



EDUCATING, ENGAGING AND EMPOWERING CALIFORNIANS TO IMPROVE OUR STATE'S FUTURE

Energy Pathways for the California Economy

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About Next 10

**NEXT 10 IS A NONPARTISAN,
NONPROFIT ORGANIZATION THAT
EDUCATES, ENGAGES AND EMPOWERS
CALIFORNIANS TO IMPROVE THE
STATE'S FUTURE.**

Next 10 is focused on innovation and the intersection between the economy, environment, and quality of life issues. We create tools and provide information that fosters a deeper understanding of the critical issues affecting our state. Through education and civic engagement, we hope Californians will become empowered to affect change.

Energy Efficiency, Innovation, and Job Creation in California is authored by Professor David Roland-Holst at the University of California Berkeley. Next 10 funds research from leading experts on complex state issues, providing critical data to help inform the state's efforts to grow the economy and reduce global warming emissions.

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Over the last four years, California has taken unprecedented initiative to cap and reduce greenhouse gas emissions. Governor Arnold Schwarzenegger signed Executive Order #S-3-05 (Schwarzenegger 2005), calling for a 30 percent reduction below business-as-usual of greenhouse gas emissions by 2020 and a long term, lower carbon future with emissions 80 percent below 1990 levels by 2050. In September 2006, the California legislature passed and Governor Schwarzenegger signed into law the Global Warming Solutions Act (AB 32), which mandates a first-in-the-nation limit on emissions that cause global warming. To promote implementation of its path breaking climate strategy, in December 2008, the California Air Resources Board (CARB) adopted the “AB 32 Climate Change Scoping Plan” — a policy roadmap to meet the emissions reduction target of 169 Million Metric Tons of Carbon (MMT_{CO2}) equivalent by 2020 to stabilize at 427 MMT_{CO2} overall.



Now, as the state moves to implement its landmark plan, the world is in the grips of a global financial crisis, and Californians face an unprecedented multibillion-dollar state budget deficit. The short- and long-term implications of this state fiscal situation are daunting — some predict a dramatic exodus of businesses, loss of jobs and erosion of academic prowess.

Within this context, *Energy Pathways for the California Economy* evaluates the state’s energy demand and supply horizons, and the economic impact of accelerating deployment of renewable energy resources and energy efficiency trends in California.

TOP FINDINGS

- From electricity to transportation, projecting status quo demand and supply horizons portends ever greater reliance on out-of-state fuel sources, and therefore greater exposure to fuel price volatility.
- Five alternative forecasting scenarios show that the faster and farther California can improve household and enterprise energy efficiency, while accelerating deployment of renewable energy resources, the faster the state economy will grow and create jobs. The most ambitious scenario (50 percent renewable energy; 1.5 percent annual efficiency increases) produces the largest number of additional jobs and income – generating half a million new FTE jobs with over \$100 billion in cumulative payrolls over 40 years.
- Renewable energy generation is more job-intensive than the traditional carbon fuel supply chain, captures more benefits within the state economy, and reduces our vulnerability to uncertain global energy markets.

Demand Horizons

California has made exemplary progress in demand-side management of electricity use; per capita energy use has remained flat for decades while rising over 60% in the rest of the country. For example, the California Energy Commission (CEC) estimates that Californians saved \$40 billion in 2006 due to increases in space heating efficiency while air conditioning efficiency improvements saved \$30 billion.

Nevertheless, the explosive growth in population, inland development, home size, rate of installation and total number of operating air conditions, has driven total electricity consumption even higher.

From 1976 to 2007, the average size of new homes grew 55 percent, from 1,560 to 2,390 square feet (CEC 2008) and a greater number of new homes are being built with central air conditioning. The increase in total number of operating air conditioners has increased total peak demand attributed to them from five percent in 1976 to over 24 percent in 2006 (CEC 2008). And the rate of installation in new homes has skyrocketed from 25 percent in 1976 to 95 percent in 2007. On current trends, the CPUC estimates that total California electricity demand could double by the middle of this century.

TRANSPORTATION

In California, transportation is the largest energy consumer. There are more motor vehicles registered here than any other state – over 28 million – and worker commute times are among the longest in country. Commuters consume the largest share of total vehicle fuel. Two-thirds of all the state's imported oil is used for transportation, and 58 percent of overall energy expenditures in California fuel transportation. According to California Energy Commission projections, transport fuel demand could double by 2050 or fall by 25%, depending on regulatory policies and fuel prices.

