

# Getting the Job Done Right

## EMPLOYMENT GROWTH THROUGH CALIFORNIA'S GLOBAL WARMING SOLUTIONS ACT

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## Executive Summary

Environmental Defense Fund requested that M.Cubed, a consulting firm specializing in resource economics and public policy analysis, investigate the potential employment impacts likely to be caused by the California Air Resource's Board's (CARB) proposed Global Warming Solutions Act of 2006 (Assembly Bill 32) implementation policies.<sup>1</sup>

A number of studies have been conducted examining the potential economic consequences of CARB's *Climate Change Proposed Scoping Plan*<sup>2</sup> and ancillary documents. CARB's own analyses indicate that AB 32 will have an overall positive but relatively small net economic benefit to the state, increasing gross state product by \$7 billion and personal income by \$16 billion by 2020. Likewise, under Assembly Bill (AB) 32 CARB estimates that 122,000 net jobs will be created. These benefits are principally due to projected AB 32-induced savings resulting from improved energy efficiency and the development of petroleum alternatives that will result in net cost reductions to businesses and consumers. Well-crafted AB 32 policies are likely to result in positive employment growth, particularly to the extent that they reinforce beneficial changes in the state's economy that have already emerged from existing state energy policies.

M.Cubed examined available analyses to assess the potential for positive changes in California's investment patterns and employment in response to AB 32's underlying policies. Based on an examination of greenhouse gas (GHG) control-related documents, in particular the Climate Change Proposed Scoping Plan (PSP) and associated analyses, an extensive literature review, and experience with evaluating the economic impacts of proposed public policies, the following observations were developed:

- **Because of changes that have occurred over the past three decades, California is well-positioned to lead the nation's transition to a clean energy economy.** Decades of high energy prices combined with other factors that make relatively low-value activities financially unattractive have already forced a significant share of the state's manufacturing sector elsewhere. Simultaneously, California has grown more competitive in the industrial design and advanced fabrication, health, education and professional services sectors, and its other primary industries – agriculture and tourism – are place-based. As a result, and particularly to the extent that AB 32 implementation results in infrastructure development (i.e., results in investment that replaces the need for capital that would otherwise be needed), California is well-positioned to take advantage of the opportunities created by efforts to reduce greenhouse gas emissions and to avoid the economic and associated employment dislocations that might otherwise have been prompted.

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<sup>1</sup> This analysis was developed by Steven Moss, with research assistance from Kerry Fleisher and Dana Perls.

<sup>2</sup> Issued October 2008.

- **The adoption of similar efforts to reduce emissions by nearby states – and, under the new U.S. administration, nationally – make significant regional employment dislocations unlikely.** Several Western states, including Arizona, California, Montana, New Mexico, Oregon, Utah, and Washington, as well as many Canadian provinces have pledged to reduce greenhouse gas emissions as part of a Western Regional Climate Action Initiative. Regional cooperation over climate change policies significantly reduces the ability of businesses to flee California as a means of avoiding AB 32-like policies and creates a networking effect that encourages private sector entities to make the necessary changes to reduce their carbon emissions with concomitant economic benefits. Likewise, if the federal government adopts a national cap on greenhouse gas emissions within the next four years, California will have a competitive advantage as a result of the investments it triggers to transition the state to a lower emitting economy.
- **Existing public policies and economic conditions are already acting to transform the state’s economy in the direction of AB 32.** Current law and public policies, including the existing 20 percent renewable portfolio standard and substantial subsidies for energy efficiency measures and solar installations as well as ongoing economic conditions such as high fossil fuel prices, are already “priming the pump” towards transforming the state’s economy to lower carbon intensity. Even before implementing the measures contained in the *Proposed Scoping Plan*, California has the lowest GHG emissions per dollar of economic value (i.e., gross state product (GSP)) in the United States and among the lowest in the world. What’s more, the state’s energy efficiency has been improving by 1.5 percent per year for the past 40 years. Current conditions are also serving to encourage businesses to reduce their transportation expenses by locating within the state for closer access to California’s massive markets, and existing policies are creating incentives for “cleantech” industries to cluster in California. This leading edge will help smooth the economic transitions associated with PSP implementation.
- **Over time, household and business expenditures for energy and transportation may be lower as a result of AB 32 Scoping Plan measures.** Similar to the productivity enhancements created by advances in telecommunications and computers over the past two decades, AB 32 implementation will ultimately prompt higher energy productivity – greater output per unit of energy input – associated with equipment and buildings. California has demonstrated this policy-induced change in the past: while electric utility *rates* have remained fairly stable on a constant dollar basis over the past two decades, average utility bills for some of the state’s utilities are lower today than they were more than 20 years ago despite the introduction of multiple new energy-using devices during the period (e.g., large screen televisions, oversized refrigerators, a host of rechargeable power consumer products). As a result, California’s per capita energy expenditures are significantly less than most other states’. Lower bills may result from a number of policies, including electricity pricing structures, appliance standards, and energy

efficiency programs. Research shows that small businesses with better environmental performance are more financially successful. Energy efficient buildings are not significantly more expensive than conventional buildings, and the extra construction costs will be recovered in lower utility bills. CARB found that AB 32 implementation would reduce California's ranking in terms of electricity expenditures per dollar of sales from seventh to 19th highest in the nation, thereby making the state more competitive.

- **AB 32's emphasis on renewable technologies should create jobs.** The influx of investment in electric power generation using renewable technologies as well as the general increased reliance on these generating sources prompted by AB 32 implementation should result in net employment gains. Employment associated with a megawatt of production from solar, wind and other renewables is significantly higher than for fossil fuel-based sources per unit of delivered energy and per dollar of investment. Post AB-32 employment is likely to be higher in a number of sectors, including:

*Construction* – rapid development of renewable energy supplies and associated infrastructure (e.g., transmission facilities) should result in significant job creation

*(Clean) Technology* – particularly related to energy and water efficiency devices and appliances, advanced materials and nanotechnology, photovoltaics and large-scale renewable power generation, and related software, as well as the associated supply chain, ranging from wholesalers to installers, necessary to bring new technologies to market

*Consumer products* – especially biodegradable packaging and plasticware and nontoxic household cleaners that are manufactured in California

*Professional Services* – particularly associated with development and deployment of clean technologies and associated infrastructure. For example, new computer software will be needed to support more efficient transportation systems and transmission and distribution of electricity which will require closer coordination and network capabilities

*Transportation and logistics* – such as high miles per gallon, plug-in and hybrid vehicles, fuel cells, and diesel retrofits, as well as the associated market infrastructure (e.g., vehicle retrofit shops; battery change-out stations)

- **AB 32 is likely to draw increased energy-related research and development (R&D) investment into the state.** AB 32 implementation will prompt higher investments in certain sectors, particularly related to “green” technology,

manufacturing, and construction. Five of the top investors in “clean” technology (e.g., solar, biofuels, smart grid systems) are located in California. However, a consistent, long-term policy commitment to market-based and technology-inducing policies is needed to maintain forward R&D momentum that leads to widespread adoption of energy efficient technologies.

