- <sup>46</sup> Phone interview with Apollo California Green MAP taskforce member Rob DeLine, VP of Marketing, Miasolé, May 31, 2011.
- <sup>47</sup> Phone interview with Rob DeLine, May 31, 2011.
- <sup>48</sup> American Wind Energy Association (AWEA). Fact sheets. ([www.awea.org](http://www.awea.org)).
- <sup>49</sup> AWEA, BGA and USW, *Winds of Change*, 11.
- <sup>50</sup> AWEA, BGA and USW, *Winds of Change*
- <sup>51</sup> Ibid. In comparison, Texas is first in wind resources, with a potential of 1,901,530 MW of wind power generation (at 80 meters). Iowa is seventh in wind resources, with 570,714 MW (at 80 meters).
- <sup>52</sup> AWEA, *Wind Energy Facts: California*, May 2011 ([www.awea.org](http://www.awea.org)).
- <sup>53</sup> See Joel S. Yudken, *Clean Energy Manufacturing in Michigan*. Memorandum Prepared for Apollo Alliance, Clean Energy Manufacturing Project, San Francisco, CA. May 5, 2011.
- <sup>54</sup> Marcy Lowe, Saori Tokuoka, Tali Trigg and Gary Gereffi. *Lithium-ion Batteries for Electric Vehicles: The U.S. Value Chain*. Center on Globalization Governance & Competitiveness, Duke University. October 5, 2010.
- <sup>55</sup> Lowe et al, *Lithium-ion Batteries*; Bill Canis, *Battery Manufacturing for Hybrid and Electric Vehicles: Policy Issues*. CRS Report for Congress [R41709], Congressional Research Service, Washington, DC. March 22, 2011:8.
- <sup>56</sup> Lowe et al, *Lithium-ion Batteries*; Canis, *Battery Manufacturing* (CRS).
- <sup>57</sup> Canis, *Battery Manufacturing* (CRS), 8.



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- <sup>58</sup> Lowe et al, *Lithium-ion Batteries*; Bill Canis, *Battery Manufacturing for Hybrid and Electric Vehicles: Policy Issues*. CRS Report for Congress [R41709], Congressional Research Service, Washington, DC. March 22, 2011:8.
- <sup>59</sup> Smith et al, *2011-2012 Investment Plan*.
- <sup>60</sup> Shane Stephens-Romero, Steve Mazor and Jonathan Leonard. *Fueling California, Projected Outlook for Next Generation and Alternative Transportation Fuels in California, 2010-2030*. Prepared by Advanced Power and Energy Program, University of California, Irvine and Automotive Research Center, Automobile Club of Southern California, and TIAX LLC. Orange County Business Council, 2011: 5.
- <sup>61</sup> Ethanol and biodiesel are the most common kinds of alternative fuels or biofuels. However, biofuels can also encompass methane and hydrogen, which can be made from a variety of biological sources.
- <sup>62</sup> Large corn-growing midwestern states, not surprisingly, are the largest manufacturers of ethanol. Iowa is by far the largest producer, with 42 plants with a combined capacity of 3.6 billion gallons per year. Other major producer states each with at least 1 billion gpy include Nebraska, Illinois, Indiana, Minnesota, and South Dakota. This is latest data, as of June 17, 2011, available online provided by *Ethanol Producer Magazine*, (<http://www.ethanolproducer.com/plants/listplants/USA/>).
- <sup>63</sup> Smith et al, *2011-2012 Investment Plan*: 48ff.
- <sup>64</sup> Along with biomethane, biomass-based diesel is considered to be one of the most effective alternative fuels for reducing GHG emissions. Smith et al, *2011-2012 Investment Plan*
- <sup>65</sup> "UOP technology for California advanced fuel plant," *Brighter Energy News*, September 1, 2010. ([www.BrighterEnergy.org](http://www.BrighterEnergy.org)).
- <sup>66</sup> Smith et al, *2011-2012 Investment Plan*; Leslie Baroody, Charles Smith, Michael A. Smith, Charles Mizutani. *2010-2011 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program* Commission Report. California Energy Commission, Fuels and Transportation Division. August 2010. Publication Number: CEC-600-2010-001-CMF: 68-69.
- <sup>67</sup> Baroody et al, *2010-2011 Investment Plan*.
- <sup>68</sup> Next 10, *2010 California Green Innovation*; BW Research Partnership et al, *Emerging Industry and Technology Sectors*.
- <sup>69</sup> Next 10; *2010 California Green Innovation*, 34; EIA, *U.S. States, California*.
- <sup>70</sup> To meet the goals for renewable substitutes for both gasoline and diesel, both the federal government and State of California have invested in the development of biofuel and biodiesel production and refueling infrastructure. Smith et al, *2011-2012 Investment Plan*, 22.
- <sup>71</sup> CEC, Clean Energy Manufacturing Program. (<http://www.energy.ca.gov/recovery/cleanenergy.html>).
- <sup>72</sup> CEC, *ARRA Summary, California*.
- <sup>73</sup> GetSolar Staff, "CEC announces clean energy business financing program. *GetSolar.com*. March 14, 2010. CEC signed a contract with the California Business, Transportation, and Housing Agency to administer program, which allows the CEC to administer the CEBFP in cooperation with four Financial Development Corporations (FDCs) located throughout California: Pacific Coast Regional Small Business Development Corporation (SBDC) and San Fernando Valley Financial SBDC in Southern California; State Assistance Fund for Enterprise Business and Industrial Development Corporation (SAFE-BIDCO) in Northern California; Valley Small Business Development Corporation in San Joaquin Valley;
- <sup>74</sup> CaliSolar also received a \$51.6 million ARRA 48C tax credit. "ENERGY COMMISSION APPROVES FIRST CLEAN ENERGY BUSINESS LOAN." *States News Service*. August 25, 2010. *HighBeam Research*. (June 28, 2011). <http://www.highbeam.com/doc/1G1-235462795.html>
- <sup>75</sup> Eligible recipients include public agencies, private businesses, public-private partnerships, vehicle and technology consortia, workforce training partnerships and collaboratives, fleet owners, consumers, recreational boaters, and academic institutions.
- <sup>76</sup> "Quallion Receives Intent From California Energy Commission to Provide Up to \$9M in Cost Sharing for Lithium Ion Battery Manufacturing Facility." *U.S. Newswire*. May 28, 2009; "Leyden Energy Launches Next Gen Lithium-Ion Battery Line." *Manufacturing Close-Up*. May 26, 2011
- <sup>77</sup> Smith et al, *2011-2012 Investment Plan*, 48ff.
- <sup>78</sup> Smith et al, *2011-2012 Investment Plan*, 129.
- <sup>79</sup> Ibid.
- <sup>80</sup> Ibid.
- <sup>81</sup> Smith et al, *2011-2012 Investment Plan*, 115. These projects, spread through the state, are in various phases ranging from feasibility to commercialization and use a variety of feedstocks including waste water

