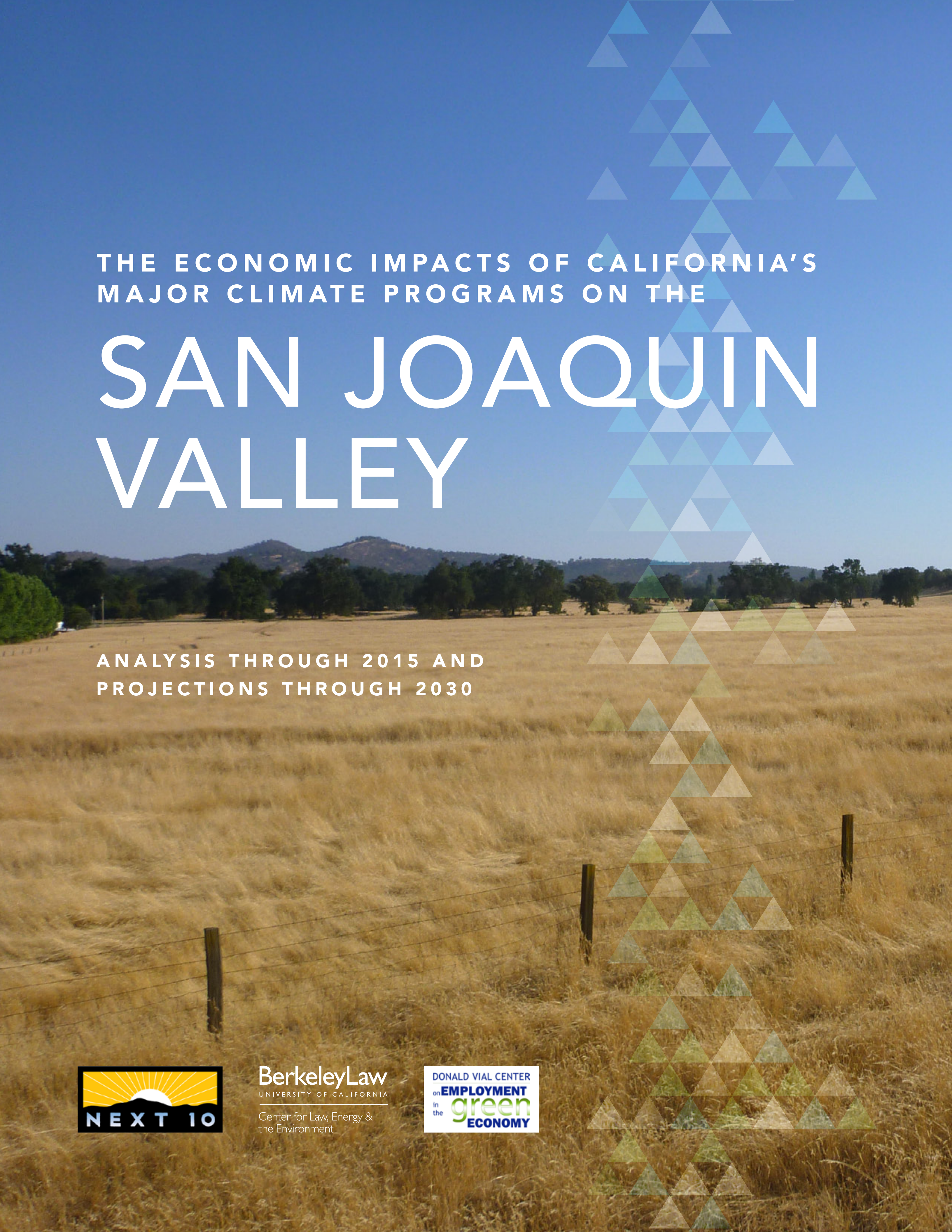

THE ECONOMIC IMPACTS OF CALIFORNIA'S MAJOR CLIMATE PROGRAMS ON THE SAN JOAQUIN VALLEY

ANALYSIS THROUGH 2015 AND PROJECTIONS THROUGH 2030

NEXT 10

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EXECUTIVE SUMMARY

The San Joaquin Valley plays a critical role in shaping California's climate policy and is worthy of study due to its function as a bellwether of the state's transition to a low-carbon economy. Reducing emissions is vitally important for the San Joaquin Valley. The Valley's topography traps pollution, and air quality and the resulting health conditions are far worse in the Valley than in other region of the state. The region also faces more socioeconomic challenges than the state as a whole. Thus the Valley is vulnerable to both climate change and to climate policy. If policymakers can make climate policy work for the Valley, it will work for the state and demonstrate that these policies and programs can work for vulnerable communities around the world.

In the California Legislature, some San Joaquin Valley ("Valley") representatives have raised concerns about the impact the state's climate policy and programs could have on jobs.[1] But claims and counter-claims about the economic impact of climate policies have been wielded in an informational vacuum. To date, no comprehensive independent or academic study has sought to calculate and analyze current and future economic impacts of state climate policies within the San Joaquin Valley, comprised of the eight counties of Fresno, Madera, Merced, Kern, Kings, San Joaquin, Stanislaus, and Tulare. Together, these counties represent 11 percent of the state's population.

With this report, the UC Berkeley Donald Vial Center on the Green Economy (DVC) and the Center for Law, Energy and the Environment (CLEE) at UC Berkeley School of Law, with support from Next 10, offer a quantitative assessment of the economic impacts of three of California's major climate programs and policies in the Valley: cap and trade, the renewables portfolio standard, and investor-owned utility (IOU) energy efficiency programs. We also offer policy recommendations based on the findings.

Results for each of the three programs and policies investigated are summarized in brief below. As the costs and benefits for each program were calculated differently, results cannot be equally compared across all programs. However, analysis from this report suggests that total net economic benefits thus far for the three programs investigated is more than $13.4 billion. In short, the findings indicate that despite the heightened fears of job loss, California's major climate policies have been a net economic boon to the San Joaquin Valley. Strengthening those policies, not backtracking on them, is likely to continue that success and accentuate the positive effect in the region. After accounting for the costs and benefits, the net impacts are bulleted below:

Cap and Trade

Net economic impacts from the cap-and-trade program through December 2016 include $200 million in total economic impact, including $4.7 million in state and local tax revenue. These programs have created 1,612 total jobs in the Valley, including 709 direct jobs.

When one includes expected benefits based on funds for projects approved but not yet spent (with funds to be disbursed on a yet-to-be-determined date), this figure balloons to nearly $1.5 billion when accounting for total impact on the economy. These projects will create 10,500 total jobs, including 3,000 direct jobs.

RPS

The state's Renewables Portfolio Standard has had a substantial economic impact on the Valley and is a key source of job creation. Construction on RPS-related projects resulted in a total economic impact of $11.6 billion in the Valley. Between 2002-15, the RPS created 88,000 total jobs, including 31,000 direct jobs.

Energy Efficiency

Energy efficiency projects in the Valley have had a net economic benefit of $1.18 billion. Energy efficiency is also a significant job creator, particularly in the construction sector, and was responsible for creating a total of 17,400 jobs in the Valley between 2006 – 2015, including 6,700 direct jobs. Benefits from efficiency programs include lower electricity costs, consumer savings from reduced energy use, jobs created to implement energy upgrades and jobs flowing from the boost in local economies that results from lower utility bills.

Economic Impacts

This analysis presents costs and benefits to the Valley economy, including job gain and loss, of three programs: Cap and trade, the Renewables Portfolio Standard and energy efficiency programs overseen by the California Public Utilities Commission (CPUC). The methods used to evaluate the economic impacts of three significant climate policies and programs varied due to the data and modeling tools readily available for an initial analysis. As a result, the impacts, and the employment impacts in particular, are reported by program rather than in aggregate. Because of this, we have not summed these impacts and caution against doing so. However, the economic data and methods used can provide the foundation for more robust regional analyses of California's climate programs in the future.

CAP AND TRADE

One of the key climate policies initiated under AB 32 is the state's cap-and-trade program, which is a market-based program to reduce greenhouse gas (GHG) emissions from designated entities.

To determine the net economic impacts of cap and trade in the Valley, we first estimated the direct impacts – the costs of compliance and investments of revenue raised from auctioning the allowances, and then used IMPLAN to model the macroeconomic effects. The negative direct impact is due to the aggregate regional compliance cost, comprised of on-site reductions plus cost of acquiring allowances or offsets, net of free allocations. The positive direct impact is based on spending and projected spending in the Valley of allowance auction proceeds.

Table 1 shows the estimated compliance obligation for the San Joaquin Valley. Cost estimates are based on the estimated compliance obligation for the Valley (emissions minus free allowances). Full details on compliance cost methodology can be found in the Methodology section for cap and trade.

The total estimated positive impact on economic activity from all expected and disbursed expected and disbursed Greenhouse Gas Reduction Funds (GGRF) is $668 million, with a total impact on employment (including direct, indirect and induced jobs) of 6,190 jobs.