- **AB 32 implementation will help reduce the economic risks associated with fuel shocks.** An important economic benefit likely to emerge from AB 32 implementation is a more diverse energy and supply regime. With petroleum prices anticipated to rise while supplies are diminished, AB32 can help to mitigate the risks of single-fuel supply disruptions and price shocks. Rapid increases in energy prices result in greater economic harm than smooth or predictable transitions. To fully realize this benefit, increased reliance on renewables needs to be supported by adoption of various support technologies such as battery storage. A properly balanced, diversified energy and transportation portfolio can lead to greater long-term economic growth and higher employment levels.

Not all families or firms will benefit equally when California transitions to a greener economy. The potential for higher costs for power and consumer goods poses risks – particularly among farmers, small businesses and low-income families – that can be managed through thoughtful and effective policies. Well-crafted policies would provide access to financial resources to those that may not have the capacity to make capital investments that eventually pay back in the form of lower energy and transportation costs.

Market-based policies that help economic transitions, reduce the costs of achieving greenhouse gas reductions, and expand access to financing would minimize the chances that adverse consequences will be visited upon particularly vulnerable populations. For example, allowing homes and businesses to aggregate their emission reductions as a way to participate in carbon trading markets would enable them to benefit economically while reducing their emissions and provide them with the necessary capital to make energy-saving investments. Likewise, implementing a comprehensive trading regime which enables cost-effective trades to be flexibly made across all sectors would help lower AB 32’s transition costs and more rapidly lead to productive outcomes. Further, the development of new financing mechanisms, such as on-bill and property tax financing and power purchase arrangements would provide greater access to capital that will lead to additional jobs.

## 1.0 Introduction

Environmental Defense Fund requested that M.Cubed<sup>3</sup> examine potential employment impacts caused by the California Air Resource's Board's (CARB) proposed implementation policies.<sup>4</sup> This investigation was principally based on a review of AB 32-related documents (in particular the *Climate Change Proposed Scoping Plan* (PSP) and associated analyses), an extensive literature review, and expert opinion informed by almost two decades of experience examining the potential economic impacts of proposed public policies.

AB 32's overall goal is to reduce greenhouse gas emissions as a means of lowering the risks that global climate change's most pernicious impacts will be realized. The bill, also known as the Global Warming Solutions Act of 2006, requires that the state's greenhouse gas emissions be reduced to 1990 levels by 2020. Although California's ability to directly impact global climate change by itself (i.e., in absence of a national and international effort) is limited, the state's potential to beneficially influence environmentally friendly outcomes should not be minimized. The state is responsible for roughly 1.3 percent of worldwide greenhouse emissions and eight percent of United States' emissions.<sup>5</sup>

There's wide agreement among economists that market-based policies nested within publicly sanctioned regulatory structures result in more cost-effective and productive outcomes than command-and-control approaches. This is best evidenced by the U.S. economy itself which is most prosperous when free market forces are allowed to operate within well-considered and effectively managed regulatory frameworks. For example, high technology companies are able to develop and market their products so long as they meet publicly mandated standards (e.g., related to health, safety, and the environment), operate under the protection of a host of property right laws (e.g., copyright), and are buoyed by a variety of publicly benefits, ranging from roads to public education to government-sponsored research and development activities.

California's early actions will also provide an innovative test bed from which the rest of the world can learn and, to the extent new technologies and services can be engendered, from which the state's enterprises can profit. That is, to some extent AB 32 reflects an investment in solutions to global climate change, solutions that can be profitably exported to the rest of the world.

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<sup>3</sup> M.Cubed is a consulting firm that specializes in resource economics and public policy analysis. This study was conducted at M.Cubed's San Francisco office.

<sup>4</sup> As principally contained in CARB, *Climate Change Draft Scoping Plan, June 2008 Discussion Draft*, and associated documents.

<sup>5</sup> United Nations Framework Convention on Climate Change, Annex 1 Inventory, Table 1; U.S. Environmental Protection Agency.

## 1.1 California's Economy is Well Suited to Take Early Actions to Reduce Greenhouse Gas Emissions

The California economy provides a particularly hospitable nesting ground from which to implement emission-reducing policies. With roughly 37 million residents, the state represents the world's eighth largest economy behind the U.S. as a whole, Japan, Germany, China, the United Kingdom, France and Italy. The state's economy is dominated by sectors that may be particularly able to cope with or prosper from AB 32 policies – tourism, high-technology industries, professional services – and could benefit from improvements in energy and water use.

California has among the highest costs of living in the United States with business costs that are 23 percent greater than the rest of the nation. However, the state's high costs are balanced by the size of its marketplace and the attractiveness of its workforce. As a result of these factors, California is home to more than one million small businesses alone.<sup>6</sup>

Statewide, industrial demand for electricity has steadily declined, dropping by almost 20,000 gigawatt-hours from 1999 to 2006.<sup>7</sup> As indicated in Table One, over the past three decades the state's economy has shifted from a heavy reliance on manufacturing – which, after government, employed the most Californians in 1990 – to a broader employment base in education, health, business and professional services, and tourism. These sectors generally have low energy use intensity or are particularly able to pass on higher energy costs. That said, California's manufacturing sector is still quite large, supporting roughly 1.5 million jobs and producing more than 12 percent of the nation's gross domestic product.<sup>8</sup>

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<sup>6</sup> U.S. Department of Commerce, *Statistical Abstract of the United States*, 2007.

<sup>7</sup> "If Not Done Right, AB 32 Plan Will Scare Away Manufacturers," *California Energy Markets*, Number 991, Page 4, August 29, 2008; *Natural Gas and Electricity Costs and Impacts on Industry*, April 28, 2008.

<sup>8</sup> Global Insight, Inc., *The Impacts*, op.cit.

Table One<sup>9</sup>  
Over the Past Twenty Years California's Economy has Shifted from an Emphasis on  
Manufacturing to Education, Health, and Professional Services  
(1,000's of Jobs)

<i>Sector</i>	<i>1990</i>	<i>2008</i>	<i>Percent Change</i>
Agriculture <sup>10</sup>	35	38.6	10
Natural Resources	36.3	26.7	-36
Construction	644.5	824.9	28
Manufacturing	1,967.1	1,445.8	-27
Trade and Utilities	2,420	2,906	20
Information	390.6	462.9	19
Financial Activities	821.9	878.7	7
Business/Professional	1,508.2	2,285.1	52
Educational/Health	1,116.3	1,708.2	53
Leisure/Hospitality	1,104.5	1,566.1	42
Government	2,074.8	2,534.6	22

Of particular importance to the state's economy are its export industries. One-fifth of U.S. international trade passes through California's ports with the state exporting more than \$200 billion of goods and services.<sup>11</sup> Export trade is dependent on efficient transportation infrastructure. Existing policies to improve trucks' fuel efficiency and to electrify ship-at-port operations, which include significant state subsidies, will likely result in a healthier transportation sector a decade from now.