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- treatment sludge, food waste, animal manures, landfill woody biomass residues, and post-sorted MSW. Once fully commercialized, these project expected to displace more than 6.5 million DGE.
- <sup>82</sup> The I-Bank began full operations in 1999, after implementation of Chapter 4, Statutes of 1998 (SB 1184). It began with transactions associated with Rate Reduction Bonds issued in FY 1997-1998. California Infrastructure and Economic Development Bank (I-Bank), *Description of the I-Bank and Programs*, Updated November 2010.
- <sup>83</sup> The eligibility requirements for IDBs are governed by provisions in the Internal Revenue Code and U.S. Treasury regulations. I-Bank, *Description of the I-Bank*.
- <sup>84</sup> A letter in support of AB 700 signed by 11 business council and regional economic development organizations notes that "instead of serving as a "program" in the Business, Transportation & Housing Agency (BT&H), AB 700 would place the I-Bank "in state government," allowing the I-Bank and its Board to more fully control its own fee—and interest earnings—supported budget, providing for greater independence, flexibility and effectiveness in terms of directing capital to where it would best support its economic growth mission." It also would make administrative changes giving it more autonomy to control its own functions. Letter to Assemblymember Felipe Fuentes, Chair, California Assembly Appropriations Committee and Assemblymember Diane Harkey, Vice Chair, California Assembly Appropriations Committee, *Re: AB 700, as amended-SUPPORT*. June 10, 2011. Signatories to the letter include the heads of the Bay Area Council, Greater Antelope Valley Economic Alliance, Los Angeles County Economic Development Corporation, Los Angeles Area Chamber of Commerce, North Bay Leadership Council, Orange County Business Council, San Francisco Chamber of Commerce, San Gabriel Valley Economic Partnership, San Diego Regional Economic Development Corporation, Inland Empire Economic Partnership, and Coachella Valley Economic Partnership.
- <sup>85</sup> CalPERS Global Real Estate Environmental Initiative Update: Report to the Investment Committee, 2009, <http://www.calpers.ca.gov/eip-docs/about/board-cal-agenda/agendas/invest/201012/item08b-2-01.pdf>; "CalPERS Deploys \$500 Million to New Environmental Investment Strategy," 2010, <http://www.calpers.ca.gov/index.jsp?bc=/about/press/pr-archive/pr-2010/nov/calpers-deploys.xml>
- <sup>86</sup> "State Treasurer Phil Angelides Launches 'Green Wave' Environmental Investment Initiative to Bolster Financial Returns, Create Jobs and Clean Up the Environment." News Release, California State Treasurer. February 3, 2004.
- <sup>87</sup> CalPERS Global Real Estate Environmental Initiative; CalPERS Deploys \$500 Million."
- <sup>88</sup> Yudken, *Clean Energy Manufacturing in Michigan*.
- <sup>89</sup> California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA), *2010 Annual Report to the California State Legislature*. Sacramento, CA, March 2011. The SB 71 Program was signed into law by Governor Arnold Schwarzenegger on March 24, 2010. The Authority began receiving applications in October 2010 and the first round of applicants were approved in November 2010. SB 71 expanded the eligibility for STEs from only new equipment purchases for zero-emissions vehicles (ZEV) to all clean-tech manufacturers.
- <sup>90</sup> CAEATFA, *2010 Annual Report*. Monterey County received 3 awards (2 for land fill gas capture and production (or alternative fuels), 1 for lithium battery manufacturing), Kern (2 alternative fuel companies), Orange (1 solar PV, 1 alternative fuel), and San Joaquin (2 landfill gas capture), each received 2 project approvals; Butte (landfill gas capture), Imperial (lithium batteries), Merced (biogas capture), and San Diego (biogas capture) each received one.] As of May 1, 2001, only three projects had used the STE, for a total STE value of \$24 million.
- <sup>91</sup> See <http://www.hcd.ca.gov/fa/cdbg/ez/EZoverview.html>.
- <sup>92</sup> See Richard Cincel, "Enterprise zone program under attack, some say: proposed bill would help smaller firms, author contends." *San Diego Business Journal*. May 11, 2009. Bruce Stenslie and Steve Kinney, "Enterprise zones a boon for California economy," *Ventura Country Star*. July 2, 2009. Mary Duan, "Companies seek faster route to profitability in San Jose's enterprise zone." *San Jose Business Journal*. July 26, 2010.
- <sup>93</sup> CEC, *HR 1 American Recovery and Reinvestment Act of 2009 (ARRA), Energy-Related Funding Summary*. Updated September 14, 2009. ([www.energy.ca.gov/recovery/documents/funding\\_summary.pdf](http://www.energy.ca.gov/recovery/documents/funding_summary.pdf)); U.S. Department of Energy (DOE), *Recovery Act State Memos, California*. June 1, 2010. (<http://www.energy.gov/recovery/ca.htm>).
- <sup>94</sup> See <http://www1.eere.energy.gov/wip/sep.html>.
- <sup>95</sup> DOE, *Recovery Act State Memos, California*.
- <sup>96</sup> "Fact Sheet: \$2.3 Billion in New Clean Energy Manufacturing Tax Credits." ENERGY.GOV. January 8, 2010. <http://www.energy.gov/news/8503.htm>. See also The White House, Office of the Press Secretary,

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- "President Obama Awards \$2.3 Billion for New Clean-Tech Manufacturing Jobs." Press release. January 8, 2010.
- <sup>97</sup> Ibid. All grid-connected solar installations generated more than 2.85 gigawatts of electricity, enough to power nearly 600,000 U.S. homes, according to a quarterly report by SEIA and GTM Research.
- <sup>98</sup> DOE, *Selections for Section 48C Manufacturing Tax Credit* (Excel database). California companies received \$235.5 million from the program the first time around, and the state has multiple approved projects and millions of dollars waiting for the tax credit to receive more funding..
- <sup>99</sup> Ibid.
- <sup>100</sup> U. S. DOE Office of Chief Financial Officer (CF), *Department of Energy FY 2012 Congressional Budget Request*. DOE/CF-0058, Volume 2. February 2011, 244.
- <sup>101</sup> Richard Caperton, "Invest in America's Clean Energy Future, Congress Should Embrace the DOE Loan Guarantee Program." Washington, DC: Center for American Progress, March 2011: 3. DOE, *Energy.gov/Recovery Table*.
- <sup>102</sup> An average project has a credit subsidy cost in the range of 5 percent to 15 percent of the total value of the loan guarantee, which yields this range of loan guarantees. Credit subsidy costs refer to the amount the federal government allocates to cover the risks of borrowers not paying back their loans when it issues a loan guarantee. Caperton, "Invest in America's Clean Energy Future," 3.
- <sup>103</sup> Caperton warns that a House proposal would take back the \$2 billion that has not yet been 'obligated' to specific projects. He notes that "[g]uarantees whose funds have been 'obligated' are now 'closed' in DOE parlance. Fewer than 20 projects have closed to date and less than \$500 million in funds has been 'obligated.' But a robust pipeline of projects is set to close by September 2011. Many projects were given 'conditional commitments' which include specific terms and are expected to eventually close. But funds set aside for "conditional commitments" have not been 'obligated' in the technical sense." Caperton, "Invest in America's Clean Energy Future," 3-4.
- <sup>104</sup> Koch, "U.S. solar power industry booms"; U.S. Department of Energy (DOE), *Recovery Act State Memos, California*. June 1, 2010. (<http://www.energy.gov/recovery/ca.htm>).
- <sup>105</sup> Koch, "U.S. solar power industry booms," SEIA and GTM, *U.S. Solar Market Insight*, 2. According to a Duke University study, eight of the 13 biggest planned CSP projects in the world are expected to be located in California and Arizona. The Sun Belt region of the United States, particularly the Southwest, is one of the largest areas in the world for CSP exploitation because of its abundant sunshine. Currently, four parabolic trough plants are operating with a combined capacity of 419 MW, two in California and one each in Arizona and Nevada. Gary Gereffi and Kristin Dubay. *Concentrating Solar Power, Clean Energy for the Electric Grid*. In *Manufacturing Climate Solutions, Carbon Reducing Technologies and U.S. Jobs. Chapter 4*. Center on Globalization, Governance & Competitiveness, Duke University. September 22, 2009. 52-64.
- <sup>106</sup> SBIR was initially funded by a 0.15 percent, phased in set-aside. The set-aside was increased to 0.3 percent in FY 2004. The program was supposed to sunset at the end of FY 2009, but has been temporarily extended. Wendy H. Schacht, *Industrial Competitiveness and Technological Advancement: Debate Over Government Policy*. CRS Report for Congress [RL33528]. Washington, DC: Congressional Research Service (CRS), November 5, 2009: 5.
- <sup>107</sup> Deborah D. Stine, *Advanced Research Projects Agency-Energy (ARPA-E): Background, Status, and Selected Issues for Congress*. CRS Report for Congress [RL34497]. Washington, DC: Congressional Research Service, April 29, 2009.
- <sup>108</sup> ARRA also provided grants to 6 solid state lighting manufacturing firms (all in Santa Clara County) worth \$13.7 million. U.S. Department of Energy, *Energy.gov/List of Awardees*. As of May 20, 2011. Excel spreadsheet.
- <sup>109</sup> See <http://www1.eere.energy.gov/>.
- <sup>110</sup> "SunPower's and Flextronics' New Solar Manufacturing Plant Creates Jobs, Economic Benefits and Clean Affordable Energy." *Benzinga.com*. April 12, 2011. *HighBeam Research*. (June 28, 2011). <http://www.highbeam.com/doc/1G1-253856251.html>; "SUNPOWER/FLEXTRONICS TO MANUFACTURE SOLAR PANELS.(Company overview)." *Worldwide Energy*. 2010. *HighBeam Research*. (July 18, 2011). <http://www.highbeam.com/doc/1G1-224773764.html>
- <sup>111</sup> CEC, *California Renewable Energy*. Since 2007, the CPUC It also funded grid-connected, solar/photovoltaic electricity systems under 30 kilowatts on homes and businesses in investor-owned utilities' service areas, wind systems up to 50 kW in size, fuel cells (using a renewable fuel), and solar thermal electric.
- <sup>112</sup> The CSI has a budget of \$2 billion for 10 years, with a goal to reach 1,940 MW of installed solar capacity by 2016. The CPUC's rebate program provides cash back for solar energy systems of less than one megawatt to new commercial, industrial, government, nonprofits and agricultural properties.