Supply Horizons

PETROLEUM

California produces one-tenth of the national share of crude oil production with drilling operations concentrated primarily in Kern County and the Los Angeles. Overall current production in California has been steadily declining as no new terrestrial oil reserves have been discovered in the past two decades.

California is a top petroleum refiner with the third largest petroleum refining capacity in the U.S. producing over two million barrels a day. Refinery capacity has been increasing in California since 2000, with an average growth rate of .5 percent or about half as fast as the U.S. ¹

With declining in-state production and Alaskan supply, California refineries are increasingly reliant on imports, with leading suppliers like Saudi Arabia and Ecuador making up 40 percent of offshore refining supply.

California fuel prices are significantly higher than the U.S. national average, and motorists are particularly vulnerable to short-term price spikes. Declining in-state production of petroleum and growing reliance on foreign crude only increases the state's vulnerability to external price and supply shocks.

COAL

Coal plays a small role in California's electricity sector – with only a few operating small coal fired power plants in

¹ California's strict environmental standards are the primary constraint on refinery expansion.

the state due to strict emissions standards and restrictions on the use of coal fired generation within its boundaries. While low coal reliance is consistent with California's rigorous air quality standards, it narrows the state's options among traditional carbon fuels.

NATURAL GAS

California has substantial natural gas deposits in geological basins in the Central Valley and Pacific Coast, but production accounts for less than two percent of total annual U.S. production and meets less than one-fifth of state demand.

Historically, state natural gas supplies have remained relatively stable, with increasing supply from Rocky Mountains and nearly a dozen storage facilities to smooth supply fluctuations. Recently, however, but Washington and Oregon's rising natural gas demand has forced California to compete for a dwindling regional supply.

Although California leads the nation in hydroelectric and other renewable power generation like solar and wind, the state still relies significantly on natural gas and imports for its electricity. In fact, California imports more electricity than any other state, including hydroelectric-based power from the Pacific Northwest and coal and natural gas-fired power from the Southwest. With greater demand and limited domestic production, natural gas prices have been continuously rising, with particularly steep increases since 2000.

California's natural gas prices are higher than other states in the region. Following historic prices trends and with growing demand from the electricity sector, natural gas prices are forecasted to continue rising in coming years.

Demand & Supply Horizon Core Findings

Overall, from electricity to transportation, greater reliance on fuel imports means California will become even more vulnerable to external price and supply shocks.

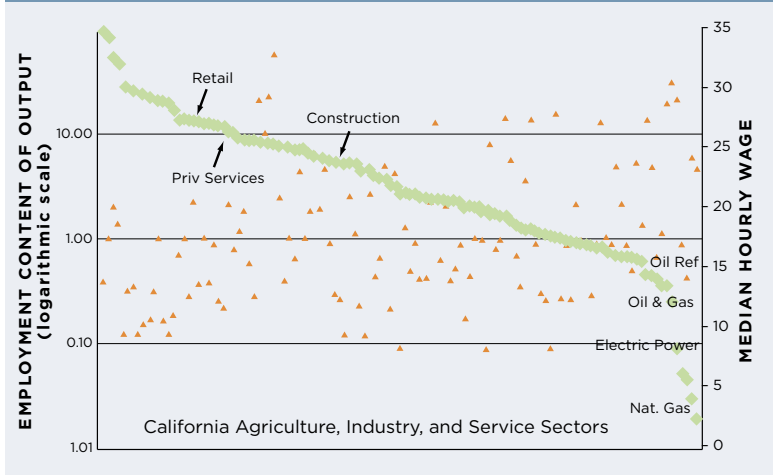
The carbon fuel supply is among the very least employment intensive economic activities, even before considering how these expenditures leak outside the state and national economies to foreign energy sources.

Energy efficiency saves money and stimulates the economy through expenditure shifting, away from

import-dependent carbon fuels and toward employment intensive in-state goods and services. Comparing the employment content of output across over a hundred different economic activities (Figure 1) reveals this expenditure shifting can have a dramatic net effect on job creation. The disparity between job growth from a dollar spent on fossil fuels and one spent on services is so great that a logarithmic scale is needed to display it.

Simply put, a dollar saved on traditional energy is a dollar earned by 10-100 times as many new workers.