Service industries as well as computers and electronics – including research and development, testing, software, and information – account for more than half of export-related employment in California.<sup>12</sup> California exports more than \$11 billion worth of agricultural products, more than the two next leading states (Texas and Illinois) combined.<sup>13</sup>

As indicated in Table Two, "clean technology" is responsible for a significant percentage of state employment. Between 1990 and 2006, the number of green technology businesses – principally related to solar, energy efficiency, and transportation – in California grew by 84 percent.<sup>14</sup> These economic changes were principally the result of the web of laws and public subsidies that have emerged, especially since the 2000-01 state energy crises. Over the next decade, California's opportunities for prosperity will be centered on innovation, design, and the application of creativity, particularly in the alternative energy sector.

<sup>9</sup> EDD News Release Number 08-015, June 20, 2008.

<sup>10</sup> Agricultural employment is not seasonally adjusted.

<sup>11</sup> Department of Finance, *California Statistical Abstract*, 2007.

<sup>12</sup> Jon D. Haveman and David Hummels, *California's Global Gateways: Trends and Issues*, Public Policy Institute of California, 2004.

<sup>13</sup> U.S. Department of Agriculture, Economic Research Service, "State Export Data," June 29, 2007.

<sup>14</sup> Next 10, "California Green Innovation Index, 2008 Inaugural Issue," 2008.

**Table Two**  
**Green Jobs Already Represent a Substantial Source of Employment in California<sup>15</sup>**

INDUSTRY SECTOR	Green Establishments	California Total	Green Jobs	California Total
31-33 Manufacturing	454	90,874	18,086	1,505,182
54 Professional, Scientific and Technical Services	1,112	208,553	12,226	864,551
23 Construction	582	113,405	4,476	769,593
42 Wholesale Trade	275	89,765	2,935	833,756
22 Utilities	61	2,190	1,796	78,073
44-45 Retail Trade	290	204,202	1,139	1,617,769
56 Administrative and Support and Waste; Management and Remediation Services	86	110,243	1,137	495,254
81 Other Services (except Public Administration)	105	177,313	641	549,256
48-49 Transportation and Warehousing	16	32,657	422	490,510
52 Finance and Insurance	44	80,237	346	480,048
51 Information	11	43,422	220	380,536
71 Arts, Entertainment, and Recreation	21	34,930	91	201,149
99 Unclassified	6	2,176	88	9,760
53 Real Estate and Rental and Leasing	12	81,466	86	299,318
55 Management of Companies and Enterprises	2	1,936	31	12,545
21 Mining	4	1,497	23	24,589
62 Health Care and Social Assistance	4	128,652	4	997,522
11 Agriculture, Forestry, Fishing, and Hunting		22,462		208,833
61 Educational Services		28,207		680,305
72 Accommodation and Food Services		61,352		668,825
92 Public Administration		8,960		849,012

Under pressure from higher production costs in California, the state’s manufacturing sector has declined by more than one-quarter since 1990. Although the state’s high electricity prices continue to place pressure on energy-intensive manufacturers, simultaneously, higher transportation costs serve to encourage these facilities to remain

<sup>15</sup> Distribution of establishments across sectors was imputed for 1,611 establishments for which the green segment was known. California totals are from the NETS database. It should be noted that this analysis does not include all government employment that could be considered a “green” job. *Clean Technology and the Green Economy*.

close to their markets or associated transit hubs (e.g., ports). California is the largest consumer market in the Western United States and is a critical gateway for exports that originate from throughout the country. By reducing travel distances and locating within the state where they can be closer to consumers, manufacturers lower their related transportation costs, helping to counterbalance the otherwise higher expenses associated with doing business in California.

Small businesses will need to take the opportunities prompted by AB 32 implementation to lower their costs, principally through the adoption of cost-effective energy, water, solid waste, and transportation efficiency measures. Small businesses that adopt state-of-the-art practices associated with resource use tend to be more profitable than those that don't. However, making this transition will not be trivial. Small firms face a host of challenges to improving their energy and water productivity, including obtaining access to low-cost financing for new equipment, a lack of capacity to evaluate new technologies, and a short time horizon. Market-based policies that help bridge difficult economic shifts and that expand access to financing would serve to reduce the incidence of adverse consequences on particularly vulnerable populations. For example, allowing homes and businesses to aggregate their emission reductions as a way to participate in carbon trading markets would enable them to benefit economically while reducing their emissions and would provide them with the necessary capital to make energy-saving investments. Likewise, implementing a comprehensive trading regime which enables cost-effective trades to be flexibly made across all sectors would help lower AB 32's transition costs and more rapidly lead to productive outcomes. Further, the development of new financing mechanisms, such as on-bill and property tax financing and power purchase arrangements, would provide greater access to capital that will lead to additional jobs. In the long run, small businesses that reflect better environmental performance are more financially successful.<sup>16</sup>

## **1.2 AB 32 is Synergistic with Other Existing Policies and Economic Trends**

Under AB 32, CARB seeks to reduce energy consumption, particularly associated with petroleum products, and diversify energy sources. These objectives would be achieved through an overall market-based mechanism – cap and trade, linked with a regional carbon market – bolstered by a mix of regulations, voluntary measures, fees, and subsidy programs.<sup>17</sup> CARB's policy framework is intended to do two things: (1) accelerate development and adoption of less carbon-intensive technologies, principally by expanding the Renewables Portfolio Standard to 33 percent, and (2) induce a 25 percent increase in energy efficiency, to be achieved through rapid adoption of efficiency measures in existing

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<sup>16</sup> Bruce Clemens, "Economic Incentives and Small Firms: Does it Pay to be Green?" *Journal of Business Research*, 59, pages 492-500, 2006.

<sup>17</sup> CARB also points to an existing web of state laws and policies, including clean car standards, goods movement measures, and the Low Carbon Fuel Standard, as key elements to achieve emission reduction goals. However, the economic consequences of current law and policies should not be attributed to AB 32.

buildings and implementation of more stringent efficiency standards for new appliances and construction.<sup>18</sup>

Although AB 32 provides an overall framework from which to achieve greenhouse gas emission reductions as indicated in Table Three, the Scoping Plan reflects a web of existing, proposed, and contemplated public policies. For example, Assembly Bill (AB) 1493 (Pavley, 2002) directed CARB to adopt vehicle standards lowering greenhouse gas emissions to the maximum extent technologically feasible. This law could result in significant fuel savings for California drivers, particularly if it leads to accelerated retirement of higher-emitting vehicles. However, AB 1493's benefits and costs should be assigned to that law, not to AB 32. Similarly, though AB 32's 33 percent Renewable Portfolio Standard goal will create quite noticeable impacts, most investment in utility-based energy efficiency and renewable programs will be determined chiefly outside the AB 32 framework. For example, federal investment and production tax credits were recently extended by eight years for solar generation, and a number of municipalities have adopted energy efficiency standards for residential and commercial buildings that exceed the California Building Standards Code, Title 24<sup>19</sup>. Likewise, most of the *Scoping Plan's* specific measures will be formally adopted as part of separate rulemaking processes, some of which have been underway for more than a year, which may result in somewhat modified policies being implemented. In that regard, CARB states in the *Scoping Plan* that it "will conduct more specific evaluations during regulatory development."<sup>20</sup>

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<sup>18</sup> CARB, *Draft Scoping Plan*, June 2008.