Table 2 summarizes the net economic impacts of cap and trade in the Valley. The results are unambiguously positive but remain a small fraction of the region's increasingly dynamic, diverse economy. We estimate that benefits (net of costs) represent 0.04 percent of total employment and regional domestic product of over $150 billion. Also notable is that

TABLE 1 Summary of Emissions, Free Allowances, and Cost of Cap-and-trade Compliance (2013-15), San Joaquin Valley and Total

	Capped Emissions* MMT CO_2e	Allocation of Free Allowances MMT CO_2e	Estimated Compliance Obligation MMT CO_2e	Estimated Compliance Cost (Dollars)
Total	632.5	504.0	128.5	$4,990 million
San Joaquin Valley	130.7	42.7*	90.9	$628 million

Source: Authors' analysis using ARB auction, emissions, and allowance allocation data **Value estimated*

TABLE 2 Summary of Costs and Benefits of Cap-and-trade Implementation in the Period 2013-15 in the San Joaquin Valley

Category	Direct Effects ($ and jobs)	Total Impact on Economic Activity	Total Impact on Employment	Impact on State & Local Tax Revenue*
Cost of Compliance (2013-15)	($200 million) (151 jobs)	($265 million)	(428 jobs)	($9.6 million)
Implemented GGRF Revenue (2013-15)	$319 million 860 jobs	$467 million	2040 jobs	$14.3 million
Expected GGRF Revenue (2013-15)**	$1203 million 3190–3800 jobs	$1750 million	7840 jobs	$54.9 million
Net Impact (to-date)	**$119 million 709 jobs**	**$202 million**	**1612 jobs**	**$4.7 million**
Expected Net Impact**	**$1003 million 3039- 3649 jobs**	**$1485 million**	**7412 jobs**	**$45.3 million**

Source: Authors' IMPLAN analysis. Results reported in 2016 dollars.

** Excludes property tax revenue*

***Expected includes both the already disbursed* even though only a small fraction of GGRF funds have been disbursed at time of writing, the net impact on jobs, total economic activity, and state and local tax revenue was positive (1612 jobs, $202 million, and $4.7 million, respectively). Generally, the industries receiving GGRF funds are more labor-intensive than the industries needing to comply with the emissions cap. Furthermore, despite the modeled negative impact indicating the contraction of 428 jobs in emission intensive industries due to cap-and-trade compliance, there has been no evidence of actual job loss in the region. In fact, total employment, personal income, and household incomes rose over the first three years of cap-and-trade implementation.

The program has had a positive stimulus effect due to the investment in the region of revenues from the auction allowances, which are collected into the Greenhouse Gas Reduction Fund (GGRF). In the San Joaquin Valley, GGRF revenues are now being spent on the planning and construction of the initial portion of the state's high-speed rail system, as well as a variety of other programs that reduce GHG emissions. Because a portion of the GGRF is required to benefit or be spent in disadvantaged communities, as defined by SB 535, and many of these communities are located in the San Joaquin Valley, the region is poised to receive a higher share of expenditures than its share of the state's capped emissions.

Should California decide to extend the cap-and-trade program beyond 2020, as the California Air Resources Board has proposed, and assuming that the state will legally be able to continue auctioning allowances, a number of factors will determine the future costs and benefits of the program to the Valley. Compliance costs will be less expensive if covered entities can reduce emissions more cheaply than the cost of procuring allowances. The benefits to the Valley will be determined by the number and price of allowances sold in the state auction, the percentage of GGRF funds spent in the Valley, allocation to utility customers, and the activities funded by the GGRF. Other more difficult to quantify benefits include improved public health and lower health care costs as well as the expansion of low carbon substitutes for carbon intensive industries.

RENEWABLES PORTFOLIO STANDARD

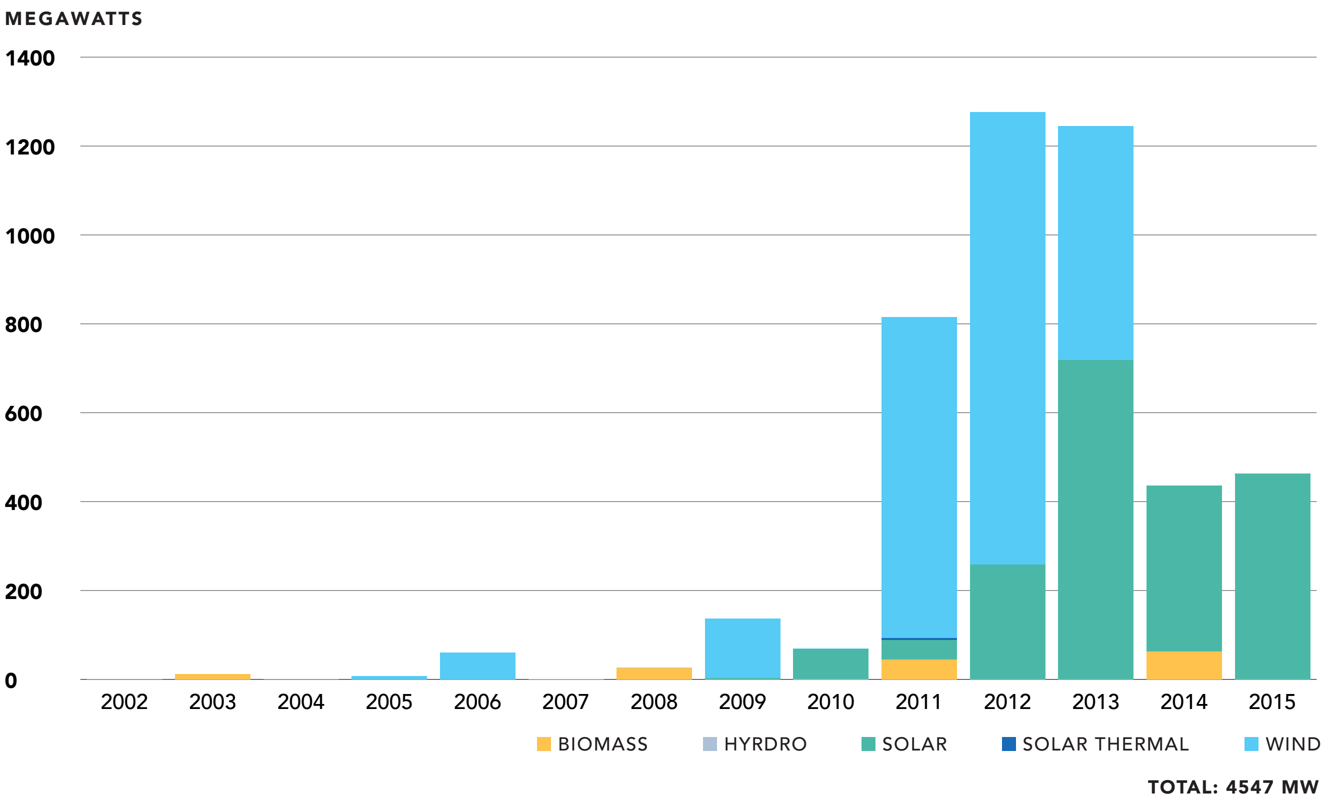
Another key climate policy shaping California's transition to a low-carbon economy is the Renewables Portfolio Standard (RPS). Initiated in 2002 and later strengthened twice, it requires all retail electricity sellers to procure 33 percent of their electricity from eligible renewable energy resources by 2020 and 50 percent by 2030.

As of December 2015, the Valley was the site of almost 31 percent of the RPS-qualifying energy capacity statewide, showing a concentration much greater than its share of the state's electricity consumption (15 percent). In total, by the end of 2015, 4547 Megawatts (MW) of renewable energy generation was constructed in the Valley (See Figure 1).

Using the Jobs and Economic Development Impact (JEDI) models developed by the National Renewable Energy Laboratory (NREL), we estimate that construction of those projects from 2002-15 created about 88,000 direct and indirect jobs,[2] of which 80,000 were created since 2012. Within this figure, 31,000 of these were "direct jobs" including jobs associated with on-site development. This construction resulted in $11.6 billion in total economic output in the Valley.

Jobs in the construction of utility-scale renewable power plants throughout California have generally been local, career-track jobs because almost all projects have been built under project labor agreements (PLAs). PLAs ensure that workers are paid a living wage and benefits and require that many of the workers are trained through the state-certified apprenticeship system, which provides broad occupational training

FIGURE 1 Renewable construction in the 8-county San Joaquin Valley region, 2002-15



and a path into a middle class skilled trade career. As it is designed, California's RPS has yielded significant beneficial economic impacts to the San Joaquin Valley and other economically depressed regions of the state.

The future economic impacts of California's renewable energy policies in the Valley will be determined, in part, by the amount of renewables built in the region to meet statewide demand. This amount is, in turn, influenced by resource cost, generation profile, and the state's decisions on how much to expand its grid market outside of California. Grid expansion could allow for more out-of-state renewables to meet in-state demand.

As California policymakers consider the modification of state rules to allow for the buying and selling electricity more freely across state lines in the Western region, it is important to consider the potential costs and benefits for California and the San Joaquin Valley. A recent California Independent System Operator (CAISO) study indicated that the results of a multi-state grid could be largely positive for the San Joaquin Valley as long as the current renewable procurement rules (i.e. category system) stay intact.[3]

Overall, given the region's prime location for solar exposure ('insolation') and wind resources (particularly in eastern Kern County), the low transmission costs from the region, the state's ambitious renewable goals and the likely increasing need for electricity for the transportation sector, the Valley is likely better positioned than any other part of the state to benefit economically from renewable deployment through 2030. The RPS-related jobs and economic benefits to-date are likely to continue to increase as the state deploys more renewable energy through 2030.