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- <sup>113</sup> This was Executive Order S-14-08, signed on November 17, 2008. It was followed by Executive Order S-21-09, which directed the California Air Resources Board, under its AB 32 authority to enact regulations to achieve the 33 percent goal. CEC, *California Renewable Energy*
- <sup>114</sup> The goals re 20 percent of retail sales by end of 2013, 25 percent by end of 2016, and 33 percent by 2020. CEC, *California Renewable Energy*.
- <sup>115</sup> <http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/feedintariffs.htm>
- <sup>116</sup> <http://www.gosolarcalifornia.ca.gov/about/nshp.php>
- <sup>117</sup> Ibid.
- <sup>118</sup> Smith et al, *2011-2012 Investment Plan*, 111.
- <sup>119</sup> See <http://www.energy.ca.gov/pier/>.
- <sup>120</sup> A full listing of the PIER portfolio can be found at: <http://www.energy.ca.gov/pier/portfolio/PIERwrite-ups.htm>. See also: [http://www.energy.ca.gov/research/reports\\_pubs.html](http://www.energy.ca.gov/research/reports_pubs.html) and [http://www.energy.ca.gov/publications/pier\\_factsheet\\_search.php](http://www.energy.ca.gov/publications/pier_factsheet_search.php).
- <sup>121</sup> Silicon Valley Leadership Group (SVLG), Policy Recommendations to Create CA Manufacturing Jobs, San Jose, CA, January 2011 ([www.svlg.org](http://www.svlg.org)).
- <sup>122</sup> iHubs are anchored by at least one major university center/institution, at least one economic development corporation, and typically contain assets such as research parks, technology incubators, universities, community colleges, business accelerators and federal laboratories. Each iHub is designated for a period of five years. The ultimate purpose is to create links to the Governor's Office of Economic Development and encourage a stronger relationship with local government entities within various regions, helping to remove barriers to public-private collaborations needed to commercialize technology. GoED, *California Investment Guide*, 7.
- <sup>123</sup> See <http://www.business.ca.gov/Innovation.aspx>.
- <sup>124</sup> Ibid.
- <sup>125</sup> The Green Collar Jobs Council is leading a statewide partnership of state agencies, educational institutions, local workforce investment boards, community organizations and employers.
- <sup>126</sup> Panama Bartholomy, *Clean Energy Workforce Training Program*. Slideshow presentation. California Energy Commission. ~2010.
- <sup>127</sup> See "Funding Priorities for FY 2011-2012" in the ETP website: <http://www.etp.ca.gov/>.
- <sup>128</sup> Ibid.
- <sup>129</sup> See <http://www.etp.ca.gov/>. ETP's green/clean technology contracts include energy generation and efficiency; renewable energy or construction; recycling of various sorts; manufacturing; facilities that convert solar, wind, and tidal power into electrical energy; wholesale distribution of automotive scrap, industrial scrap, and other recyclable materials; environmental consulting in a myriad of areas; clean up services that address contaminated buildings, mines sites, soil, or ground water; promoting the preservation and protection of the environment and wildlife; and other types of green strategies.
- <sup>130</sup> Next 10; *2010 California Green Innovation*, 48.

## APPENDIX A

### Estimating CEM Employment in California

A survey by the California's Employment Development Department (EDD) to estimate the amount and distribution of green jobs across the state's industrial sectors, came up with a rough estimate of 88,810 workers in the manufacturing sector associated with some responsibilities tied to green activities.

<sup>1</sup> The definition of green jobs employed in this survey however are far too broad to be useful.

Next 10's study, *Many Shades of Green*,<sup>2</sup> introduces the notion of a "Core Green Economy" which focuses on a narrower cross-section of the state's green economy. It is confined to businesses that provide the products and services that produce alternatives to carbon-based energy sources, conserve energy and all natural resources, and reduce pollution and repurpose waste.<sup>3</sup> The fifteen industrial segments or clusters comprising the Core Green Economy, each focusing on specific green or clean energy areas, include both high-value services and manufacturing.<sup>4</sup> However, only some parts of employment in each segment as defined here can be properly called CEM.<sup>5</sup>

In any case, services and manufacturing make up the largest shares of green employment in the state—and within each cluster, though the mix of their value chain roles varies widely. According to the Next 10 report, *2010 California Green Innovation Index*, services accounts for 45 percent of all green employment in California, 2008, and manufacturing accounts for 21 percent—in contrast to a 11 percent share of total employment in the state economy. Recognizing that only manufacturing jobs *within* the larger energy generation, energy storage and transportation clusters can be associated with CEM. These make up only about 16 percent of an estimated total 33,331 green energy manufacturing jobs in California in 2008, or 5,200 jobs which count as CEM in the Apollo definition.<sup>6</sup>

Another study, which assessed Silicon Valley's green economy, on the other hand, indicates that this number may be too low. Silicon Valley is probably the leading clean energy center in the state and a worldwide leader in green technology, especially in the research, development and production of solar technology products and services. The study examined five industry sectors where "emerging green employers" are likely to be found: energy, materials and manufacturing, specialized suppliers and supporting industries, transportation, and water. It further identified three types of green employers which either (i) produce or manufacture products (or are in the process of developing) green products), (ii) provide or are in the process of developing green services, or (iii) directly support the development or production of green products or services that will be provided to customers.<sup>7</sup>

Of the key sectors, energy (solar, wind, smart grid devices and networks, energy storage, and infrastructure), transportation (hybrid and all-electric vehicles, advanced batteries, electric rail and transportation infrastructure), and specialized suppliers & supporting industries (including contract manufacturing, engineering and design services) include many firms that also qualify as CEM employers. The study estimated that total employment in the five industrial sectors accounts for 175,077 jobs or 14 percent of all employment in Silicon Valley. Of these, it identified a total of 14,401 jobs within 1,158 firms that fall with one or more types of green firms. As the study also found that overall 46 percent of green firms identify as green manufacturing, this suggests that up to 550 firms and 7,000 employees in Silicon Valley may qualify as CEM.<sup>8</sup> This suggests a much higher number of firms and employees may count as CEM around the state, compared to the Next 10-based estimates.

## APPENDIX B

### California Clean Energy Manufacturing Sectors

#### a. Solar Energy

Solar energy is the fastest growing energy technology, and one of the fastest-growing sectors in the U.S. economy. The U.S. solar market grew 67 percent in 2010, rising from \$3.6 billion in 2009 to a \$6 billion industry.<sup>9</sup> This is in contrast to U.S. GDP growth of 2.8 percent in 2010.<sup>10</sup> The U.S. solar PV market remains the industry's most attractive and stable growth market.<sup>11</sup> U.S. PVs generated 66 percent more power in the first quarter of 2011 than during the same time last year, with commercial installations posting the largest gains. This growth has been attributed to reduced equipment costs and a rush to take advantage of ARRA federal tax credits (48C) that were expected to retire in 2010 but extended through 2011.<sup>12</sup> According to the SEIA, the U.S. PV manufacturing sector enjoyed strong growth in 2010, as production of upstream PV components by domestic manufacturers increased substantially—for example, year-over-year growth for wafers was 97 percent, for cells, 81 percent and for modules, 62 percent.<sup>13</sup> Substantial expansion in both in global and domestic demand is largely responsible for stimulating domestic production in solar PVs.<sup>14</sup> However, although these encouraging trends augur well for California's PV manufacturers (and other domestic PV producers), they are facing significant competitive challenges from low-cost regions such as China and Taiwan.

California leads the nation in PV installations, followed by New Jersey, Arizona and Pennsylvania.<sup>15</sup> It also is one of six states with concentrating solar power (CSP; a.k.a., concentrating solar thermal power) installations and is the leading installer of solar heating systems in 2010.<sup>16</sup> California is expected to get a large addition to its CSP capacity. The DOE is offering a \$1.2 billion loan guarantee for the Mojave Solar Project in San Bernadino, CA and \$681.6 million for Genesis Solar Project in Riverside County, CA. At 250 MW each, the projects together will double the nation's current CSP capacity and displace 40 percent of the output of a typical 500-megawatt coal-fired plant. These projects are expected to generate about 1,630 construction jobs and 114 jobs.<sup>17</sup>

Not surprisingly, California leads the nation in the number of solar businesses; it currently is home to about 30 percent of all solar companies and estimated solar jobs in the United States.<sup>18</sup> These range from contractors/installers, distributors, and manufacturers/suppliers to other service providers (including architects, consultants, and researchers). Of the 1,049 solar companies in California compiled in a list by the Solar Energy Industries Association (SEIA), 188 are identified as manufacturers and/or suppliers.