<sup>19</sup> After the credits were extended, Silicon Valley-based Sun Power, a PV panel manufacturer, announced it would add hundreds of jobs by the end of the year. Likewise, 12 California cities including San Francisco have adopted standards that exceed Title 24. See "CEC Approves Green Energy Incentives, SF Building Standards," *California Energy Markets*, number 995, page 7, September 26, 2008; "Solar Industry Waits for Credit Clouds to Lift Before Boom Begins," CEM, number 997, page 10, October 10, 2008.

<sup>20</sup> Page 75.

**Table Three**  
**AB 32 Greenhouse Gas Reduction Measures Reflect a Web of Existing and Proposed Public Policies**

<i>Recommended Measures</i>	<i>Legal Status</i>
California Light-Duty Vehicle Standards	Adopted, awaiting implementation or formal rulemaking.
Energy Efficiency	Builds on substantial ongoing public sector investments and local government standards. State-sanctioned utility investments in energy efficiency exceed \$1.2 billion a year.
Renewables Portfolio Standard	Increase to 33 percent from existing 20 percent standard
Low Carbon Fuel Standard	Reflected in ongoing rulemaking processes, and required by Executive Order.
Regional Transportation-Related GHG Targets	Voluntary measures.
Vehicle Efficiency Measures	Principally AB 32-driven.
Goods Movement	Already adopted or part of ongoing rulemaking processes.
Million Solar Roofs	Current Policy.
Medium/Heavy Duty Trucks	Already adopted or part of ongoing rulemaking processes.
High Speed Rail	Approved by ballot measure in November 2008 election.
Industrial Measures	Principally AB 32-driven.
Recycling and Waste	Some elements already adopted at state and local levels.
State Government Operations	Principally AB 32-driven.
Local Government Operations	Some elements already adopted at local level.
Green Buildings	Some elements already adopted at local level.
Water Sector Measures	Principally AB 32-driven, though builds on existing state and local programs.
Methane Capture at Large Dairies	Already occurring in many cases.

In addition, background economic conditions will importantly influence the state’s greenhouse gas emissions – and its ability to achieve AB 32 emission reduction goals – and the benefits and costs associated with specific emission-reducing proposals. For example, already high fossil fuel prices and the likelihood of a significant and potentially lengthy economic downturn have encouraged Californians to reduce their reliance on fuel inefficient private vehicles. Ongoing drought conditions have triggered renewed water conservation efforts. And the distressed housing market is serving to reduce vehicle miles travelled between employment centers and outlying low density areas, and, along with higher fuel prices, is contributing to a steady increase in demand for higher-density housing communities, infill commercial development, and more fuel efficient transportation modes. In the face of these conditions many larger businesses have already set aside funds to invest in energy efficiency improvements.<sup>21</sup>

<sup>21</sup> Johnson Controls Energy Efficiency Indicator Research, *Final Report: North America*, March 28, 2008.

It is unknown whether the combination of current laws and economic conditions serving to reduce greenhouse gas emissions represent an important backdrop to AB 32 implementation or could lead to a change in the basic character of the state's economy. California is already considerably ahead of the rest of the nation in shifting away from fossil fuels and towards more productive energy technologies and practices that also prompt greater employment. In part, AB 32's impacts will depend on how its implementation interacts with ongoing trends that are acting to create a more productive, lower carbon economy.

### **1.3 Economic Incentive Approaches are more Efficient than Command and Control Measures**

There is broad agreement in the economic literature that effectively crafted market-based policies result in lower abatement costs when compared to command and control (CAC) measures. The advantages of market-based policies tend to be realized over time because they provide a continual incentive to reduce emissions, create new technology, and permit maximum flexibility in achieving emissions reductions.<sup>22</sup>

One recent study found that energy price changes induced both commercialization of new appliance models and elimination of old models. Regulatory standards, however, largely prompt energy inefficient models to be eliminated from product lines since that's their intended effect (i.e., models below a certain energy efficiency level many not be offered for sale).<sup>23</sup>

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<sup>22</sup> Winston Harrington and Richard D. "Economic Incentives Versus Command and Control," *Resources*, Fall/Winter 2004.

<sup>23</sup> Newell, R.G., A.B. Jaffe, and R.N. Stavins (1999), "The Induced Innovation Hypothesis and Energy-Saving Technological Change," *The Quarterly Journal of Economics*, 114:941-75.

## **2.0 Increased Investment Is Likely to Induce Increased Employment Over Time**

A number of factors will importantly influence AB 32's economic impacts and are discussed in the sections that follow. Under AB 32 policies, energy and transportation costs will increase in the short-term because the marginal (renewable or energy efficient) alternatives will be more expensive than status quo (fossil fuel) inputs, excluding the impacts of additional conservation. However, these costs will be offset by at least two countervailing trends: increased investment activity, which is likely to engender greater employment in both alternative energy sources and related to consumption-reducing measures; and more rapid adoption of energy, water, and other resource saving technologies, which will lead to lower net water and energy utility bills. Reduced utility bills, in turn, will prompt consumer spending in other economic sectors, leading to a net increase in jobs.<sup>24</sup>

Outcomes will depend on (1) greater investment occurring in-state rather than elsewhere, (2) AB 32-induced price increases remaining sufficiently low so as not to inadvertently drive away other economic activity, and (3) the speed by which businesses and families retire inefficient equipment. In this respect, the availability of financing for private entities to extend the time horizon associated with investments in cost-saving measures will be important to economic success. In the longer term, if implemented well, AB 32 should result in both lower overall expenditures and greater employment, principally as a result of the higher productivity engendered by its implementation.