TABLE 3 Economic Impacts of the Renewables Portfolio Standard on the San Joaquin Valley, 2002-2015

Renewable technology	Capacity in Megawatts (MW)	Direct jobs (construction phase)	Total economic output (construction phase)	Total jobs (construction phase)
Solar	1926	28,880	$9,708 million	76,330*
Wind	2471	1,600	$1,726 million	10,400*
Other	151	600	$166 million	1110*
TOTAL	**4547**	**31,000**	**$11,600 million**	**87,800***

Source: Authors' analysis using JEDI with power plant data from the California Energy Commission

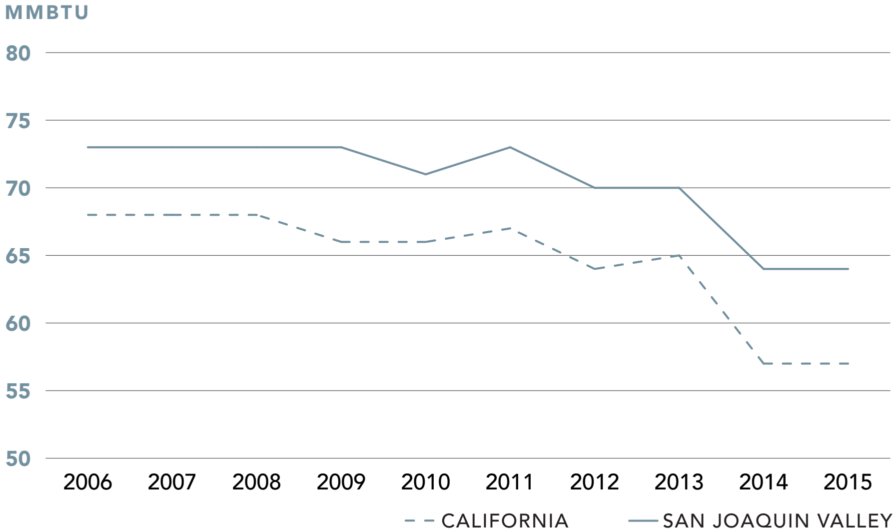
ENERGY EFFICIENCY (EE)

Energy efficiency (EE) is the highest priority energy resource in the state's energy planning system and is key to minimizing the costs of transitioning to a cleaner energy system. The Valley has one of the hottest climates in the state, and per household energy use is slightly higher than the state average (Figure 2). As a result, energy efficiency has special significance for this region. Ratepayer-funded programs, administered by the investor-owned utilities, are the largest consolidated source of funding for incentives and assistance for energy efficiency investments in California and represent the basis for the analysis in this report.[4] These programs help residential, commercial, and industrial and agricultural customers by reducing the cost of energy-efficient technologies and related energy services.

Based on county-specific CPUC data from 2010-15 program years, Valley customers received a total of $257 million in rebates and other incentives including direct install services. Additional calculated spending associated with administering, marketing, and implementation, combined with customer investments, brought the total investment in energy efficiency in the Valley (through IOU programs) to $846 million.

Energy efficiency investments have a high positive rate of return. Customers save money year after year, and energy efficiency helps keep rates low for everyone by reducing the need for costly new energy generation infrastructure. The CPUC evaluates the cost-effectiveness of the IOU energy efficiency programs in order to ensure they return more benefits to ratepayers than they cost. Since 2010, the Valley has had the highest cost effectiveness in the state, with benefits from EE projects totaling $1.183 billion. After subtracting total ratepayer and consumer costs, these programs provide a net benefit of $248 million.

FIGURE 2 Per Household energy consumption in the San Joaquin Valley compared to California, 2006-2015



In addition to the benefits of avoided future costs, energy efficiency investments in the Valley create work in the construction sector. This impact is important because construction jobs have higher economic and employment multipliers than retail and service jobs: a job created in construction will stimulate more economic activity in the region. Based on publicly available data at California's energy agencies, a wide review of literature on energy efficiency job impacts, and research from the Lawrence Berkeley National Laboratory, we estimate that between 2006-15, IOU energy efficiency programs created 6,700 direct job and 10,700 indirect and induced jobs, for a total of 17,400 jobs.

While California's IOU energy efficiency programs represent only a fraction of the state's commitment to efficiency, they account for the largest consolidated source of funding for energy efficiency in the state. If the amount of expenditures were to stay constant or increase with a corresponding increase in energy efficiency investment in the Valley, the Valley and the state would see even greater benefits.

The benefits include lower electricity costs due to the avoidance of additional energy generating infrastructure, consumer savings from reduced energy use, the number and quality of jobs created to implement energy upgrades, and the jobs created in the local economy due to increased discretionary spending as a result of lower utility bills.

If the rate of annual energy savings from efficiency projects in the Valley were to remain constant through 2030, we project that Valley efficiency investments would likely create continued job and economic benefits. Doubling the rate of energy efficiency savings by 2030, as SB 350 (de Leon, 2015) requires, would increase these benefits for the Valley, particularly if more funding for efficiency is directed to the Valley. Based on past cost effectiveness of energy efficiency programs in the Valley, the region presents considerable opportunities for high impact EE investments.

TABLE 4 Estimated Costs and Benefits of IOU Energy Efficiency Programs, San Joaquin Valley, 2010-15

Region	Sum of TOTAL IOU energy consumption (GWh)*	Share of IOU Energy Consumption (combined gas and electric)	Estimated Funding Collected from Ratepayers ($ million)*	Total Customer Costs*^ ($million)	Total Costs (Ratepayer + Customer) ($million)	Share of Total Costs
SAN JOAQUIN VALLEY	430,416	14.3%	$646	$288	$934	13.5%
TOTAL STATEWIDE	1,177	100.0%	$4,516	$2,486	$6,936	

Region	Sum of Total Incentives** ($million	Share of IOU Incentives	Total IOU Expenditures (Incentives + Program Costs) ($million)	Total Customer Investment ($million)	Total IOU + Customer Investment ($million)	Share of Total Investment
SAN JOAQUIN VALLEY	$257	12.0%	$558	$288	$846	13.0%
(NO GEOGRAPHIC DATA)	$67	3.1%	432	$66	$498	7.7%
TOTAL STATEWIDE	$2,149	$2,367	$4,516	$2,420	$6,504	

** Source: Calfornia Energy Commission, California Energy Consumption Database (by IOU by County, 2008 - 2015). MMTherms have been converted to GWh using conversion ratio 29.3001 GWh: 1MMTherm*

*** Estimated based on region's share of IOU energy (combined electricity and gas) consumption*

**** Total incentive paid including rebates, direct install labor costs, direct install materials, and incentives to others.*

***** Program-level costs are allocated based on the avoided costs (i.e. the ElecBen + GasBen). This includes Market&Outreach, Implementation, Administrative, Overhead, and EM&V.*

****** Total ratepayer funds incurred to run the program. Total expenditure = Weighted Program Costs + Incentives. This is different from (higher than) the reported Program Administrator Cost (PAC).*

TABLE 5 Energy Savings and Gross Employment Gains of the IOU Energy Efficiency Programs on the San Joaquin Valley, 2006-2015

Sector	Net GWh	Direct jobs	Indirect + induced jobs	Total jobs
Residential	207	940	810	1,750
Commercial	750	2,890	4,420	7,310
Industrial/Ag	734	2,830	5,500	8,330
TOTAL	**1,691**	**6,650**	**10,740**	**17,390**

**may not sum exactly due to rounding*

Policy Recommendations

Climate program design and implementation has had positive impacts overall in the San Joaquin Valley, but there is also room for improvement. To maintain and improve the positive impacts, state leaders should consider the following priority law and policy changes to ensure the state's climate programs continue to benefit the Valley:

- Remove uncertainty for the cap-and-trade program, particularly the allowance auction mechanism, beyond 2020. The program is having net positive economic effects on the Valley, despite a thread in the public discourse to the contrary.
- Disburse auction proceeds in a timely and predictable manner and ensure that the Valley receives an appropriate level of statewide spending based on its economic and environmental needs.
- Ensure that cap-and-trade auction proceeds are spent on Valley programs that create jobs, further greenhouse gas reduction benefits, and reduce co-pollutants, particularly in disadvantaged communities, per SB 535 (de Leon) and AB 1550 (Gomez) governing auction revenue spending.
- Improve the economic and job benefits of renewable energy and energy efficiency projects through labor agreements that promote local and career-track jobs.
- Expand energy efficiency incentives for the Valley where per capita energy use is higher than the state average, cost effectiveness is the highest in the state, and unemployment is far above the state average. This will help ensure greater cost-effectiveness of the portfolio as a whole, improve the building and housing stock in the Valley, reduce energy costs for residents, businesses, and industry, create jobs, and increase economic activity in the region. GGRF funding should be used, in addition to ratepayer funds.
- Develop robust transition programs for workers and communities affected by the decline of the Valley's greenhouse gas-emitting industries, including re-training and job placement programs, income supports, bridges to retirement, and regional economic development and diversification initiatives.

California has other critical climate programs in addition to the ones studied here, such as the low carbon fuel standard, zero-emissions vehicle incentives, net-metering, and the draft plan to reduce short-lived climate pollutants plan. Future studies should analyze the combined impacts of these programs in addition to the ones studied here. Ultimately, given the significant economic needs and environmental challenges in the San Joaquin Valley, policy leaders who wish to continue the positive momentum in the Valley should stay the course on existing policies and strengthen them as needed.