***PV manufacturing.*** The state especially excels and leads the nation in PV manufacturing, mainly located in the Bay Area (largely in Silicon Valley). The state

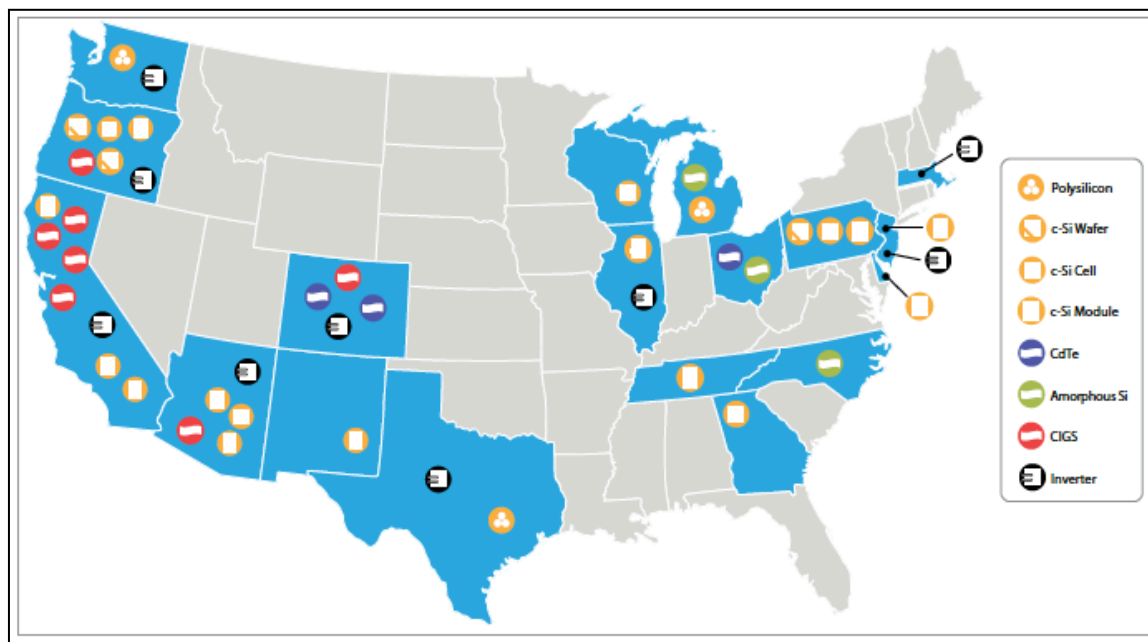


is home to the largest share of the 39 active facilities engaged in manufacturing PV components (polysilicon, wafers, cells, modules, inverters) spread across 17 states in the nation (see figure 1). California's strong position in PV manufacturing is due to its leadership as an end-market, as well as the adjacent states of Oregon and Arizona, which offer skilled labor and strong policy support for PV manufacturers.<sup>19</sup>

According to the SEIA, the U.S. PV manufacturing sector enjoyed strong growth in 2010, as production of upstream PV components by domestic manufacturers increased substantially—for example, year-over-year growth for wafers was 97 percent, for cells, 81 percent and for modules, 62 percent.<sup>20</sup> Substantial expansion in both in global and domestic demand is largely responsible for stimulating domestic production in solar PVs.<sup>21</sup> However, although these encouraging trends augur well for California's PV manufacturers (and other domestic PV producers), they are facing significant competitive challenges from low-cost regions such as China and Taiwan.

**Solar market competition.** California currently accounts for nearly half of all solar power in the United States. Its solar market continued to grow by 33 percent in 2009, despite the recession. In the three years prior to and leading through 2009, China's share of California's solar market rose from 1 percent to nearly 46 percent, while American companies' share fell from 43 percent to 16 percent.<sup>22</sup> China dominates globally as well—it has 85 percent of world's PV manufacturing capacity.<sup>23</sup>

**Figure 1—U.S. PV Manufacturing Map**



Legend of PV technologies: c-Si=crystalline silicon, CdTe=cadmium telluride; CIGS= Copper-Indium-Gallium-Selenium. Source: Solar Energy Industries Association and GTM Research, U.S. *Solar Market Insight™*, 2010 Year in Review, Executive Summary. <[www.gtmresearch.com/solarinsight](http://www.gtmresearch.com/solarinsight)> [www.seia.org/cs/research/solarinsight](http://www.seia.org/cs/research/solarinsight)>. Figure 2-9, p. 13.



Cost pressures will continue to be an issue affecting the international competitiveness of domestic manufacturers. However, as Rob DeLine, VP of Marketing of the Silicon Valley solar PV company Miasolé, notes, Chinese PV cells are commonly based on crystalline-Silicon-based technology. This technology has been around for around 30 to 40 years, and to be low-cost, the solar PV installations need to be giant scale, about 1 gigawatt (GW) or more. His firm, along with other California firms (including many start-ups), is exploring the development of more advanced technologies (e.g., CIGS, or copper, indium, gallium and selenium cell technology) for making solar PVs, which are high performing at a lower cost.<sup>24</sup> Hence, technology innovation is key for U.S. solar manufacturers to remain competitive in the face of lower-cost foreign competition.

The pressures of low-cost international competition also has intensified the competition between states within the United States for attracting new investment in solar PV manufacturing, not to mention other clean energy technologies. For example, in January 2011, two Silicon Valley solar panel manufacturers announced they would build new factories in southern states that “offer business-friendly conditions and strong clean energy markets.” This includes San Jose-based Stion Corp., which will invest \$500 million to build a new production facility in Hattiesburg, MS, after the state agreed to a \$75 million loan, and tax and training incentives. AQT Solar of Sunnyvale plans to spend \$300 million on a new plant in Blythewood, SC. Both factories are expecting to create 1,000 new jobs each.<sup>25</sup>

## **b. Wind Power**

The growth of wind power capacity in the United States increases the market opportunities for U.S. manufacturing throughout the wind energy supply chain. Nationally, total U.S. utility-scale wind power capacity through the first quarter of 2011 was 41,400 MW, which can power over 10 million homes. This represents over one-fifth of the installed wind capacity in the world. In 2010, wind power provided 2.3 percent of the U.S. electricity mix and accounted for 25 percent of all new U.S. electric capacity in 2010. Over the past four years, wind power added 35 percent of all *new* U.S. electricity capacity, second only to natural gas, and more than nuclear and coal combined.<sup>26</sup>

U.S. wind capacity has increased at a steady rate since the mid-1990s, especially between 2006-2009, though new installations dropped in 2010. Before 2005, only 6,700 MW had been installed cumulatively in the United States; since then wind power capacity increased five-fold.<sup>27</sup> Installation growth reached an all time high in 2009, with 10,010 MW added wind power installations. The U.S. wind industry built only half that in 2010, 5,116 MW of new wind power, posting a 15 percent growth. However, new capacity under construction was 5,600 MW entering into 2011, already more than the previous year.<sup>28</sup>

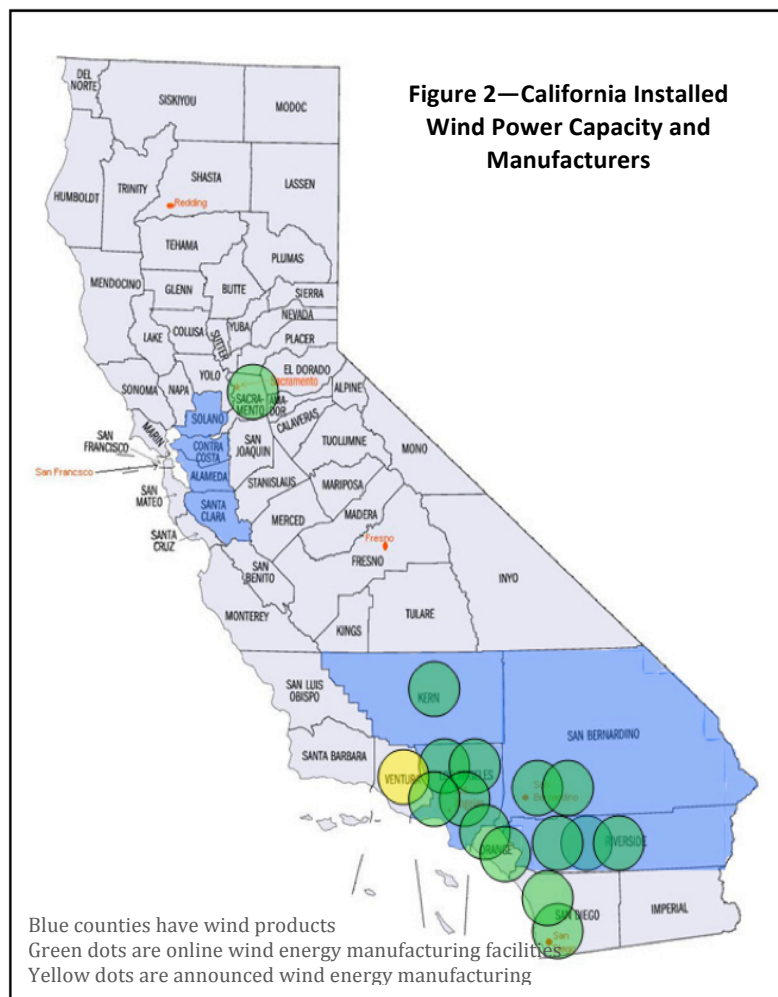
**State comparisons.** The first wind farms were constructed in California in the 1980s, and until 2000 California led the nation in wind power. Today 38 states have utility-scale wind installations, and California is no longer first in the nation in installed utility-scaled wind power capacity. It currently is third, behind Texas and Iowa in overall wind installation and in new wind capacity in 2010 (455 MW).<sup>29</sup> At the end of 2010, California had 3,177 MW of installed wind power online, 594 MW was under construction, and 18,269 MW of wind power projects in queue. In 2009, the share of California power provided by wind was 3.3 percent, equal to powering 850,000 homes.<sup>30</sup>