### **2.1 Well-Crafted and Effectively Implemented Energy Efficiency and Load-Shifting Measures Will Ultimately Reduce Business and Consumer Costs**

Substantial efforts to conserve and increase the efficiency in which energy is used have been underway for more than two decades in California. Although the state's electricity rates are 34 percent higher than the rest of the country,<sup>25</sup> overall energy expenditures per capita tend to be lower. As indicated in Figures 1 and 2, policies to encourage energy conservation have contributed to the state's ability to modulate increases in electric utility bills. For example, existing residential building standards are estimated to result in more than 7,000 gigawatt-hours of energy savings by 2018.<sup>26</sup>

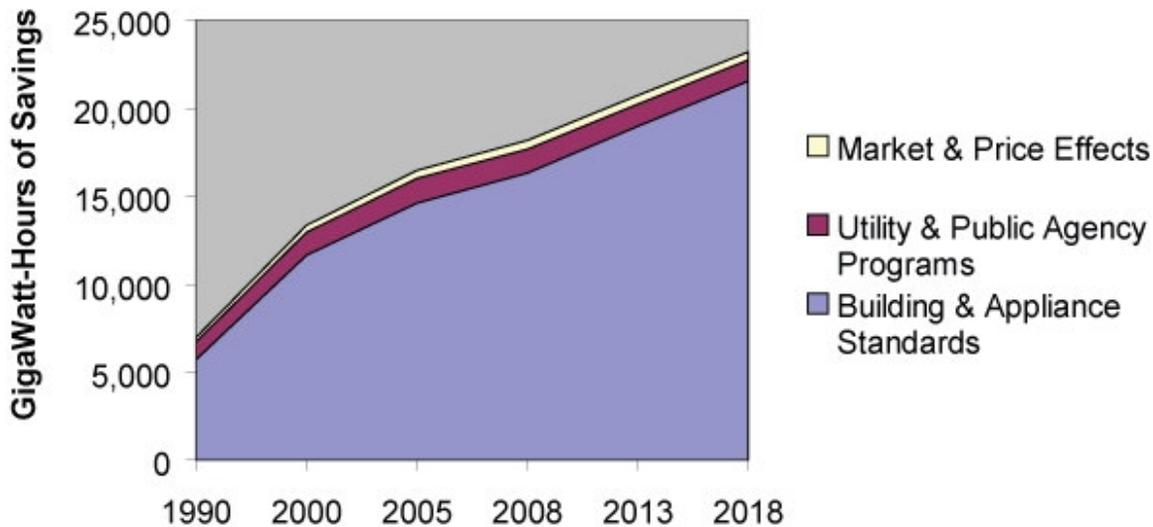
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<sup>24</sup> David Roland-Holst, *Energy Efficiency, Innovation, and Job Creation in California*, Center for Energy Resources and Economic Sustainability.

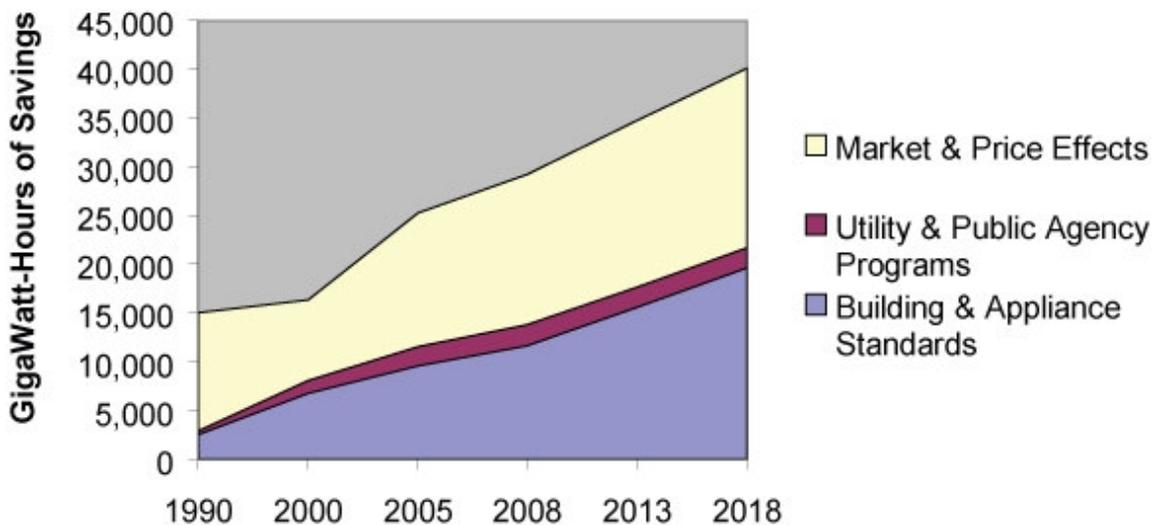
<sup>25</sup> CEM, op.cit.

<sup>26</sup> CEC, "Energy Conservation in California Energy Commission Demand Forecast Models."

**Figure 1: Residential  
Historic and Forecasted Energy Savings  
for PG&E, SCE and SDG&E Service Territories**



**Figure 2: Commercial  
Historic and Forecasted Energy Savings  
for PG&E, SCE and SDG&E Service Territories**



California’s energy efficiency policies are estimated to have created nearly 1.5 million net jobs over the past three decades with a total payroll of \$45 billion. Most of these employment gains occurred in the manufacturing, wholesale and retail trade, financial

and insurance, and service sectors. Job growth was prompted by consumers reducing their expenditures on energy and shifting the resulting savings to other purchases.<sup>27</sup>

As previously discussed, the *Scoping Plan* reflects a mix of energy efficiency programs and policies that have already been adopted, or will be under separate regulatory proceedings, and new measures. Many energy efficiency measures – including lighting retrofits, improved heating, ventilation and air conditioning, building control systems, and higher performing electronics and appliances – can more than pay for themselves over time. Under one analysis, almost 40 percent of efficiency-engendered carbon emission reductions could be achieved at “negative” marginal costs.<sup>28</sup>

To be fully successful, AB 32 will need to effectively address existing barriers to adoption of energy efficiency measures which include:

- High transaction costs (e.g., locating appropriate information sources, identifying suitable vendors);
- The need for shorter payback periods for private firms and individuals compared to society as a whole;
- Split financial incentives in which property owners have little incentive to invest in measures that reduce utility bills;
- The small portion of overall expenditures represented by energy and transportation-related costs associated with families’ and business budgets.

These barriers can be addressed through properly designed market-based approaches. For example, some of the barriers could be overcome through policies that enable aggregators to create carbon credits by helping customers install emission reducing measures, such as energy efficiency; others could be addressed by sector-specific performance standards that allow for credit trading among manufacturers, builders and landlords. However, to the extent that specific energy efficiency improvements are impeded by market barriers that represent real economic costs rather than market failures,<sup>29</sup> the cost of policies to induce greater levels of efficiencies may exceed resulting savings unless effective countervailing policies are adopted.

To the extent that businesses aren’t adopting efficiency measures that would pay off in short time periods as a result of the barriers identified above, AB 32 implementation could help create a “networking effect.”<sup>30</sup> That is, as greater numbers of energy users

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<sup>27</sup> David Roland-Holst, *Energy Efficiency, Innovation, and Job Creation in California*, Center for Energy Resources and Economic Sustainability.

<sup>28</sup> McKinsey & Company, *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?* December 2007.

<sup>29</sup> Stavins et al 2007.

<sup>30</sup> Studies have show that expectations and network effects influence the timing of technological adoption. For example, while price expectations tend to delay adoption of energy efficient measures, (indirect) network effects, principally in the form of information sharing, tends to foster more rapid adoption.

adopt energy-saving measures, adoption rates can increase logarithmically. Likewise, as the number of customers and suppliers – particularly if there are many small suppliers – and the associated work force increases, more enterprises are drawn into the sector, creating additional economic activity.<sup>31</sup>

Particularly noteworthy are the new building and appliance standards authorized under AB 32. The economic impacts associated with these policies will depend on how they are ultimately crafted. For example, under a market-based approach, developers and manufacturers could be provided with the flexibility to meet the standards in a variety of ways, enabling them to choose the path that is most cost-effective.