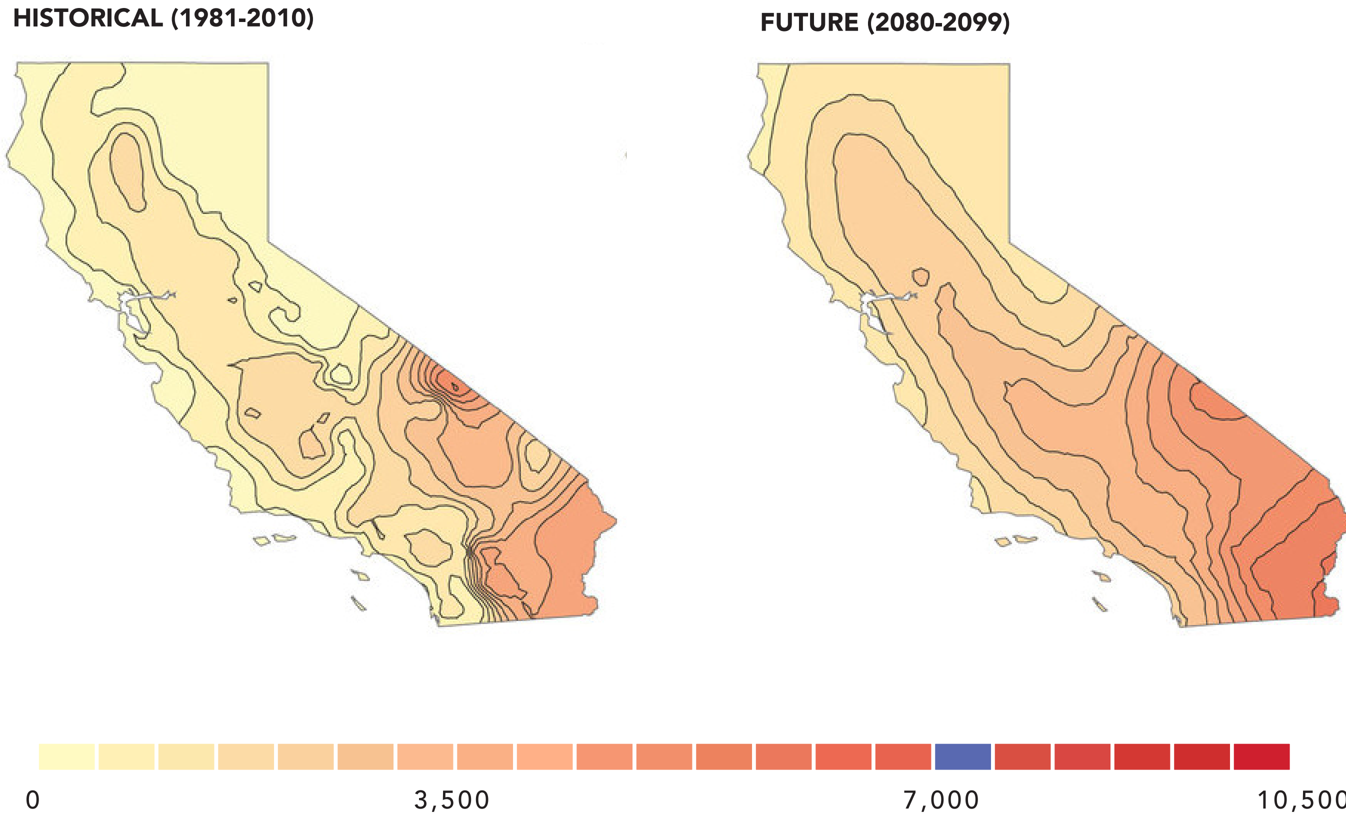
INTRODUCTION

For more than a decade, California has embarked on an ambitious effort to reduce greenhouse gas emissions. The state seeks to reduce emissions to 1990 levels by 2020, per California's Global Warming Solutions Act of 2006, (AB 32, Nuñez, 2006).[5] SB 32 (Pavley, 2016) sets further targets of 40 percent reductions below 1990 levels by 2030. Executive orders issued by Governor Schwarzenegger in 2005 (Executive Order S-3-05) and Governor Brown in 2015 (Executive Order B-30-15) both set the state's long-term goal of an 80 percent reduction below 1990 levels by 2050.[6] Meanwhile, SB 350 (de Leon, 2015), set 2030 targets for increasing renewable energy to 50 percent, accelerating widespread transportation electrification, and doubling the energy savings from efficiency.[7]

While the negative and costly effects of a changing climate and the pollution causing it are significant, there is also concern around how policies to reduce emissions and prepare for climate change might affect the state's residents and businesses. The San Joaquin Valley faces not only extreme challenges of climate change, but also economic challenges that could be somewhat exacerbated or partially offset by climate policy.

Reducing emissions is vitally important for the San Joaquin Valley. The Valley's topography traps pollution, and air quality and the resulting health conditions are far worse in the Valley than in other regions of the state. Between 2008 and 2014, the Valley had 892 days exceeding the state ozone standard compared to 75 for the Bay Area.[8] More residents of the Valley are diagnosed with asthma and other pollution-related health conditions. Heat waves associated with climate change can make these conditions even worse.

FIGURE 3 Cooling Degree Days



Source: Petri and Caldeira, 2014

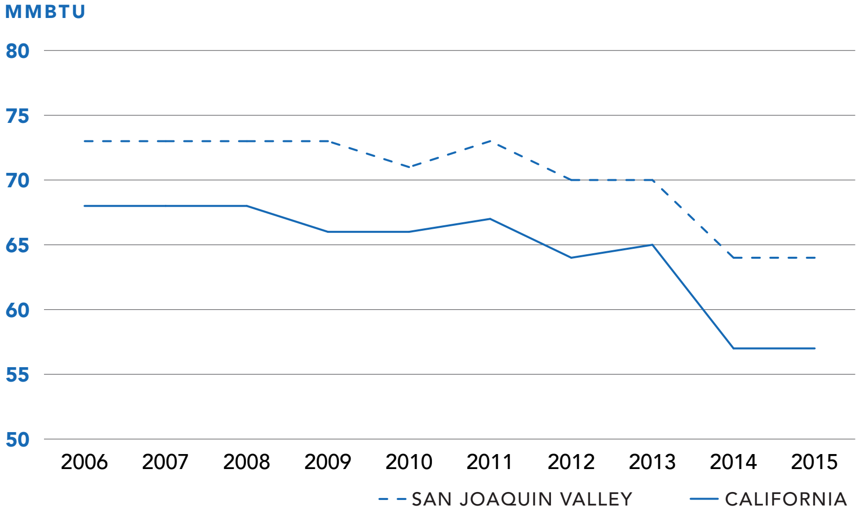
Also, as temperatures get hotter throughout California (see Figure 3 which depicts the historic and future temperatures in the state by cooling degree days, which are the number of days when the average temperature exceeds 65 degrees Fahrenheit and people start to use air conditioning) demand for air conditioning will increase. The per household energy use for the Valley is already higher than for the state and the gap is widening even as overall energy use decreases (see Figure 4). Hotter temperatures could exacerbate this challenge as demand for air conditioning increases.

Due to these regional characteristics, acting on climate change to stall or mitigate its worst effects is of critical importance to the San Joaquin Valley region. At the same time, climate policy design needs to consider the region's socio-economic vulnerabilities.

While the California statewide economy has been thriving, per capita income in the Valley is just over $20,000 compared to a state average of almost $30,000. Twenty-four percent of the population is living below the federal poverty line ($24,300 for a family of four), compared to 16 percent of California's entire population.[9] The unemployment rate is consistently a few percentage points higher than the state average (Figure 5). In addition, the region is a bellwether of the state's demographic trends: over 51 percent of Valley residents are Latino, compared with 38 percent for the state as a whole.[10]

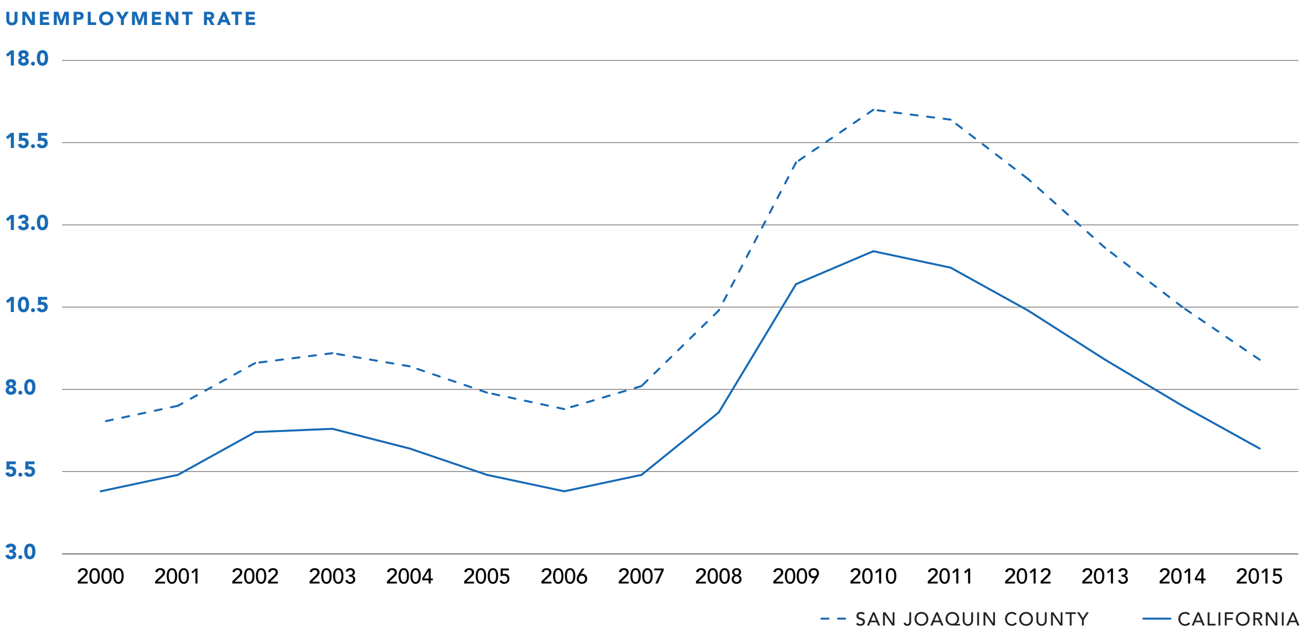
The Valley's population is growing, but permits for new housing are not keeping pace, and average household size in the Valley is 15 percent higher than the state average.[11] Population increases can drive up

FIGURE 4 Per Household Electricity and Gas Consumption, San Joaquin Valley and California, 2006-15



Source: Authors' analysis using population data from the American Community Survey and energy consumption data from the California Energy Commission, Energy Almanac

FIGURE 5 Unemployment in San Joaquin Valley Counties and California Average, 2000-2015



Source: Employment Development Department, http://www.labormarketinfo.edd.ca.gov. Accessed June 17, 2016 (not seasonally adjusted) housing costs, a potential threat posed by the state's high speed rail project, which could make the San Joaquin Valley more attractive for people with jobs in the Bay Area.