In comparison, Texas has become the national leader in current wind installation, with 10,135 MW online and 63,504 MW of wind projects in queue.<sup>31</sup> This reflects the huge wind resources available to Texas compared to California—the former’s wind resource is 1.9 million MW, while the latter’s is 34,100 MW (at 80 meters) and ranks nineteenth in the nation.<sup>32</sup>

**U.S. wind power manufacturing.** The rapid expansion in wind power installations over the past five years has attracted investments in both domestic and foreign businesses in U.S.-based

manufacturing for the wind industry.<sup>33</sup> The U.S. wind power manufacturing sector has grown significantly over the past few years as a result. Compared to only a few dozen manufacturers in 2004, there were over 400 wind-related manufacturing facilities in 2010 making components for wind turbines, such as towers, blades and assembled nacelles in every region of the country. Fourteen new wind-related manufacturing facilities were brought online in 2010.

Earlier in the 2000s decade foreign manufacturers



dominated in supplying components for U.S. wind turbines and wind power installations. In 2004-2005 domestic content in wind turbines, by value, was only around 25 percent. By 2009, domestic content had risen to approximately 50 percent. Domestic supply bases first developed to supply components that are large and expensive to transport, i.e., towers and blades. After five years of a strong domestic market, the majority of blades and towers used in U.S. wind power installations are domestically made. Turbines subsequently began to be constructed in U.S. nacelle assembly facilities, and the domestic manufacturing base for this market segment is growing.<sup>34</sup>

Currently, there are 20 U.S. tower makers, 11 blade manufacturers, and 12 turbine nacelle assembly facilities in the United States. At the end of 2010, GE Energy dominated the market share of total U.S. wind turbines manufactured, accounting for 41.3 percent (16,500 MW).<sup>35</sup> Blade manufacturing primarily occurs in the Midwest and the Pacific region of the United States, while towers are produced mainly in the Midwest and the South. Nacelles and controls are mostly made in Midwest, and gearboxes and drive trains are manufactured almost totally in the Midwest.<sup>36</sup>

***California wind power manufacturing.*** California remains a leading state housing wind turbine and components manufacturing. At least 15 different facilities around the state are currently involved in manufacturing facilities (see figure 2 above). The state is home to several major wind manufacturers, including wind turbine leader GE Energy and major tower supplier Ameron. Other states, such as Ohio, Texas, and Michigan, have a great deal more wind power-related manufacturing facilities (50, 35, and 31, respectively) and several have comparable manufacturing activity, including Pennsylvania, Minnesota, Wisconsin, and Indiana, for example.<sup>37</sup> As the map in figure 2, shows, installed wind power generation capacity resides in San Bernadino, Kern, Los Angeles, and Riverside counties in southern California, and Santa Clara, Alameda, Contra Costa, and Solano counties in Northern California. It also shows that in California wind power; tends to mainly be concentrated in Southern California, especially Los Angeles, Riverside, and San Diego counties.

### **3. Advanced Energy Storage**

Advanced energy storage (AES) technology, especially lithium-ion batteries, is not at this time employed on any appreciable scale in clean energy electricity generation. Lithium-ion batteries have emerged as an important technology for use in hybrid and electric vehicles, however. This market is expected to grow over the next decade, globally and domestically, generating potentially substantial manufacturing opportunities in California and other states throughout the nation. For example, the Duke University-based Center on Globalization, Governance & Competitiveness (CGGC) estimates that although demand for electric vehicle (EV) batteries is currently small, it is expected to grow very quickly. For example, in 2009, the global market for batteries for hybrid electric vehicles (HEV) and Plug-in Hybrid

Electric Vehicles (PHEV) was only \$1.3 billion, but by 2020 the global market for advanced batteries for EVs is expected to reach \$25 billion. This is three times the size of the entire lithium-ion battery market for consumer electronics today.<sup>38</sup>

***Asian competition.*** CGGC notes that China, Japan, South Korea and the United States are currently the major lithium-ion battery manufacturers for EVs. Asia dominates however, capturing the overwhelming market share of lithium-ion battery manufacturing. Japan leads with a 57 percent market share, followed by Korea (17 percent) and China (13 percent). The United State remains far behind (about 2 percent of the global market), with only one U.S. company near the top of the list of major lithium-ion manufacturers in the world: A123Systems, Inc, which ranked 14<sup>th</sup> in 2009, with 1 percent of the global lithium-ion battery market.<sup>39</sup>

Asia's lead can be attributed to the government policies of Japan, South Korea, and China, which have poured considerable funding for building a competitive supply chain of lithium-ion for vehicles. In addition, since Asian companies have become better established, with the help of their governments' support, they now devote more of their own funds into R&D, compared to U.S. companies.

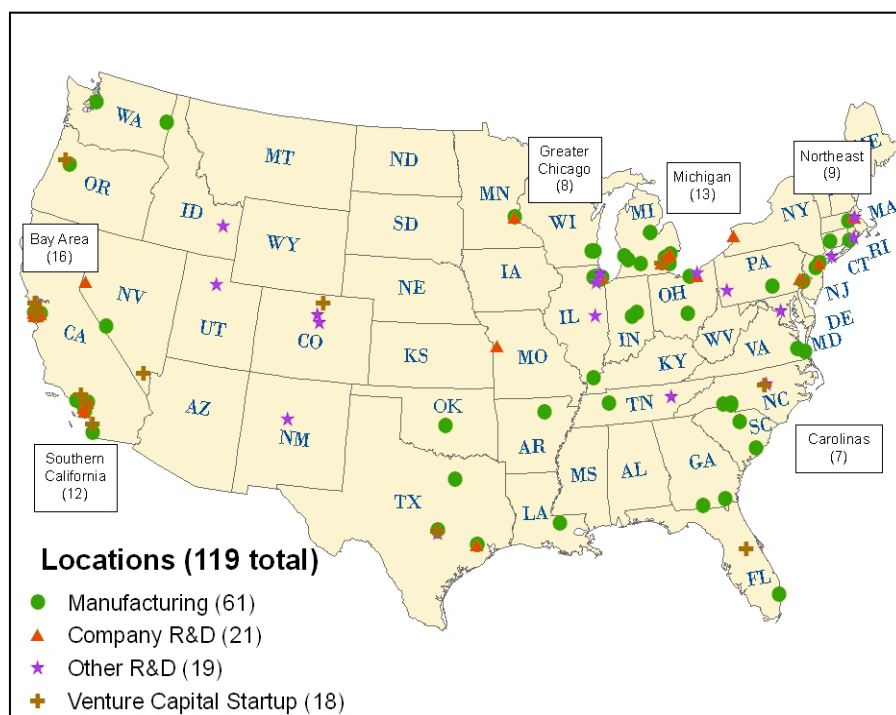
***California battery manufacturing.*** Nevertheless, the United States can still assume a strong leadership role in this emerging market. It is notable that it ranked second international and U.S. patents related to lithium-ion in 2009. Two states, California and Michigan, in particular, have become centers for advanced battery manufacturing. CGGC has identified 119 U.S. manufacturing R&D locations relevant to lithium-ion batteries (2009) (see figure 3). These include 61 U.S. manufacturing locations distributed over 27 states, 40 R&D locations, including 21 representing company R&D centers, 19 representing national labels or research centers affiliated with universities.<sup>40</sup>

About 30 percent of the total locations are in either California or Michigan, not coincidentally the two states with U.S. EV automakers, Tesla (California) and General Motors (Michigan). California has the most manufacturing locations (28), followed by Michigan (8), and Illinois (6). CGGC also reported 18 advanced battery startup firms in the United States, more than half located in California.<sup>41</sup> Table V, lists many of the California Lithium-ion battery manufacturing, R&D and start-up locations identified by CGGC.