To the extent that the new standards result in higher upfront housing, commercial space, and appliance costs, they are likely to dampen demand for these products. That is, in the face of higher prices, businesses and consumers are likely to defer the purchase of a new home, building, or appliance. This dynamic would lower economic activity and associated employment.

However, available data indicates that, other than “green trophy” buildings, there are minimal differences – one percent or less – in average costs for green buildings as compared with non-green buildings. Green buildings may produce long-term benefits related to higher employee productivity, improvements in health and safety, as well as indoor air and environmental quality, and reduced energy-related operation and maintenance costs.<sup>32</sup> Green buildings can also command rent premiums over conventional buildings.<sup>33</sup> The costs associated with a requirement that all new state buildings exceed existing energy standards and meet nationally recognized building sustainability standards such as Leadership in Energy and Environmental Design (LEED) Gold Standards, can be managed by appropriately scheduling construction projects as well as accessing low-cost financing available from the state.

In this respect AB 32 implementation is likely to trigger three primary outcomes. First, as costs rise in the short term, businesses and consumers will implement zero or net-positive efficiency measures, such as switching off lights and turning down/up heating and air conditioning. Second, businesses and consumers will make investments or significant changes that serve to directly reduce their expenditures (e.g., shift to public transportation, move to higher density housing). These shifts can be assisted through

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See [http://hq.ssrn.com/Journals/RedirectClick.cfm?url=http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1273635&partid=40369&did=33457&eid=46443485](http://hq.ssrn.com/Journals/RedirectClick.cfm?url=http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1273635&partid=40369&did=33457&eid=46443485) > *Expectations, Network Effects and Timing of Technology Adoption: Some Empirical Evidence from a Sample of SMEs in Italy*.

<sup>31</sup> [http://hq.ssrn.com/Journals/RedirectClick.cfm?url=http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1286411&partid=40369&did=34112&eid=47244247](http://hq.ssrn.com/Journals/RedirectClick.cfm?url=http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1286411&partid=40369&did=34112&eid=47244247); *Local Industrial Conditions and Entrepreneurship: How Much of the Spatial Distribution Can We Explain?*

<sup>32</sup> Davis Langdon, *Cost of Green Revisited: Reexamining the Feasibility and Cost Impact of Sustainable Design in the Light of Increased Market Adoption*, July 2007; Robert Reis, “The Economic Benefits of Green Buildings: A Comprehensive Case Study,” *The Engineering Economist*, 2006.

<sup>33</sup> Charles Lockwood, “The Dollars and Sense of Green Retrofits,” 2008.

public sector policies and programs such as California Public Utility Commission-sanctioned energy efficiency subsidies. Third, in the longer term, energy costs per unit of productivity associated with equipment and buildings will decline (i.e., prices may be higher but bills will be lower).

Overall, according to CARB's analysis, AB 32 could result in a net reduction in energy bills of 5 percent in 2020, with businesses generally not expected to experience significant total energy cost changes.<sup>34</sup> The economic impacts prompted by these changes will depend in large part on specific economic sectors and populations' ability to make the necessary shifts and to retire older equipment and replace it with more efficient technologies.

## **2.2 Shift to Less Carbon Intensive Fuels Will Benefit Some Economic Sectors**

A key AB 32 policy is the proposed increase in the Renewable Portfolio Standard (RPS), from 20 to 33 percent. While there are some lower cost renewable sources – such as wind and biomass – these technologies often need access to transmission infrastructure that has not yet been developed, or regulatory structures that have not yet been adopted. By creating ongoing incentives, PSP measures will prompt other technologies to become cost competitive over time through scaling, learning-by-doing, and low-interest public financing, among other measures. For example, the levelized costs associated with publicly owned generating sources range from 3.4 cents per kilowatt/hour (kWh) for biomass from food – the large scale development of which would require substantial new collection and storage infrastructure – to almost 20 cents per kWh for solar parabolic trough technology.<sup>35</sup> Though the overall expenses associated with an enhanced RPS policy can be reduced through the use of targeted market-based approaches, electricity rates can be expected to rise in the short-term though, as previously noted, this need not result in higher bills.

The investment – from the research to adoption stages – prompted by RPS would result in substantial new economic activity, much of which would be captured within the state. This investment, in turn, would prompt greater employment. According to PriceWaterhouseCoopers and the National Venture Capital Association, California's share of national venture capital investment in innovative technologies more than tripled from 1995 to 2007. More than \$800 million of \$2 billion of venture capital invested globally in the second quarter of 2008 was directed towards California's cleantech sector.<sup>36</sup> Three globally competitive wind power companies, two of the largest photovoltaic plants in the world, and eight of the leading LED lighting firms are located in California. The state is also home to the world's premier research and development consortium for fuel

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<sup>34</sup> CARB, *Climate Change Draft Scoping Plan, Economic Analysis Supplement*.

<sup>35</sup> 2007 dollars. California Energy Commission, *Comparative Costs of California Central Station Electricity Generation Technologies*, CEC-200-2007-011-SF, December 2007.

<sup>36</sup> Patrick R. Burtis, *Creating the California Cleantech Cluster*, September 2004.

cells for vehicles, the California Fuel Cell Partnership, as well as energy research centers at the University of California and Stanford University.

AB 32 implementation would serve as a compelling signal to investors to maintain their focus on California. According to a recent survey, 91 percent of venture capitalists (VCs) say that a pro-environmental public policy stance can be a driver in bringing new business and investment in the state, and 79 percent of VCs say that current California public policies are a prominent factor in their investment decisions.<sup>37</sup>

Emerging supply-chain studies reveal that low-emissions technologies can create jobs throughout the full chain of technology innovation, production and use<sup>38</sup>. For example, the potential advantages of highly efficient, long lasting LED lights have created jobs in research. As LED lighting market grows, it will spur jobs in materials supply, manufacture of semiconductors and other light components, product finishing and distributing, and end use. LED lighting is already creating jobs for at least 12 companies operating in California with total employment over 20,000 workers.

As indicated in Table Four, a number of recently published studies have found that investments in renewable energy sources would result in substantial job gains, particularly as compared with investments in fossil fuel-based energy sources. Investments in green technologies produce jobs at a higher rate than investments in comparable conventional technologies.<sup>39</sup> The National Venture Capital Association estimates that each \$100 million in venture capital funds helps create at least 2,700 jobs.<sup>40</sup>

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<sup>37</sup> Patrick R. Burtis, *Creating the California Cleantech Cluster*, September 2004.

<sup>38</sup> Gereffi, G., Dubay, K. and Lowe, M. *Manufacturing Climate Solutions*. Center for Globalization, Governance & Competitiveness. Duke University. 2008.