Households in the Valley also experience greater challenges with other variables of housing affordability. Forty-eight percent of households in the San Joaquin Valley experience a home energy affordability gap,[12] compared to 36 percent of statewide households. Furthermore, that gap—the difference between what households pay and what would be considered affordable (6 percent of monthly household income)—is also larger for the Valley than for the rest of the state.[13] Efforts such as climate zone-based rate schedules used by the utilities allow for higher usage at baseline rates in the hotter regions, helping to keep energy spending contained. In addition, rate assistance provided through California Alternate Rates for Energy (CARE) and Family Electric Rate Assistance (FERA) subsidize energy costs for low-income households. Efforts like the California Climate Credit rebate from cap-and-trade revenue, and energy efficiency programs can also help reduce energy expenditures, but even with these efforts, the energy affordability gap in the Valley persists.

Finally, the region has far lower rates of both high school and college education than the state average. In 2015, only 16 percent of Valley residents over the age of 25 had a bachelor's degree compared to 31 percent for the state as a whole.[14] Educational attainment influences lifetime earnings, and we see lower household income than the state average – the Valley average is $46,920 compared to a statewide average of $61,489.[15]

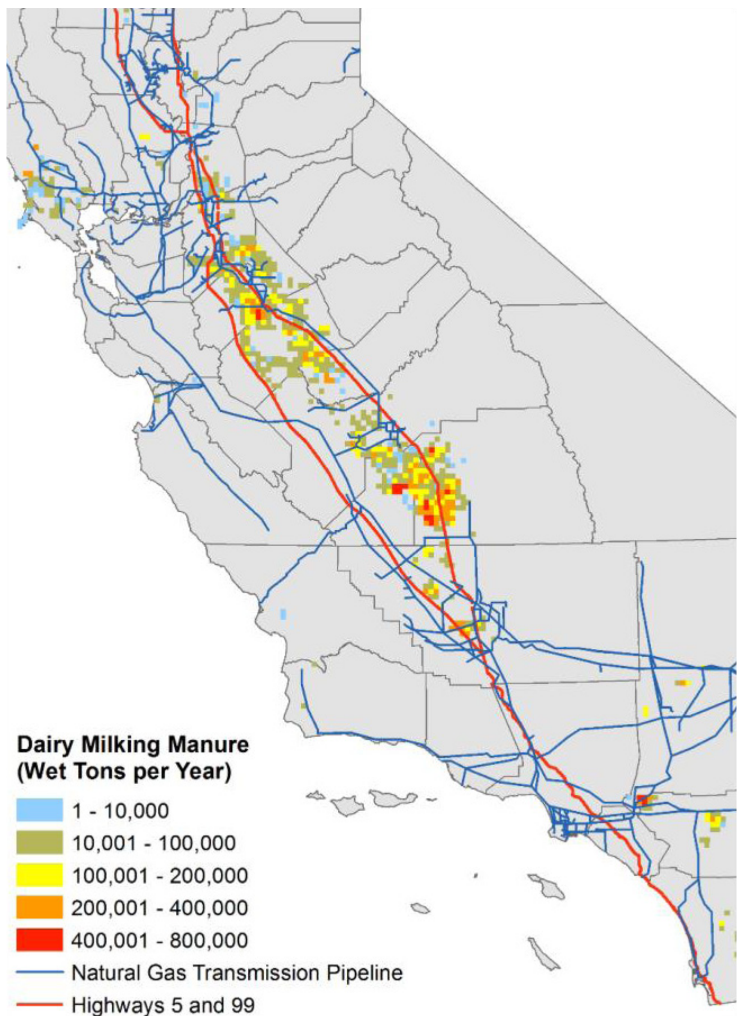
While there have been other studies modeling the regional economic and health consequences of a changing climate,[16] the following analysis explores how the state's primary policies and programs to slow climate change are affecting the economy of a particularly vulnerable region. If policymakers can get climate policy right for the San Joaquin Valley, they will almost inevitably get it right for the whole state and model policies and programs that can work for vulnerable communities around the world.

A Note on the Agricultural Sector

The San Joaquin Valley is one of the most productive agricultural regions in the world. Climate change, and corresponding water shortages, have dire consequences for the region's economy. Already, the depth to water in the Valley is over 150 feet compared with a state average of 85 feet, and climate projections show a clear trend toward decreasing precipitation throughout the 21st century, by as much as 10% in some parts of the Valley.[17] Agricultural activities, representing 8 percent of the state's total emissions,[18] also contribute to climate change. Agriculture is an important part of the Valley's economy, and a sector central to discussions about climate change.

This report, however, does not cover the agricultural sector, because there have not yet been major, mandatory limits on agricultural emissions.[19] In the future, agriculture will be regulated by the state's emerging strategy for short-lived climate pollutants, such as methane, pursuant to SB 605 requiring the strategy and SB 1383, which requires reducing livestock methane emissions by 40% by 2030. Further, AB 1613 commits $50 million in cap-and-trade funds to support methane reductions at dairies during the 2016/2017 fiscal year.[20] The November 2016 release of ARB's Revised Proposed Short-Lived Pollutant Reduction Strategy provides economic and jobs analysis for this strategy, reporting that, "if digesters were built on farms accounting for about 1 million dairy cows, many in the San Joaquin Valley, it could result in over 30,000 construction jobs and 2,500 permanent jobs."

FIGURE 6 Location of Manure from Milking Cows in California



Source: ARB Revised Proposed Short-Lived Climate Pollutant Reduction Strategy (November 2016)

CAP AND TRADE

The cap-and-trade program is a key element of AB 32 and is intended to work in concert with numerous complementary measures and programs. Pursuant to authority granted by AB 32 (Nuñez, 2006), which set the 2020 greenhouse gas emissions targets, the California Air Resources Board (CARB) adopted the first set of cap-and-trade regulations in October 2011, with an effective date of January 1, 2012.[21] The cap-and-trade program is explicitly authorized by law through 2020, but ongoing litigation creates uncertainty about the state's legal authority for extending the auction beyond 2020.

The program works by setting a hard "cap" or limit on emissions from covered entities, which declines over time. The CARB-established cap covers approximately 85 percent of total statewide GHG emissions. Major emitting sectors regulated under the cap-and-trade program include natural gas and electric utilities, transportation fuel suppliers, and large industrial facilities. While some food product manufacturing is under the cap, the state's agriculture sector is largely exempt.

CARB issues a limited number of tradable permits, or allowances, equal to the permissible emissions (the cap) over a given compliance period. Each allowance equals one metric ton of carbon dioxide equivalent (using the 100-year global warming potential).[22] As the cap declines over time, fewer allowances are issued, with the goal of ensuring that emission reductions occur.[23]

The cap is enforced by requiring that each source operating under the cap turn in one allowance or offset credit for every ton of carbon dioxide-equivalent emissions it produces. To comply with the program, covered entities can reduce on-site emissions and/or buy allowances or offsets;[24] they may also trade allowances on a secondary market.[25] A portion of the issued allowances is distributed for free, a portion is placed in a cost-containment reserve, and the remainder is auctioned as are the allowances allocated to the investor-owned utilities (IOUs).

The California Air Resources Board conducts quarterly auctions, and the state receives its share of the proceeds. The IOUs must use the bulk of their proceeds to offset energy bill impacts for customers, and publicly-owned (municipal) utilities retain that option as well.[26] State proceeds from cap-and-trade auctions are deposited into the Greenhouse Gas Reduction Fund (GGRF) and then appropriated via legislative actions.

Statutes require that the state portion of the proceeds from the auction be used to further reduce GHG emissions, benefit disadvantaged communities, and, to the extent feasible, further the goals of AB 32 and the Legislature.[27]

Expenditures must also comply with the requirements of SB 862, the 2014 trailer bill that provides continuous appropriations of GGRF monies for high speed rail, affordable housing and sustainable communities, transit capital and transit operations beginning in FY 2014-15.[28]

As of February 2016 (the date range of this analysis), the auctions have generated more than $4 billion in auction proceeds for the GGRF.[29] During that time, the agencies developed and began implementing a suite of programs and activities around sustainable communities and clean transportation, clean energy and energy efficiency, and natural resources and waste diversion.[30]

BEYOND 2020

The future of the cap-and-trade program beyond 2020, particularly the state's ability to raise revenue from auctioning allowances, is tied to a number of intertwined legal and political issues. The first issue is raised by an appeal of a trial court decision filed by the California Chamber of Commerce in 2014,[31] which alleges the auctions are invalid under Proposition 13 because the revenue raised is a tax and the cap-and-trade program was not adopted by a two-thirds vote of the legislature as required by Proposition 13.[32] Proposition 13 passed in 1978 and amended the state constitution to require a two-thirds supermajority vote to raise taxes. Legal experts disagree on whether revenue raised from auctioning allowances constitutes a tax within the meaning of Proposition 13.[33]

The next issue is whether authority under AB 32 for the cap-and-trade program expires in 2020. Legal experts also disagree on this question.[34] If it does expire, and assuming a new statute must be adopted in order to extend the program with a revenue-raising auction mechanism beyond 2020 (notably, cap and trade can still function without generating state revenue), the third issue is whether that statute requires a two-thirds vote of the Legislature because the auction proceeds would be "taxes" under the broad definition provided in Proposition 26, rather than "fees."[35] Proposition 26 amended the state Constitution in 2010 to include a more stringent definition of "tax" (compared to courts' interpretations of Proposition 13) that would encompass revenues previously classified as "fees" exempt from the Proposition 13 requirements. Proposition 26 provides five exceptions to the definition of a tax, but a court would almost certainly have to decide if the cap-and-trade program fits any of these exceptions. [36]