#### **4. Biofuels**

Biofuels use plant or animal feedstock to produce fuels that can be used in transportation, as well as for providing heat and power for industrial processes and generating electricity. Biomass-based products can also be used as feedstock—substituting for petroleum or natural gas-based feedstock—in a wide range of manufactured products (e.g., plastics, solvents, chemical intermediates, lubricants, etc.).

**Figure 3—Advanced Battery Locations in the United States**



Source: Lowe et al, *Lithium-ion Batteries: 48*, figure 18.

The bio-industry value chain begins with collection of biomass feedstock that can take the form of agricultural residues, forestry residues, municipal solid waste, or energy crops (soybeans, corn). Biomass feedstock is then separated, processed, handled and transported to where it will undergo conversion. Conversion processes can take several forms: thermochemical (combustion, gasification, pyrolysis), biochemical (anaerobic, digestion, fermentation, aerobic, direct hydrogen), physiochemical (oil extraction, hydrocarbon extraction), and manufacturing (physical and chemical processing). The end products can include biofuels, such as ethanol, biodiesel, methanol, and hydrogen, electricity or heat power, bioproducts and chemicals, and food and feed and fiber.<sup>42</sup>

Most bio-industry activity, nationally and in California, has focused on providing low-carbon alternatives for as substitutes for petroleum-based transportation fuels, i.e., gasoline, diesel, and aviation fuels. Transportation fuels account for two-thirds of the 20 million barrels of petroleum consumed daily in the United States, two-thirds of which is imported from foreign sources. In California, transportation uses roughly half of all energy consumed in the state, and is 90 percent reliant on petroleum. Despite the economic crisis, Californians consume more than 50 million gallons of gasoline and diesel each day. This sector also accounts for approximately 40 percent of the state's greenhouse gas emissions (GHG), the largest from any sector.<sup>43</sup>

**Table V—Lithium-ion Battery Relevant Locations in California**

Company Name (Parent)	California	Components Involved in California Locations
<b>Relevant Manufacturing and R&amp;D Locations</b>		
AC Propulsion	San Dimas	Lithium-ion battery pack
Atmel	San Jose	Electronics (control system)
Applied Materials	Santa Clara	Battery cell design
Coda	Santa Monica	Lithium-ion battery back, battery cell
Intersil	Milpitas	Electronics
LithChem	Anaheim	Battery cell; electrolyte
Maxim Integrated Products	Sunnyvale	Electronics
Quantum Technologies	Irvine	Lithium-ion battery pack
Tesla Motors	Palo Alto	Lithium-ion battery pack, relevant automotive OEM
TIAX LLC	Cupertino	Cathode active material
<b>Startup Firms in the Lithium-Ion Industry</b>		
Amprion	Menlo Park	Anode active material
Atieva	Mountain View	Lithium-ion battery pack; electronics; software components
Contour Energy Systems (formerly CFX Battery)	Azuza	Battery Cell
Envia Systems	Hayward	Battery Cell
Farasis Energy	Hayward	Battery cell
Flux Power	Vista	Electronics
Leyden Energy	Fremont	Battery Cell
Quallion	Sylmar	Lithium-ion battery pack; battery cell
Seeo	Berkeley	Solid polymer electrolyte

Source: Lowe et al, *Lithium-ion Batteries*: 45, table 9; 50, table 10.

**Biofuels demand in California.** Biofuels, substituting for gasoline and diesel, can play a major role in reducing California’s dependency on petroleum imports and cutting its GHG emissions. A recent report by the California Council on Science and Technology (CCST), states that biofuels are an important component of California’s future fuel industry as it works to reduce its GHG emissions to 80 percent below 1990 levels by 2050. It notes that, “In 2050, even after aggressive electrification and efficiency gains, we will likely require 70 percent as much liquid and gaseous fuel as we use today.” It further estimates that the state will need about 13 billion gallons of gasoline equivalent per year (bgge/yr) to meet projected 2050 residual fuel demand including heavy transport, high quality heat, and gas to produce electricity for load balancing.<sup>44</sup>

Resources within California could provide between 3 and 10 bgge/yr of biofuels from waste products, crop residues, crop residues and marginal land. The remainder of its needs would come from imports. However, the report estimates that the construction of 110 plants, each with a 50 Mmg capacity, would be necessary to produce just 5.5 bgge/year of biofuel, requiring a total investment of between \$33 and \$55 billion over 40 years.<sup>45</sup>

**Ethanol production.** California has become a global leader in the development of alternative fuels mainly due to historic state policies and investment trends.<sup>46</sup> Petroleum is expected to continue fuel at least three-quarters of California's vehicles over the next two decades. However, alternative fuels' market share also will continue to grow, with ethanol providing the largest contribution.<sup>47</sup> This is largely because of the state's E10 mandate, with the potential to increase the blending requirement to E15 in the future.<sup>48</sup> Ethanol has become a controversial fuel, as critics claim corn ethanol production—and to a lesser extent sugarcane ethanol to be an inefficient process. Although cellulosic ethanol has the advantage of not using food crops, it is not yet a commercially developed technology and therefore unlikely to be counted on to contribute to the state's alternative fuel mix in the next 20 years. There are also doubts about how much ethanol can contribute to the GHG emissions reductions.<sup>49</sup>

Nevertheless, one projection is that ethanol will make up 15 percent of the state's fuel mix by 2025, up from 9 percent in 2010, and will remain steady at 15 percent through 2030.<sup>50</sup> In 2010 ethanol consumption rose to 1.5 billion gallons, up from 600 million in 2003 and only 100 million year before. However, most of this demand was met by imports, with only 4 percent met by ethanol produced in-state.<sup>51</sup>

Six Midwestern states account for 80 percent of the nation's ethanol production, which must be shipped to distribution terminals in other regions via truck, barge, or rail. California currently has 6 ethanol plants, five of which are corn-based, with a combined production capacity of 250 million gpy.<sup>52</sup> This capacity was built up just over the past decade, growing at an annual average rate of 55 percent between 2004-2008. However, all but one of these plants have been idled since January 2009 due to poor operating economics and high debt loads. According to the latest CEC draft investment plan for 2011-2012, not until the State's Low Carbon Fuel Standard (LCFS) begins in earnest will there be a mechanism in place to value and remunerate California producers for their lower carbon ethanol products.

**Biodiesel manufacturing.** The situation for biomass-based diesel or biodiesel is different, and a little more optimistic than for ethanol in California. Biodiesel is a substitute for petroleum-based diesel, produced from renewable resources such as vegetable oil, animal fats, or waste vegetable oil. Because it is less energy intensive than the production of ethanol from corn, it offers greater potential for reducing GHG emissions and environmental impacts. There also have been promising developments in technologies for producing biodiesel from algae. Early demonstrations suggest that this technology is feasible in terms of efficiency and resources inputs and therefore could be scalable to large plant-sizes to make it economically viable.<sup>53</sup>

According to the CEC *2010-2011 Investment Plan for Alternative and Renewable Fuel and Vehicle Technology Program*, along with biomethane, biomass-based diesel

represents one of the most effective alternative fuels for reducing GHG emissions. Biomass-based diesel fuels reduce GHG emissions 50 percent to 88 percent compared to conventional diesel fuel.<sup>54</sup> In addition, biodiesel is currently available to heavy-duty vehicle (HDV) fleets either commercially or in demonstration fleets.<sup>55</sup>

According to an Orange County Business Council report, “In theory biodiesel use is not constrained by the availability of vehicles; essentially all diesel-fueled vehicles in the population can utilize it, in some blend form.”<sup>56</sup> Pure biodiesel (B100) is available in the marketplace and some engines can use them without modification. Blends of up to 20 percent (B20) can be used in most diesel engines, without modification, which entails no major fueling infrastructure costs. It also delivers near equivalent vehicle range and refueling time, as diesel, and requires no special training for fleet fueling personnel. As a result, biodiesel can be a cost-effective petroleum displacement strategy. It also in some cases offers a solid air quality improvement strategy, although air quality regulators have expressed concerns that biodiesel use could significantly increase NOx emissions.<sup>57</sup>

Today, the National Biodiesel Board (NBB) identifies 16 biodiesel plants with combined annual production capacity of 84.5 million gallons per year (see table VI). The largest facility is that of Crimson Renewable Energy, LP in Bakersfield, which opened its doors in 2009, with a capacity of 30 million gallons. This list doesn’t include the Rialto Renewable Energy Center, a biodiesel plant under construction being developed Rentech, Inc. in Rialto, California. That facility is being designed to convert biomass including wood-waste into renewable fuels, from biodiesel to jet fuel. The plant is expected to produce 640 barrels per day of liquid fuel. In addition, it will produce 35 megawatts of base-load electricity, enough to power approximately 30,000 homes each day.<sup>58</sup>

According to the CEC, due to the industry’s inability to compete with petroleum-based diesel prices, six plants representing one-third of the state’s biodiesel production capacity are idle due to the price disparity. In 2010, therefore, the CEC noted that these plants likely produced far below their capacity, less than 5.5 million gallons, and in 2009, they likely produced only 25 million gallons.<sup>59</sup>

***Biomethane.*** California is also developing biomethane production capacity. Biomethane is made by treating organic matter with heat and bacteria, producing a biogas, which in turn is converted to biomethane by removing impurities. It can be used as an energy source in transportation, power generation, and combined heat and power applications. Biomethane is the alternative fuel with the lowest carbon intensity readily available in California.