<sup>39</sup> Kammen, D., Kapadia, K. and Fripp, M. "Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?" Energy and Resources Group/Goldman School of Public Policy, University of California, Berkeley, 2004.

<sup>40</sup> Global Insight, National Venture Capital Association, "Venture Impact 2004: Venture Capital Benefits to the U.S. Economy," 2004.

**Table Four**  
Average Employment is Higher for Renewable versus Fossil Fuel Generation<sup>41,42,43</sup>

Energy Technology	Source of Estimate	Average Employment Over Life of Facility (jobs/MWa)		
		Construction, Manufacturing, Installation	Operation and Maintenance/fuel processing	Total Employment
PV 1	REPP, 2001	6.21	1.20	7.41
PV 2	Greenpeace, 2001	5.76	4.80	10.56
Wind 1	REPP, 2001	0.43	0.27	0.71
Wind 2	EWEA/Greenpeace, 2003	2.51	0.27	2.79
Biomass – high estimate	REPP, 2001	0.44	2.44	2.84
Biomass – low estimate	REPP, 2001	0.4	0.38	0.78
Coal	REPP, 2001	0.27	0.74	1.01
Gas	Kammen, from REPP, 2001; CALPIRG, 2003; BLS, 2004	0.25	0.70	0.95

Post AB 32 implementation employment is likely to increase in the following sectors or market segments, as well as their associated supply chains:

- Biofuels, particularly as used in transportation and to generate electricity.
- Construction, particularly solar installation, heating, ventilation, and air conditioning contractors and construction of new generation and transmission facilities.
- (Clean) Technology, particularly associated with energy efficiency, advanced materials and nanotechnology, high efficiency vehicles, photovoltaics, and related software.
- Environmental engineering services, particularly associated with testing and compliance.
- Consumer products, particularly biodegradable packaging and plasticware and nontoxic household cleaners.
- Information technology, particularly environmentally related software.
- Transportation and logistics, such as fuel cells, diesel retrofits, hybrids.
- Waste and water purification and conservation, especially efficiency measures.

<sup>41</sup>“MWa” refers to average installed megawatts rated by the capacity factor of the technology; for a 1 MW solar facility operating on average 21% of the time, the power output would be 0.21 MWa. Kammen, Kapadia & Fripp, op.cit.

<sup>42</sup> See also Virinder Singh and Jeffrey Fehrs, *The Work that Goes Into Renewable Energy, Renewable Energy Project Research Report*, Number 13, November 2001.

<sup>43</sup> See also CEERT, op.cit.

Some sectors, such as manufacturing and energy generation, would likely experience a mix of employment gains and losses. For example, there would be increased manufacturing employment associated with solar panels, wind turbines, and low carbon vehicles. Likewise, fewer fossil fuel power plants would be constructed, but there would be significant activity related to the development of generation, storage, and infrastructure, such as photovoltaics, wind, hydrogen, geothermal, batteries and power management. Interestingly, despite incipient AB 32 implementation, Southern California Edison, the state's second largest investor-owned utility, expects to see an annual asset growth rate of at least 12 percent through 2012.<sup>44</sup>

### **2.3 Capital Availability Important to Economic Success**

An important element to AB 32's success will be businesses' and households' access to the capital necessary to purchase new energy efficient equipment and building stock. Existing financing conditions serve to inject significant uncertainty into this element, though within a few years current problems will almost certainly have been resolved. Likewise, while the credit crises could slow investment in alternative energy sectors, the impact will be muted to the extent that renewables development is directly tied to utilities purchasing goals.

In any case, to facilitate the benefits of AB 32 implementation a host of new financing instruments will be necessary, including:

- Community trading mechanisms to enable families and small businesses to benefit economically from reducing their greenhouse gas emissions, thereby providing them, as well as third-parties who facilitate energy efficiency transactions, with a stream of income with which to make efficiency investments and installation.
- Capitalization mechanisms, such as on bill financing, property tax-based financing, climate efficient mortgages, lease-financing arrangements, and power purchase arrangements, which enable consumers and businesses to pay for investments over long time periods while capturing efficiency-related benefits immediately.
- Investment opportunities, such as consumer-based power purchase agreements, which would enable third parties to make the investments necessary to reduce resource use and retain a portion of the bill savings.

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<sup>44</sup> Steven Greenlee, "Edison Predicts Robust Growth Despite Peevey Term Ending at CPUC," California Energy Markets, Number 992, page 7, September 5, 2008.

In general, however, clear, long-term (financial) commitments need to be made for innovation to occur. Investment is essential to creating technological innovation, and innovation, in turn, engenders economic growth, principally as a result of associated productivity gains and the creation of new markets. To the extent that the innovation prompted by AB 32 – in the form of new products and services – is owned by California firms and individuals, the profits generated from associated sales outside the state would benefit the California economy. That is, under AB 32, California is likely to increase its exports of energy-related goods and services, thereby contributing to the state’s prosperity.

There’s wide agreement among economists that significant technological innovation will be necessary if the state’s ambitious stabilization targets are to be reached. There have been few empirical analyses of the effectiveness of public policies to spur technological innovation in pollution abatement, principally because of the paucity of available data. However, there is evidence of a strong association between pollution abatement expenditures and the rate of patenting in related technology fields.<sup>45</sup> By and large the literature implies that to prompt innovation, investment and regulation are both needed.<sup>46</sup> That is, investments can result in new technologies, but particularly in the environmental marketplace, regulation is often needed to force adoption.<sup>47</sup> Publicly supported research and development can result in the creation of new technologies; however, market-based policies, such as a cap-and-trade system, serve to accelerate deployment of new technologies by increasing market demand.

To the extent that AB 32 implementation induces beneficial innovation, the costs of stabilizing greenhouse gasses will be reduced. In this respect well-designed policies that prompt innovation would create the opportunity for a win-win strategy.<sup>48</sup>

Likewise, improvements in living standards, economic growth, and the emergence of prosperous regional clusters such as Silicon Valley have historically been linked to productivity growth. Productivity can be improved through a number of factors including the development and adoption of new technologies. For example, information technology played a central role in the productivity spurt the United States experienced between 1995 and 2000, which coincided with the largest economic expansion since World War II.<sup>49</sup>

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<sup>45</sup> Landjouw, J.O. and A. Mody (1996), “Innovations and the International Diffusion of Environmentally Responsive Technology,” *Research Policy* 25:540-71.

<sup>46</sup> Carolyn Fischer, *Emissions Pricing, Spillovers, and Public Investment in Environmentally Friendly Technologies*, February 2004, Resources for the Future DP 04-02.

<sup>47</sup> David Popp, *R&D Subsidies and Climate Policy: Is there a “Free Lunch?”* National Bureau of Economic Research, Working Paper 10880, October 2004.

<sup>48</sup> Valentina Bosetti, Carlo Carraro, Marzio Galeotti, *Stabilisation Targets, Technical Change and the Macroeconomic Costs of Climate Change Control*, Fondazione Eni Enrico Mattei, January 2006.