The litigation would be moot with a two-thirds vote of the Legislature in order to inoculate the auction from Proposition 26 challenges.[37] Legislative options that might not require a two-thirds vote include authorizing an allowance auction where the proceeds are collected and maintained by non-governmental entities, such as non-profit organizations, in order to squarely fit a Proposition 26 exception.[38] The Legislature could also enact a carbon "fine" or "penalty." Proposition 26 includes a clear exception to the supermajority requirements for any "fine, penalty, or other monetary charge imposed by the…state, as a result of a violation of law." The fine or penalty could be applied at a value predetermined by a method such as economic modeling or the use of the US EPA social cost of carbon.[39]

Meanwhile, the California Air Resources Board is proceeding on a regulatory basis to extend the cap-and-trade program with the auction through 2030, based on existing AB 32 authority and the governor's 2030 executive order.[40]

Recently, the state legislature both bolstered and complicated the agency's continuation of the program by passing new legislation regarding the 2030 greenhouse gas targets and requirements to prioritize rules and regulatory actions aimed at emissions reductions. The legislature passed and the governor signed SB 32 (Pavley, 2016) to codify the 2030 targets. This legislation bolsters the Air Resources Board's reliance on 2030 targets in its proposed cap-and-trade regulations to extend the program beyond 2020. Yet SB 32 is unlikely to fully protect the auction mechanism in the cap-and-trade program from legal challenge because it did not pass with a super-majority vote, which would insulate the auction from legal challenge under Proposition 26, as discussed above.

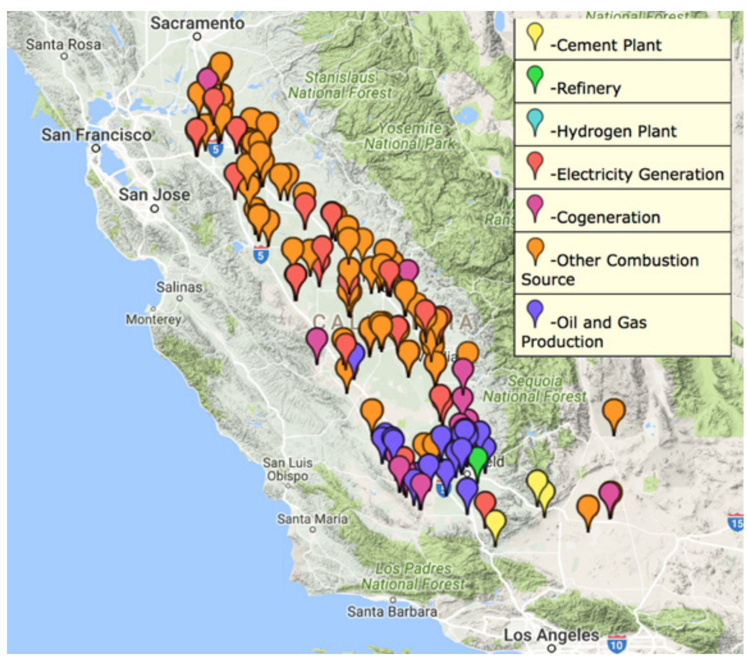
Finally, the passage of SB 32 was contingent upon the enactment of an additional bill, AB 197 (Garcia, 2016), which the legislature passed and the governor signed. AB 197 requires the agency to prioritize emission reduction rules and regulations that "result in direct emission reductions at large stationary sources of greenhouse gas emissions sources and direct emission reductions from mobile sources."[41] These "command-and-control" type regulations could therefore replace market-based alternatives like cap-and-trade, depending on how the California Air Resources Board evaluates regulatory options going forward. The legislature may address the uncertainty through future legislation, and the governor recently explored options for a potential ballot initiative in 2018.

Economic Impacts of Cap and Trade on the San Joaquin Valley

The cap-and-trade program has both positive and negative impacts on the economy of the San Joaquin Valley. The introduction of a carbon price creates advantages for low-carbon businesses, such as biofuel producers that have located in the Valley, whose growth will be assisted by carbon pricing. On the other hand, the carbon cap increases costs for some emission-intensive industries in the Valley, primarily the oil and gas extraction industry and fuel suppliers (see Figure 7, for the stationary sources of GHG emissions in the Valley. The map does not show emissions from fuel suppliers or electricity importers).

Some of these entities take steps to reduce greenhouse gas emissions through investments in renewable energy and energy efficiency, which often yield cost savings as well as emission reductions. Other entities decide to purchase the allowances necessary to cover their cap-and-trade obligation. The costs of these investments and purchases will either be passed on to consumers or absorbed by the affected businesses. If the costs are passed on, economic logic indicates that demand for and sales of the affected products will decrease. This decrease in product sales will cause a negative impact on economic activity and employment in the region, but the amplitude of this impact depends on price elasticity (how sensitive consumers are to price changes) and corresponding changes in non-local demand for goods and services produced in the Valley. In this paper, because we are measuring flows of money into and out of the region, only reductions in *non-local* demand (demand from consumers outside the Valley) will reduce the flow of money *into* the region.

FIGURE 7 Stationary Sources of GHG Emissions* covered by Cap-and-Trade program in the San Joaquin Valley (2013-14)[42]



**excludes electricity importers and fuel suppliers*

Some of the costs of compliance will recirculate within the region as entities invest in on-site reductions (which creates local work), trade allowances with one another or purchase Valley-based offsets.[43] Other costs flow out of the region as they are collected by the state through the quarterly allowance auctions. The proceeds from these auctions are then distributed to projects throughout the state, including the Valley, that further reduce greenhouse gas emissions. The Valley sees money flowing back into the region as these proceeds are invested in projects ranging from the construction of the initial portion of the state's high-speed rail system, incentives for clean vehicle purchases, methane digesters, weatherization improvements, solar panel installations, affordable housing, and other spending programs. While the costs of compliance may reduce some economic activity, this flow of money into the Valley has a stimulating effect on economic activity and employment.

These contrasting positive and negative impacts alter economic activity in ways that ripple throughout the regional economy, affecting businesses that are not major direct emitters of greenhouse gases.[44] We modeled cap and trade's direct and ripple effects on economic activity, employment, and state and local tax revenue in the Valley. Overall, we found net impacts of the cap-and-trade program are positive, but those benefits are also a comparatively small portion of the region's increasingly dynamic, diverse economy, each representing about 0.4 percent of total employment and regional gross domestic product.

METHODOLOGY

To conduct the economic impact analysis, we used the IMPLAN software[45] with 2014 data for the eight-county San Joaquin Valley region. IMPLAN contains an input-output model that measures the inter-industry relationships within an economy. Input-output analysis is a means of measuring the market transactions between businesses and between businesses and consumers. In this way, input-output analysis can measure the regional economic impacts of both the costs of complying with cap and trade as well as the benefits from the investment of auction proceeds. It measures the ripple effects of an initial impact to each specific industry that is affected positively or negatively. As money flows into or out of an industry, it stimulates further changes in transactions between other businesses and households. These ripple effects are known as multipliers.

The overall multipliers are based on direct, indirect, and induced effects. The **direct effect** is the initial impact: a spending or employment change in directly affected industries. In this particular analysis, the direct impacts are both the direct costs of complying with cap and trade as well as the investment of cap-and-trade auction proceeds.

Indirect effects are the supply chain effects of the activities undertaken by the directly affected industries. Indirect effects measure the jobs and economic activities of industries that supply goods and services directly to the affected industries. The indirect effects capture increases and decreases in demand for supplies, like construction materials, caused by the initial impact.

Induced effects are the outer ripples resulting from changes in the income and spending of employees and proprietors of industries directly affected by the policy. These changes in spending re-circulate in the economy affecting industries that are not directly involved in the cap-and-trade program (such as retail, services, and restaurants, etc.). These effects are measured over the time period needed for all of the ripples to work through the regional economy.

There are several advantages with the use of IMPLAN in this application. First, IMPLAN allows for separate measurements of the negative impact associated with cap-and-trade compliance as well as the positive impact due to the allocation of auction proceeds. Finally, the software uses data specific to the 8-county San Joaquin Valley region.

The impacts of cap and trade are modeled by measuring the effects of compliance costs and likely investment of auction proceeds collected from 2013-15 in the Valley economy. Results are reported in 2016 dollars. The CA Department of Finance has used a similar methodology (although they use REMI rather than IMPLAN) to forecast the impact of cap and trade on the state as a whole. This report assesses the regional impact on the Valley and looks at impacts to date. This requires information about the likely distribution of both compliance costs and GGRF expenditures in the Valley, which we collected from publicly available records from the California Air Resources Board.[46]

While the IMPLAN analysis in this paper looks backward at the impacts to date, the spending and employment multipliers can be used for forecasting purposes. An important caveat, however, is that no methodology can adequately incorporate unrelated contemporaneous developments. For example, from 2013-15, the cap-and-trade program increased costs for fuel suppliers; however, during the same period, the price of crude oil fell dramatically, providing a major boost to consumer incomes via a drop in retail gasoline prices and allowing some gasoline companies to earn record profits.[47]

EMISSIONS, ALLOWANCES, AND COMPLIANCE OBLIGATION BY INDUSTRY

We calculated the program's total capped emissions and free allowance allocations for the period 2013-15, using emissions reports and public data on allowance allocations (Table 6). Emissions covered by the California cap totaled 633 million metric tons CO2e (carbon dioxide equivalent) in the period 2013-15.[48] About 88 percent of these emissions were from entities located in California. The other 12 percent was from entities outside the state providing fuel and electricity for use in California, thus having to comply with the cap-and-trade program. Fuel suppliers accounted for an additional 400 MMT CO2e (not shown in Table 6) before they were required to comply with the cap starting in 2015. Some industry sectors fared well during this period with free allowances either covering or exceeding that sector's emissions. The electricity industry in particular, received considerably more allowances (55 million) than its emissions in this period.