The main potential sources for biomethane include dairies, landfills, wastewater treatment facilities, woody biomass from forest management activities, and municipal solid waste streams. Although biomethane has significant production potential, only a handful of biomethane or biogas projects currently are operating in



California. The most common feedstock being used is landfill gas. The CEC reports that currently 70 landfills in California are used to capture methane emissions as an energy source, at least two of the landfills produce biomethane for use as a transportation fuel.<sup>60</sup>

**Table VI—Biodiesel Plants in California 2011**  
(as of June 7, 2011)

Company	City	Ann. Production Capacity (gallons/year)	Feedstock
Crimson Renewable Energy, LP	Bakersfield	30,000,000	Multi Feedstock
Imperial Western Products	Coachella	10,500,000	Multi Feedstock
Community Fuels	Stockton	10,000,000	Multi Feedstock
Baker Commodities	Los Angeles	10,000,000	Multi Feedstock
Noil Energy Group	Commerce	5,000,000	Multi Feedstock
Blue Sky Biofuels	Oakland	4,000,000	Waste Oil
Bay Biodiesel, LLC	San Jose	3,000,000	Multi Feedstock
Biodiesel Industries of Ventura, LLC	Port Hueneme	3,000,000	Full Spectrum*
Whole Energy Fuels	Pacifica	3,000,000	Recycled Cooking Oil
Ecolife Biofuels, LLC	San Jacinto	1,500,000	Multi Feedstock
New Leaf Biofuel, LLC	San Diego	1,500,000	Used Cooking Oil
Promethean Biofuels Cooperative Corp.	Temecula	1,500,000	Multi-Feedstock
Simple Fuels Biodiesel, Inc.	Chilcoat	1,000,000	Waste Oil
Yokayo Biofuels, Inc.	Ukiah	500,000	Recycled Cooking Oil
Manning Beef, LLC	Pico Rivera		Tallow
San Francisco Public Utilities Commission	San Francisco		
<b>Total</b>		<b>84,500,000</b>	

\* including but not limited to yellow grease, jatropha & algae

<http://www.biodiesel.org/buyingbiodiesel/plants/showall.aspx?AspxAutoDetectCookieSupport=1>; As of June 7, 2011.

However, for the industry to grow it will need supportive government policies and additional financial incentives to offset the high capital costs associated with it being relatively new. Because of capital constraints and the uncertainty of how the economics of the industry would play out, a number of California biomethane projects were stalled in 2010. The CEC's biomethane program has provided \$33 million in funds for nine biomethane projects.<sup>61</sup> Nevertheless, funding remains a major need, and CEC is allocating \$8 million for FY 2011-2012 to continue to develop the biomethane for transportation industry in California.<sup>62</sup>

## APPENDICES ENDNOTES

<sup>1</sup> Next 10, *Many Shades of Green, Regional Distribution and Trends in California's Green Economy*. Prepared by Collaborative Economics, 2011, ([www.next10.org](http://www.next10.org)): 6.

<sup>2</sup> Next 10, *Many Shades of Green*: 8.

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- <sup>3</sup> Ibid., 4.
- <sup>4</sup> Ibid., 12. These segments include energy generation, energy efficiency, clean transportation, energy storage, air & environment, recycling & waste, water & wastewater, agriculture support, research & advocacy, business services, finance & investment, advanced materials, green building, manufacturing & industrial support, and energy infrastructure.
- <sup>5</sup> Employment and establishments in the energy generation cluster, for example, can be classified as services (renewable generation, including all forms of solar, wind, geothermal, biomass, hydro, marine and tidal, hydrogen, and co-generation), manufacturing of renewable energy products and components (e.g., solar cells and modules), installation, suppliers, research and development, among other activities. Others include public education service organizations, sales and finance and investment. Ibid.; See also Next 10; *2010 California Green Innovation*.
- <sup>6</sup> Within the major green economy clusters, manufacturing accounts for 44 percent of jobs in energy efficiency, 30 percent in energy generation, 64 percent in energy storage, 48 percent in transportation, and 37 percent in energy infrastructure. But, only manufacturing jobs in the energy generation, energy storage and transportation cluster can be associated with CEM. See Next 10, *Many Shades of Green*; Next 10; *2010 California Green Innovation*, 50.
- <sup>7</sup> BW Research Partnership, Green LMI, and Center for the Continuing Study of the California Economy, *Emerging Industry and Technology Sectors in Silicon Valley's Green Economy: Workforce Implications*. Conducted for work2future and NOVA. Carlsbad, CA, March 2011.
- <sup>8</sup> Many green employers identify themselves with more than one type of green firm: hence nearly 80 percent identify as green support firms, of which half identify also as green manufacturing and half as green service firms. Similarly, while overall, 46 percent of green firms identify as green manufacturing, about half also identify as green service firms and 86 percent as green support. Of the 56 percent of overall green firms that identify as a green service firm, 43 percent also identify as green manufacturing and 72 percent as green support. BW Research Partnership et al, *Emerging Industry*, 19.
- <sup>9</sup> Solar Energy Industries Association, Research, Industry Data.  
[http://www.seia.org/cs/research/industry\\_data](http://www.seia.org/cs/research/industry_data)
- <sup>10</sup> SEIA and GTM Research, *U.S. Solar Market Insight™, 2010 Year in Review, Executive Summary*, 2010. ([www.seia.org/cs/research/solarinsight](http://www.seia.org/cs/research/solarinsight)): 2
- <sup>11</sup> Wendy Koch, "U.S. solar power industry booms, gain globally," *USA Today*, June 16, 2011
- <sup>12</sup> Ibid. All grid-connected solar installations generated more than 2.85 gigawatts of electricity, enough to power nearly 600,000 U.S. homes, according to a quarterly report by SEIA and GTM Research.
- <sup>13</sup> SEIA and GTM, *U.S. Solar Market Insight*, 11. In total, the U.S. produced 42,561 metric tons (MT) of polysilicon, 624 MW of wafers, 1,058 MW of cells, and 1,205 MW of modules in 2010.
- <sup>14</sup> Ibid., SEIA reports that global demand grew from 7.1 GW in 2009 to over 17 GW in 2010, a significant portion of U.S. component production exported to markets such as Germany. Meanwhile, domestic demand has doubled, from 435 MW in 2009 to 878 MW.
- <sup>15</sup> Ibid. See also SEIA and GTM, *U.S. Solar Market Insight*, 2. Of the top 10 states with PV installations, California leads with 258.9 MWdc, almost twice next largest state, New Jersey with 137.1 MWdc.
- <sup>16</sup> SEIA and GTM, *U.S. Solar Market Insight*, 2. CSP projects uses sunlight to heat water or another fluid that generates steam to power a turbine.
- <sup>17</sup> Koch, "U.S. solar power industry booms," SEIA and GTM, *U.S. Solar Market Insight*, 2. According to a Duke University study, eight of the 13 biggest planned CSP projects in the world are expected to be located in California and Arizona. The Sun Belt region of the United States, particularly the Southwest, is one of the largest areas in the world for CSP exploitation because of its abundant sunshine. Currently, four parabolic trough plants are operating with a combined capacity of 419 MW, two in California and one each in Arizona and Nevada. Gary Gereffi and Kristin Dubay. *Concentrating Solar Power, Clean Energy for the Electric Grid*. In *Manufacturing Climate Solutions, Carbon Reducing Technologies and U.S. Jobs. Chapter 4*. Center on Globalization, Governance & Competitiveness, Duke University. September 22, 2009. 52-64.
- <sup>18</sup> The Solar Foundation, *National Solar Jobs Census 2010*. Washington, DC. October 2010: 5, 63. California ranks 1<sup>st</sup> on top ten states for solar jobs—an estimated 1,072 solar firms and 36,000 solar jobs.
- <sup>19</sup> SEIA and GTM, *U.S. Solar Market Insight*, 12
- <sup>20</sup> SEIA and GTM, *U.S. Solar Market Insight*, 11. In total, the U.S. produced 42,561 metric tons (MT) of polysilicon, 624 MW of wafers, 1,058 MW of cells, and 1,205 MW of modules in 2010.