<sup>49</sup> Stephen D. Oliner, Darrel E. Sichel, and Kevin J. Stiroh, “Explaining a Productive Decade,” *Journal of Policy Modeling*, pages 633 to 673, 2008,

Productivity growth sparked by increased energy efficiency would confer important advantages to California. Although increased productivity tends to produce widely dispersed benefits, the state’s energy intensive industries, including agriculture, would experience particular gains if AB 32 results in higher, long-term productivity.

## 2.4 AB 32 May Provide Economic Opportunities for Low Income Populations

As previously discussed, low income populations and small businesses are particularly vulnerable to AB 32 implementation-prompted price increases. Other than direct conservation, these populations have less of an ability to respond to short-term cost increases due to limited access to the capital necessary to invest in efficiency measures. Market-based policies can help address potential economic disruptions. In addition, as indicated in Table Five, a substantial percentage of jobs in the clean technology cluster pay working class or entry-level wages, indicating that they may provide an employment ladder for lower-skilled workers. Likewise, to the extent that AB 32 prompts additional training in the sector, new employment opportunities may open up for low income populations.

Table Five  
Clean Technology Occupations and Wages<sup>50,51,52,53</sup>

Occupation	Median Annual Earnings	Percentage of All Jobs in Green Industries
Carpenters	\$46,307	2.5%
Construction Laborers	\$33,096	1.9%
Computer Software Engineers	\$88,084	1.4%
Truck Drivers, Heavy and Tractor-Trailer	\$36,612	1.4%
Team Assemblers	\$23,255	1.0%
Maintenance and Repair Workers	\$38,423	1.2%
Supervisors/Managers of Construction Trades and Extraction Workers	\$61,995	1.0%
Electricians	\$52,859	1.0%
Plumbers, Pipefitters, and Steamfitters	\$47,439	0.9%
Business Operations Specialists	\$61,396	0.8%
Computer Software Engineers	\$92,542	0.7%
Supervisors/Managers of Production and Operating Workers	\$52,072	0.7%
Management Analysts	\$73,816	0.6%

<sup>50</sup>“Mwa” refers to average installed megawatts rated by the capacity factor of the technology; for a 1 MW solar facility operating on average 21% of the time, the power output would be 0.21 MWa. Kammen, Kapadia & Fripp, op.cit.

<sup>51</sup> See also Virinder Singh and Jeffrey Fehrs, *The Work that Goes Into Renewable Energy, Renewable Energy Project Research Report*, Number 13, November 2001.

<sup>52</sup> See also CEERT, op.cit.

<sup>53</sup> <http://www.census.gov/hhes/www/income/medincenersandstate.xls>.

Occupation	Median Annual Earnings	Percentage of All Jobs in Green Industries
Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	\$66,371	0.6%
Inspectors, Testers, Sorters, Samplers, and Weighers	\$32,041	0.6%
First-Line Supervisors/Managers of Mechanics, Installers, and Repairers	\$60,579	0.5%
Statewide, 2007	\$47,363	

## 2.5 AB 32-Induced Geographic Employment Dislocation Can Be Mitigated

Classical economic theory suggests that if the costs to conduct business in a region, state or nation are higher than another, all things being equal, the impacted firms will relocate to lower costs places if possible. In this respect, to the extent that AB 32 implementation results in significantly higher production costs for certain business sectors, these populations may choose to locate outside the state, resulting in reductions in in-state economic activity. Alternatively, to the extent that the increased building and other efficiencies prompted by AB 32 implementation lower operating costs, firms that seek low-energy intensity (i.e., low operating costs) could be attracted to the state.

However, it's important to note that all things are not equal. Firms consider many factors when deciding to (re)locate their facilities, including the quality of the workforce (e.g., education and skills), sunk costs (e.g., relatively permanent physical plants), local government permitting requirements, access to markets, transportation infrastructure, and lifestyle opportunities.

To the extent that the federal government adopts similar standards, California could be at an advantage in terms of creating an economic infrastructure capable of supporting a low carbon economy. Likewise, as nearby states and Canadian provinces agree to adopt greenhouse gas emission reduction programs – for example, under the Western Climate Initiative consisting of Arizona, California, New Mexico, Oregon, Washington, Utah, Montana, British Columbia, Manitoba, and Quebec – the ability of firms to find lower-cost places will be diminished.

## 2.6 AB 32 Implementation Will Likely Reduce the Risks of Fuel Shocks.

An important economic benefit likely to emerge from AB 32 implementation is a more diverse energy and supply regime in which the risks of single-fuel shocks and reliability disruptions is diminished. Expanding the portfolio of fuel sources and delivery systems helps protect against failures or cost spikes associated with a single fuel or delivery source.

Like many other studies, a recent forecast by the International Energy Agency indicates that petroleum prices will continue to rise as supplies become increasingly scarce.<sup>54</sup> For example, the California economy is more sensitive to higher natural gas prices than the national economy, principally because almost half of the electric power generated in the state comes from burning natural gas.<sup>55</sup> The state needs to develop a more diversified fuel portfolio if it is to reduce the risks associated with (unexpected) natural gas price increases.

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<sup>54</sup> International Energy Agency. *World Energy Outlook*. 2008.

<sup>55</sup> Global Insights, Inc. *The Impacts of Natural Gas Prices on the California Economy: Final Report*, February 2006.

### **3.0 Conclusion**

AB 32 adoption coincided with, but did not cause, worldwide increases in fossil fuel prices that were driven by booming economies in Asia. While the current economic downturn has acted to moderate these price run-ups, rising global demand will continue to trigger substantial fossil fuel price pressures when the economy recovers. High prices are simply a market signal that demand is increasing faster than supply; in the long-term, the way to reduce prices is to reduce demand and increase available alternatives to fossil fuels.

In this respect, AB 32 implementation would serve to accelerate an economic transformation that has already been prompted by both the market and a host of already-adopted local, state, and federal policies. This web of economic trends and public policies form a broad basis from which to reduce statewide carbon emissions and concomitant fossil fuel use under the AB 32 framework. Some of this reduction will be achieved through increased energy efficiency (i.e. the same amount of productivity will be supported by lower fuel inputs). Efficiency will be obtained by substituting fuel for capital (e.g., energy efficient appliances) and for labor (e.g., taking the time to turn off energy-using devices when they're not in active use). In addition, AB 32 will prompt substitution of fossil fuel-based energy for other sources such as biomass, solar, and wind. While some of these sources are currently more expensive than fossil fuels, costs will decline as associated technology is developed and adopted at large scales. Further, these sources tend to support more employment than fossil fuels.

In the short-term, AB 32 will trigger increased investment in the state with associated employment gains. While there may be some adverse consequences associated with the transformation to a low carbon economy, well-crafted policies can significantly reduce bad outcomes. In the longer term, California is likely to be more productive and support higher employment as a result of implementation of well-designed AB 32 policies.

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