The state allocated about 500 million free allowances to industrial entities and utilities in the state for several reasons. Electricity and gas utilities suppliers are given allowances so that end users will not experience sudden bill impacts as a result of cap and trade. Industrial entities are given allowances to prevent leakage (moving activities out of state) and for transition assistance. These 500 million free allowances covered about 80 percent of the total compliance obligation for the cap-and-trade program and about 90 percent of the compliance obligation of California-based entities. After accounting for free allowances, capped entities would have needed to acquire an additional 129 million allowances, and more than half of these allowances were needed by entities based outside the state of California.

TABLE 6 Reported Total Capped GHG Emissions and Allowances from Cap-and trade Regulated Entities, 2013-15 (in metric tons CO_2e)

Industry Sector	Capped Emissions	Free Allowance Allocation	Remaining Compliance Obligation
Cement and Industrial	46,743,981	45,418,147	1,325,834
Electricity	235,062,001	290,429,216	(55,367,215)
Oil and Gas Production	47,182,098	29,257,431	17,924,667
Refinery	102,450,130	93,519,000	8,931,130
Fuel Supplier*	201,133,394	45,357,000	155,776,395
TOTAL	**633,855,070**	**503,980,794**	**128,789,137 (net)**

Source: Authors' analysis using MRR Report data[49] and allowance data[50] from the Air Resources Board

**During the first compliance period covered entities were those (other than transportation fuels) whose annual emissions equaled or exceeded 25,000 metric tons CO2e in any year from 2008-2011. The second compliance period, beginning January 1, 2015 covers all entities whose annual emissions equaled or exceeded 25,000 metric tons CO2e in any year from 2011-14. The compliance obligation remains in place until GHG emissions fall to less than 25,000 metric tons of CO2e per year during one full compliance period, or if the entity shuts down.*

While capped entities statewide only would have needed to acquire about 129 million allowances for compliance in 2013-15, far more (428 million) 2013-15 vintage allowances were purchased through the CARB auction.[51] In addition, almost 21 million offsets were surrendered for compliance in 2013-15.[52] Of course, no one knew in advance exactly how many allowances they or others would have needed. (The year's actual emissions are released to the public in November of the following year.) As the emission reports indicate, actual emissions have been about 12 percent under the cap (See Table 7). The uncertainty around actual emissions, activities undertaken to reduce emissions, and the demand for allowances, partly explains the excess allowances purchased, and it also explains the lower than expected auction sales in 2016.

TABLE 7 Energy Savings and Gross Employment Gains of the IOU Energy Efficiency Programs on the San Joaquin Valley, 2006-2015

	California Cap[53]	**Allowance Demand**	**Allowance Supply**				**Balance**
Year (past)		Actual Emissions	Free Allocations	Sold in Auction	Offsets Surrendered	Total	
2013	162.8	145.5	152.8	81.0		233.8	88.3
2014	159.7	146.1	147.3	81.0	12.7	241.0	94.9
2015	394.5	340.9	203.9	265.6	8.1	477.6	136.7
TOTAL	**717**	**632.5**	**504**	**427.6**	**20.9**	**952.4**	
YEAR (FUTURE)							
2016	382.7	TBD	193.0	188.6	TBD	393.4	TBD

Source: Air Resources Board Compliance Reports, Auction Data, and Allocation Data (https://www.arb.ca.gov/cc/capandtrade/capandtrade.htm)

TABLE 8 Reported Capped GHG Emissions and Allowances from Cap-and-trade Regulated Entities, San Joaquin Valley 2013-15 (in metric tons CO2e)

Industry Sector	Capped Emissions	Free Allowance Allocation*	Remaining Compliance Obligation
Cement and Industrial	13,937,763	14,115,225	(177,462)*
Electricity	38,135,695	36,694,445	1,441,251
Oil and Gas Production	41,921,773	26,600,347	15,321,426 *
Refinery and Fuel Supplier	36,700,475	830,753	35,869,722*
TOTAL	**130,695,706**	**78,240,770**	**52,454,937* (net)**

Source: Authors' analysis using MRR Report data[55] and allowance data[56] from the Air Resources Board

AND COMPLIANCE OBLIGATION BY INDUSTRY

We conducted the same analysis for the San Joaquin Valley. Table 8 shows the total capped emissions for entities located in the San Joaquin Valley based on emissions reports. In addition we allocated a share of the emissions of electricity imports for Pacific Gas and Electric (PG&E) and Southern California Edison (SCE) proportional to the region's share of those utilities electricity use (28 percent and 7 percent, respectively).

The number of free allowances each entity receives depends on the ARB's assessment of their leakage risk and transition assistance factors as well as a sector- and entity-specific emissions allocation that is based on production rather than energy consumption or emissions.[54] This way of distributing allowances ensures that entities with more efficient or lower emission systems than their industry competitors are not inadvertently penalized for their climate leadership.

By design, this allocation process is complex and the resulting allowance allocation is unique to each capped entity. To protect confidential business information, allowances by specific entity are not publicly available, so for most entities, we had to estimate its share of free allowances. To do so, we proportionally assigned shares of each sector's allowances to the entities in that sector based on their reported emissions. For the electrical utilities, we also allocated to the Valley the share of their allowances the same way we allocated a share of the emissions from electricity imports. The results of this process are summarized in Table 8.

From 2013-15, emissions for the Valley represent about 21 percent of the total capped emissions, and the emissions were concentrated in industries that did not receive many free allowances. For example, the region has a disproportionately high share of oil and gas producers who didn't receive as high a share of allowances as other industries with higher leakage and transition assistance needs. However, if the costs of cap-and-trade compliance for emission-intensive fuel and electricity industries are fully passed on to consumers throughout the state, the negative economic impact to these industries would have been widely dissipated throughout the state rather than concentrated in the San Joaquin Valley.

ESTIMATED COSTS OF CAP AND TRADE FOR SAN JOAQUIN VALLEY REGION

To estimate the economic impacts of the cap-and-trade program on the Valley we first calculated direct compliance costs. The Valley's capped emissions for this period totaled about 131 million metric tons of carbon dioxide equivalent (CO_2e). We estimate that entities in the Valley received 78 MMTCO_2e in free allowances (one allowance equals one metric ton CO_2e). Consequently, the remaining compliance obligation (total emissions minus free allowances) over the period for the Valley was approximately 52 MMT in CO_2e. The compliance obligation can be met with on-site emission reduction, the purchase of verified emission offsets (up to eight percent of emissions), the purchase of allowances from primary auctions, or the purchase of allowances in secondary markets.

From 2013-14, San Joaquin Valley entities consumed 37 percent of the total (4.8 million) offsets used for compliance, at an average price of $9.63, totaling $44.4 million. In 2013-14, these offsets covered 7.7 percent of the region's capped emissions. While a few offset projects were developed and registered in the San Joaquin Valley (all of them livestock gas capture projects in Merced, Tulare, and Stanislaus Counties), none of those offsets were used

TABLE 9 Purchased offsets for Cap-and-trade Compliance (2013-15), San Joaquin Valley

Industry Sector	Offsets Surrendered (2013-15)	Cost of Offsets
Cement and Industrial	417,428	$4,074,144
Electricity	2,812,733	$25,414,284
Oil and Gas Production	114,607	$1,103,717
Refinery and Fuel Supplier	4,881,526	$49,071,549
TOTAL	**8,226,294**	**$81,364,391**

** Authors' analysis of data based on Offset Prices in Tables of Market Transfers (2014 and 2015) and 2013-2015 Compliance Summary Reports.[57]*

for compliance in 2013-15. Table 9 above shows the offsets purchased by Valley entities in 2013-15.

We used the settled auction prices over the period to estimate the value of free allowances and the costs of compliance for the region.[58] Table 10 shows the value of free allowance allocations by sector and the cost of required allowances to meet the compliance obligation after accounting for offset purchases and free allowances.

Table 11 sums the costs of offsets purchases and the costs of purchasing required allowances to show total estimated compliance cost based on the average offset price and auction allowance settlement prices. This table does not account for any allowances or offsets that firms have acquired but not surrendered for compliance.

A source of possible over-estimation of compliance costs relates to the existence of excess allowances in the California cap-and-trade market. Based on reported and estimated emissions (from Mandatory Reporting Regulation (MRR) reports), there were about 330 million allowances available in excess of the statewide compliance obligation from the period 2013-15. Excess allowances indicate an oversupply, and the cost of allowances through private transactions would likely have been lower than the auction settlement price we used. This excess availability of allowances signifies both the success of California's policies in actually reducing emissions and is likely a main factor underlying the low sales of allowances in two of the 2016 cap-and-trade auctions.

The Valley industries with highest greenhouse gas emissions that were covered by the cap-and-trade program were petroleum refining and fuel suppliers and oil and gas extraction.[60] Other high-emissions industries such as electricity, food and other manufacturing, cement manufacturing, and mining activity received free allowances that covered the majority or all of their emissions. Between free allowances and actual emission reductions, these industries represented a very small percent of estimated compliance or were net beneficiaries.