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- <sup>21</sup> Ibid., SEIA reports that global demand grew from 7.1 GW in 2009 to over 17 GW in 2010, a significant portion of U.S. component production exported to markets such as Germany. Meanwhile, domestic demand has doubled, from 435 MW in 2009 to 878 MW.
- <sup>22</sup> “China Invades California Solar Market,” *CalFinder*. Solar Blog. January 25, 2011. <http://solar.calfinder.com/blog/news/china-invades-california-solar-market/>. Aside from the lower costs of Chinese competitors, trade policies are also important factors in encouraging the sale of U.S.-made products.
- <sup>23</sup> Phone interview with Apollo California Green MAP taskforce member Rob DeLine, VP of Marketing, Miasolé, May 31, 2011.
- <sup>24</sup> Phone interview with Rob DeLine, May 31, 2011.
- <sup>25</sup> Joanna Lin, “California solar firms lured to other states,” Daily Report, *California Watch*, January 7, 2011.
- <sup>26</sup> American Wind Energy Association (AWEA). Fact sheets. ([www.awea.org](http://www.awea.org)).
- <sup>27</sup> AWEA, Bluegreen Alliance (BGA), and United Steel Workers (USW), *Winds of Change, A Manufacturing Blueprint for the Wind Industry*, June 2010: 11.
- <sup>28</sup> AWEA, *2010 U.S. Wind Industry Market Update* ([www.awea.org](http://www.awea.org)). in 2008--8,366 MW; 2007-5,258 MW, 2006-2,462 MW AWEA, BGA and USW, *Winds of Change*, 11.
- <sup>29</sup> AWEA, *2010 U.S. Wind Industry Annual Market Report: Rankings*, 2011. [www.awea.org](http://www.awea.org). AWEA, *2010 U.S. Wind Industry Market Update*. Minnesota and Washington State round out the top five.
- <sup>30</sup> AWEA, *2010 U.S. Wind Industry Market Update*. In Iowa, North Dakota, and Minnesota wind was 10 percent or more of state electricity generation (15, 12, 10 percent respectively)
- <sup>31</sup> AWEA, *Wind Energy Facts: California*, May 2011 ([www.awea.org](http://www.awea.org)); AWEA, *Wind Energy Facts: Texas*, May 2011 ([www.awea.org](http://www.awea.org)). The percentage of Texas power provided by wind in 2010 was 6.4 percent, enough to power over 2.7 million homes. Second ranked Iowa’s current wind installation at the end of 2010 was 3,675 MW, with 143 MW under construction, and 14,569 MW in queue. AWEA, *Wind Energy Facts: Iowa*, May 2011 ([www.awea.org](http://www.awea.org)).
- <sup>32</sup> Ibid. In comparison, Texas is first in wind resources, with a potential of 1,901,530 MW of wind power generation (at 80 meters). Iowa is seventh in wind resources, with 570,714 MW (at 80 meters).
- <sup>33</sup> AWEA, BGA and USW, *Winds of Change*, 11.
- <sup>34</sup> AWEA, BGA and USW, *Winds of Change*
- <sup>35</sup> Vestas was next with 17.3 percent (7,000 MW), Siemens with 11.6 percent (4,500 MW); Mitsubishi, with 7.6 percent (3,000 MW), and Suzlon, with 5.2 percent (2,000 MW). AWEA, *2010 U.S. Wind Industry Market Update*.
- <sup>36</sup> Source: More than forty companies across the nation supply smaller parts including blade composites, blade extenders, bolts, cables, cranes, fraction hoists, ladders, lift systems, substations, and tower flanges.
- <sup>37</sup> See AWEA wind energy fact sheets for each state, downloadable at [www.awea.org](http://www.awea.org).
- <sup>38</sup> Marcy Lowe, Saori Tokuoka, Tali Trigg and Gary Gereffi. *Lithium-ion Batteries for Electric Vehicles: The U.S. Value Chain*. Center on Globalization Governance & Competitiveness, Duke University. October 5, 2010.
- <sup>39</sup> Lowe et al, *Lithium-ion Batteries*; Bill Canis, *Battery Manufacturing for Hybrid and Electric Vehicles: Policy Issues*. CRS Report for Congress [R41709], Congressional Research Service, Washington, DC. March 22, 2011:8.
- <sup>40</sup> Lowe et al, *Lithium-ion Batteries*, 47.
- <sup>41</sup> Ibid.
- <sup>42</sup> Valentino Tiangco, *Current Biofuels Production in California*, Presentation to IEPR Biofuels Workshop. California Energy Commission, Public Interest Energy Research (PIER). January 13, 2009.
- <sup>43</sup> Smith et al, *2011-2012 Investment Plan*.
- <sup>44</sup> The CCST study is titled *California’s Energy Future—The View to 2050*. Cited in Erin Voegele, “Report outlines biofuels’ role in California GHG reduction goals.” *Biodiesel Magazine*, June 9, 2011 (<http://www.biodieselmagazine.com/articles/7834/report-outlines-biofuels-role-in-california-ghg-reduction-goals>)]
- <sup>45</sup> Ibid.
- <sup>46</sup> Shane Stephens-Romero, Steve Mazor and Jonathan Leonard. *Fueling California, Projected Outlook for Next Generation and Alternative Transportation Fuels in California, 2010-2030*. Prepared by Advanced Power and Energy Program, University of California, Irvine and Automotive Research Center, Automobile Club of Southern California, and TIAX LLC. Orange County Business Council, 2011: 5.
- <sup>47</sup> Ethanol and biodiesel are the most common kinds of alternative fuels or biofuels. However, biofuels can also encompass methane and hydrogen, which can be made from a variety of biological sources.

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- <sup>48</sup> Romero et al, *Fueling California*, cited in Kris Bevill, "California studies present conflicting views on ethanol." *Ethanol Producer Magazine*. June 1, 2011. (<http://www.ethanolproducer.com/articles/7818/california-studies-present-conflicting-views-on-ethanol>).
- <sup>49</sup> Smith et al, *2011-2012 Investment Plan*.
- <sup>50</sup> See Bevill, "California studies present conflicting views," and Romero et al, *Fueling California*.
- <sup>51</sup> Smith et al, *2011-2012 Investment Plan*, 98.
- <sup>52</sup> Large corn-growing midwestern states, not surprisingly, are the largest manufacturers of ethanol. Iowa is by far the largest producer, with 42 plants with a combined capacity of 3.6 billion gallons per year. Other major producer states each with at least 1 billion gpy include Nebraska, Illinois, Indiana, Minnesota, and South Dakota. This is latest data, as of June 17, 2011, available online provided by *Ethanol Producer Magazine*, (<http://www.ethanolproducer.com/plants/listplants/USA/>).
- <sup>53</sup> Romero et al, *Fueling California*, 31. Diesel substitutes include several different kinds of biomass-based diesel fuels, which are lumped together under the term "biodiesel" in the current report. These include biodiesel, renewable diesel, biomass-Fischer-Tropsch diesel, diesel from thermal depolymerization of industrial waste, and specific feedstock-and process-based diesels such as algae-based diesel. Biodiesel in the more detailed breakdown is made from vegetable oils or animal fats that blends bio-oils with an alcohol such as methanol or ethanol, which then is often blended with conventional petroleum-based diesel. Renewable diesel is made from a variety of feedstock typically processed in a refining facility where the feedstocks are transformed into diesel fuels through hydrocracking and hydrogenation. Biomass Fischer-Tropsch is made from agricultural waste, green waste, food waste, or forest residue. In the United States soybean oil has been the primary feedstock, mainly because this country is the world's largest producer of soybean oil. See Baroody, Leslie, Charles Smith, Michael A. Smith, Charles Mizutani. *2010-2011 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program* Commission Report. California Energy Commission, Fuels and Transportation Division. August 2010. Publication Number: CEC-600-2010-001-CMF: 68-69.
- <sup>54</sup> Baroody et al, *2010-2011 Investment Plan*.
- <sup>55</sup> Ibid.
- <sup>56</sup> Romero et al, *Fueling California*
- <sup>57</sup> Ibid.
- <sup>58</sup> "UOP technology for California advanced fuel plant," *Brighter Energy News*, September 1, 2010. ([www.BrighterEnergy.org](http://www.BrighterEnergy.org)).
- <sup>59</sup> Smith et al, *2011-2012 Investment Plan*; Baroody et al, *2010-2011 Investment Plan*.
- <sup>60</sup> Baroody et al, *2010-2011 Investment Plan*.
- <sup>61</sup> Smith et al, *2011-2012 Investment Plan*, 115. These projects, spread through the state, are in various phases ranging from feasibility to commercialization and use a variety of feedstocks including waste water treatment sludge, food waste, animal manures, landfill woody biomass residues, and post-sorted MSW. Once fully commercialized, these project expected to displace more than 6.5 million DGE.
- <sup>62</sup> Ibid.