Figure 1: Employment Intensity and Median Wage by Sector
(labor/output ratios for 124 primary, secondary, and tertiary activities)



Economic Impact of Increased Renewable Energy and Efficiency

METHODOLOGY

For the last three years, University of California at Berkeley's Center for Energy, Resources, and Economic Sustainability (CERES) has been conducting independent research to inform public and private dialogue surrounding California climate policy. Among these efforts has been the development and implementation of a statewide economic model, the Berkeley Energy and Resources (BEAR) model, the most detailed and comprehensive forecasting tool of its kind.

BEAR is a computable general equilibrium model of California's economy that simulates demand and supply relationships across many sectors of the economy

and tracks the linkages among them. It can thus be used to trace the ripple effects, throughout the economy and over time, of new economic and technology policies.

Using BEAR, we evaluated the economy-wide impacts of five new energy scenarios, three degrees of Renewable Portfolio Standards (20 percent, 33 percent, and 50 percent) and new energy (NE) efficiency (with RPS50) improvements of 1.0 percent and 1.5 percent annually.

Renewable & Energy Efficiency Core Findings

- Renewable fuel generation is more job intensive and less price volatile than traditional carbon fuel supplies.
- Modeling five scenarios shows that the faster and farther California improves the efficiency of household and enterprise energy use while accelerating the deployment of renewable energy resources, the faster the state economy will grow and more jobs will be created. The most ambitious scenario (50 percent renewable fuels; 1.5 percent efficiency increase) produces the greatest number of jobs and largest payroll – generating half a million additional jobs with over \$100 billion in cumulative payrolls over 40 years.
- Employment creation outweighs employment reduction in every scenario.
- Over the time period we consider, the renewables industry increases in-state employment to about half the size of California’s biotech sector, but meanwhile up to twice as many jobs are created in upstream and downstream sectors.
- When renewables are the primary new energy strategy, employment growth is concentrated in that sector, in electronics, and in machinery.
- Depending on the degree of renewable deployment, direct job creation would be between 10,000 and 40,000 FTE jobs, though our estimates suggest that total “green jobs” attributable to RPS (including up and downstream) would be closer to column totals, or 14-57,000 jobs for California. Even these figures are

net of employment reductions against the baseline. Adding up the new jobs only, green job creation becomes 22-87,000.

- By comparison with renewables alone (RPS50), integrating energy efficiency measures increases statewide job benefits almost tenfold. Employment gains are more widespread, particularly in construction and services, with the former responding to new building standards and the latter benefiting from expenditure diversion. Note, however, that the energy efficiency component moderates the growth of RPS, since efficiency applies both to traditional and new energy sources.

Table 1: Employment Results²
(Change from Baseline in 2050, thousands)

	RPS20	RPS33	RPS50	NE1.0	NE1.5
Agriculture	0.154	0.353	0.611	9.686	14.645
Oil and Gas	-2.203	-5.062	-8.789	-46.004	-62.058
Electricity	-0.183	-0.433	-0.777	-17.642	-23.807
Renewables	10.184	23.429	40.730	6.061	5.301
Natural Gas Dist.	0.035	0.079	0.138	-17.051	-22.865
Construction	1.701	3.925	6.847	112.404	167.689
Food Processing	0.047	0.107	0.183	9.120	15.312
Oil Refining	-0.120	-0.276	-0.480	-10.650	-14.336
Chemicals	0.242	0.555	0.960	4.126	6.238
Pharmaceutical	0.063	0.145	0.253	-0.288	-0.222
Cement	-0.134	-0.308	-0.535	3.658	5.636
Metals	1.017	2.326	4.019	-2.640	-3.270
Machinery	2.070	4.761	8.276	-60.240	-86.992
Elec App and Semi	5.021	11.514	19.955	4.207	5.164
Vehicles	0.044	0.099	0.171	1.352	2.652
Other Industry	-1.783	-4.108	-7.156	2.193	7.045
Wholesale Trade	0.055	0.120	0.199	10.489	12.526
Retail Trade	1.202	2.745	4.738	57.037	73.017
Transport Serv	-2.077	-4.773	-8.291	23.994	38.778
Other Private Serv	-0.999	-2.373	-4.266	218.095	280.295
Total	14.335	32.826	56.785	307.907	420.747
New Jobs	21.834	50.159	87.078	462.422	634.298
Job Reduction	-7.499	-17.333	-30.293	-154.516	-213.551

Note: Employment results given in Table 1 for the five scenarios are stated in thousands of jobs against Baseline levels. All results are differences against a dynamic (2008-2050) baseline in which all sectors of the California economy grow.

² When a result in this table is positive, more jobs are created than in the Baseline, less when it is negative. In particular, negative results do not mean that a sector necessarily contracts or that existing jobs are lost. It is more accurate to think of these results as comparisons of shifting job opportunity across the economy. The last two lines decompose the employment impacts between new jobs in sectors that expand more rapidly, and “reduced” job creation in sectors that grow more slowly relative to the baseline. In the latter case, it is important to note that total employment in a sector may not fall in absolute terms (i.e. sector contraction) over the 2008-2050 period, but it will grow more slowly than in the baseline.

- In terms of relative income effects, renewables deployment generates 2-3 times as many new payrolls as it displaces in traditional carbon fuel supply chains.
- Renewables generate jobs with relatively high wages and obvious new technology appeal. Even when a significant portion of green tech manufacturing is outsourced (we assume about 25 percent of value), California still captures significant employment and payroll benefits from greater renewable deployment.
- In addition to direct renewable technology sector (“green-collar”) employment, significant indirect income benefits travel up and down supply chains, increasing payrolls in construction, manufacturing, and services.
- These jobs, particularly those in services related to marketing, installation, and maintenance, cannot be outsourced, and are a lasting dividend accruing to the large domestic market adopting these new technologies.
- Finally, household energy efficiency savings translate, via expenditure shifting, into even greater income growth for consumer sectors, including more diverse, bedrock in-state employment in food, services, etc.

Conclusion

Our economic assessment strongly supports the notion that a new California energy agenda, emphasizing efficiency, renewables, and infrastructure, can be a potent catalyst for economic growth in both the short- and long-term.

We find that dramatically increasing energy efficiency and renewable energy’s share of electricity generation can be a powerful source of job creation, and that this employment is diverse and attractive in terms of average skill content and wages.

It is clear from this research that “green job” creation goes far beyond “green collar jobs”. That is, green job creation is much more widespread than direct employment in green technology sectors. This fact is often ignored in the enthusiasm surrounding green/clean energy. Although direct employment in such new energy technologies may be significant, it is not the primary source of job creation arising from greater energy efficiency or renewable development. Indirect employment benefits from these innovation trends are much greater, more diverse and income-equitable, and in-state job retention is much higher. In addition, most of these jobs are in the services bedrock of the state’s labor force and cannot be outsourced.

Energy efficiency measures offer much more potent growth leverage to the economy than renewable energy deployment alone. Only a fraction of the employment benefits of a new energy agenda are on the supply-side, as our results demonstrate that energy efficiency measures offer strong multiplier effects through expenditure shifting.

As California looks to a future of dramatically increasing energy demand, dwindling traditional energy supplies, and greater fuel price volatility, it is clear from this analysis that pursuing an aggressive schedule of renewable fuel and energy efficiency deployment now is the most prudent economic course of action if we are to avert even greater financial crises in the future.

Table 2: Cumulative Income Results
(change from Baseline over 2010-2050, in 2007 USD millions)

	RPS20	RPS33	RPS50	NE1.0	NE1.5
Agriculture	34	77	134	1,767	2,554
Oil and Gas	-575	-1,322	-2,295	-10,012	-13,858
Electricity	-87	-206	-370	-5,742	-7,984
Renewables	3,444	7,924	13,774	2,203	1,952
Natural Gas Dist.	11	25	43	-4,513	-6,264
Construction	41	95	165	5,762	8,529
Food Processing	12	28	48	2,732	4,068
Oil Refining	-41	-94	-164	-2,803	-3,906
Chemicals	71	162	280	1,303	1,872
Pharmaceutical	26	59	102	0	-16
Cement	-13	-31	-54	169	259
Metals	224	513	886	41	29
Machinery	548	1,262	2,196	-9,311	-13,649
Elec App and Semi	1,765	4,046	7,005	2,173	2,466
Vehicles	12	27	46	604	928
Other Industry	-407	-938	-1,633	2,085	3,270
Wholesale Trade	10	21	33	2,187	2,650
Retail Trade	226	515	885	9,218	11,809
Transport Serv	-517	-1,187	-2,061	4,906	7,966
Other Private Serv	-374	-886	-1,586	44,834	58,529
Total	4,409	10,089	17,436	47,604	61,204
New Payroll	6,424	14,753	25,600	79,986	106,882
Reduction	-2,014	-4,664	-8,164	-32,382	-45,678
New/Old	3.2	3.2	3.1	2.5	2.3

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