For the IMPLAN analysis, we grouped the estimated compliance costs by industrial sectors. Ignoring the small positive effect of free allowances worth $3 million for the cement and other industrial sectors, we divide $631 million between the industries with net costs: fossil fuel electric power generation, oil and natural gas extraction, and petroleum refineries and fuel suppliers, as shown in Table 11. This translated to a roughly 1 percent-29 percent-70 percent

TABLE 10 Cap-and-trade Allowance Costs, Net Free Allowances and Offsets, San Joaquin Valley 2013-15

Industry Sector	Free Allowance Allocation*	Value of Allowances	Offsets Purchased (2013-15)	Remaining Compliance Obligation	Cost of Required Allowances (2013-15)
Cement and Industrial	14,115,225	$169,780,206	417,428	(594,890)	($7,144,629)
Electricity	36,694,445	$441,295,863	2,812,733	(1,371,482)	($16,444,070)
Oil and Gas Production	26,600,347	$320,295,881	114,607	15,206,819	$182,785,964
Refinery and Fuel Supplier	830,753	$9,947,838	4,881,526	30,988,196	$383,014,103
TOTAL	**78,240,770**	**$941,319,788**	**8,226,294**	**44,226,929 (net)**	**$542,211,368 (net)**

TABLE 11 Cap-and-trade Compliance Costs, San Joaquin Valley 2013-15 (Offsets + Allowance Purchases)

Industry Sector	Offset Cost (2013-14)**	Net Allowance Cost (2013-15)*	Net Compliance Cost	Percent of Costs
Cement and Industrial	$4,074,144	($7,144,629)	($3,070,485)	
Electricity	$25,414,284	($16,444,070)	$8,970,214	1.4%
Oil and Gas Production	$1,103,717	$182,785,964	$183,889,681	29.1%
Refinery and Fuel Supplier	$49,071,549	$383,014,103	$432,085,652	69.5%
TOTAL	**$81,364,391**	**$542,211,368 (net)**	**$628,016,032**	

** * Authors' analysis of data from "Mandatory GHG Reporting - Reported Emissions," Air Resources Board, California Environmental Protection Agency. Accessed September 2, 2016, at: http://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/ghg-reports.htm and Auction Allowance Settlement Prices for 2013-15 vintage allowances.*[59]

***Based on Offset Prices in Tables of Market Transfers (2014 and 2015). Accessed December 1, 2016, at https://www.arb.ca.gov/cc/capandtrade/2015transferssummary120916.xlsx; 2013-2014 Compliance Report. Accessed December 5, 2016, at https://www.arb.ca.gov/cc/capandtrade/2013-2014compliancereport.xlsx; Auction Allowance Settlement Prices. Accessed September 2, 2016, at: http://www.arb.ca.gov/cc/capandtrade/auction/results_summary.pdf* split for electric power generation, oil and natural gas extraction, and petroleum refineries and fuel suppliers, respectively. This distribution is based on the analysis of compliance obligation costs for these industries, including offset purchases and net of free allowances. Complying with cap-and-trade requirements will increase overall production costs for these industries.[61] Over the three-year period, the costs of compliance on the electric power generation, oil and gas extraction, and petroleum refining industries were 0.05 percent of total production costs, 1.33 percent, and 1.32 percent, respectively.[62] How cost increases affect production depends on the extent to which prices are determined locally or in a wider market, and how sensitive consumer demand is to price, commonly termed the price elasticity. We obtained measures of price sensitivity for the affected industries from an extensive literature review conducted by the Sightline Institute and other sources.[63]

Using petroleum refineries as an illustration, research suggests that demand for refined petroleum (gasoline) decreases by 0.62 percent for each 1 percent increase in the price of gasoline. If cap-and-trade compliance increased gasoline production and distribution costs by 1.32 percent from 2013 to 2015, and if retail prices increase by the same percent, then demand would have decreased by 0.08 percent over the period (–0.06 percent x 1.32 percent = -0.08 percent). This assumes 100 percent cost pass through.[64] The price elasticity for electricity is -0.47 (demand reduction is -0.02 percent). For oil and gas, price elasticity is -0.37 (demand reduction -0.49 percent).

The economic impact of demand reduction in the Valley is based on the reduction in demand by consumers residing *outside* of the Valley. Reduced demand from within the Valley simply redistributes spending within the region, while the decrease in demand from outside the Valley represents a decrease in spending flowing into the region.[65] Information for the Valley obtained from the IMPLAN software was used to determine the decrease in demand for refined petroleum products from outside the Valley.[66]

The method employed to measure the effect of cap-and-trade compliance on non-local demand for refined petroleum was also used to measure the decreases in non-local demand for electric power generation and oil and gas extraction. Our findings indicate that demand for refined petroleum produced in the Valley decreased by approximately $118 million between 2013 and 2015 as a result of cap and trade, demand for crude petroleum produced in the Valley decreased by approximately $81 million, and demand for Valley-based fossil fuel power generation decreased $0.2 million (see Table 12). A caveat on economic models is necessary here. How firms actually behave may differ from the estimations based on elasticities. Firms may be able to change product mix, may absorb cost increases through declines in profits instead of production levels, and a variety of other strategies, each with implications for the regional economy that are not captured by this analysis, which assumes the costs are completely passed on to customers.

The data reported in Table 12 indicate that between 2013 and 2015, the cost of cap-and-trade compliance resulted in a decrease in demand for these three commodities. Of the three categories, the decrease in demand by nonlocal consumers is the smallest for electricity generation due to the effect of the investor-owned utility sale of free allowances and cost mitigation for the customers from the proceeds. These decreases in demand due to cap-and-trade policy have a negative, but very small, impact on the regional economy. The total gross regional product for 2013-15 totaled $471 billion, and total compliance costs represented just one tenth of one per-

TABLE 12 Estimated Decrease in Demand for Electricity Generation, Oil and Gas Extraction, and Petroleum Refiners in the San Joaquin Valley, 2013-15

Industry Sector	Decrease in Demand for Valley Producers
Fossil Fuel Electric Power Generation	$0.25 million
Crude Petroleum and Natural Gas Extraction	$81.37 million
Petroleum Refineries	$118.30 million
TOTAL	**$199.93 million**

Source: Authors' analysis of IMPLAN study area data

cent (0.1 percent) of regional GDP. The reduction of money flowing into the region as a result of non-local demand is even lower (0.04 percent).

While complying with cap and trade added to the prices of oil and gasoline produced in the Valley between 2013 and 2015,[67] these increases were small and overwhelmed by general trends that saw the price of oil plummeting. It is worth noting that this time period was characterized by falling oil and gasoline prices in California and elsewhere. For example, mid-grade prices for regular gasoline in California fell from $3.99 per gallon in 2013 to $3.29 per gallon in 2015, a 17.5 percent decrease.[68]
Similarly, world oil prices fell from approximately $106 per barrel in 2013 to under $50 in 2015, an approximate 53 percent decrease.[69]

California Energy Commission data[70] show that the average refiner margin (the amount refiners receive for each gallon of gasoline) in 2014-15 was $0.68 per gallon for branded gasoline compared to an average pre-cap-and-trade margin of $0.48 per gallon in 2006-12. This increase in refiner margin is double the estimated $0.10 cost per gallon of cap and trade, indicating the cost was absorbed by the industry. This is further evidenced by record refiner profits in this period. Profits for Valero in California on branded gasoline in second quarter 2015 exceeded the company's California refining profits by 1,100 percent over the same quarter in 2014, and Chevron quarterly profits were double their average since 2005.

ESTIMATED BENEFITS FROM CAP AND TRADE IN SAN JOAQUIN VALLEY REGION

Between 2012 and 2015, the State of California reported state-owned cap-and-trade auction proceeds in the Greenhouse Gas Reduction Fund (GGRF) of $3.527 billion.[71] Once appropriated, the money goes to projects that further reduce greenhouse gas emissions. As of December 31, 2015, $911 million was implemented (money spent). Of this, $259 million went to high-speed rail in the Valley, equaling 28 percent of the early spending. Since construction of the rail system has begun in the Valley, these funds represent new spending mostly in the region. In addition, the Valley received $60 million (7 percent of the total) for other projects. These funds are distributed by the categories in Table 13.[72] In total, the eight-county Valley region has so far received 35 percent of the implemented funds ($319 million).

State law requires 25 percent of GGRF funding to be directed to the development of the state's new high-speed rail system.[75] So far, $850 million has been appropriated to high-speed rail. A full 25% of the 2013 – 2015 revenue will be $907 million. If all of this is spent in the Valley, an assumption that may not be accurate,[76] and if other projects in the Valley receive 7 – 8 percent of the total revenue ($247 - 296 million), the Valley would receive $1154 - 1203 million (32 percent of the total). Most of this funding is already appropriated but has not yet been implemented or designated for specific locations.[77]

The Office of the Governor announced the new Cap-and-trade Expenditure Plan Agreement on August 31, 2016.[78] The distribution of future GGRF funds for climate investments under the new expenditure plan differs from the distribution of implemented funding over the 2013-2015 period that is reported in Table 13.[79] Under the new expenditure plan we expect larger shares of funding for clean vehicle and fleet modernization purchase incentives, waste diversion, and ecosystem restoration. With a shift in spending priorities, construction spending on affordable housing, weatherization, and solar power installation, etc. in the Valley is expected to decrease. Funding for irrigation modernization is expected to remain near the previous level. The expected distribution of these funds is reported in Table 14.

In looking at the net benefits of cap and trade, it is important to consider the time lag between when cap-and-trade compliance costs are incurred and when cap-and-trade revenue is redistributed, so the pain is felt before the gain. This time lag is necessary and, in fact, desirable. The process of collecting funds, appropriating them to the relevant agencies, finding and selecting suitable projects, and then implementing the projects, is complex, allowing stewards of the funds to make sure they are spent efficiently and deliberately. Any assessment of the costs on an annual basis and the benefits for that same year will be impacted by this lag, particularly in the early years when GGRF spending is just beginning and programs are just being launched. We try to address this issue by examining the benefits that will be produced by the revenues collected into the GGRF even though they have not yet been implemented. Therefore, we estimate the benefits by extrapolating the already realized benefits.

ESTIMATED ECONOMIC IMPACTS OF CAP AND TRADE THROUGH 2015

This analysis attempts to quantify the net economic impact of cap and trade for the Valley, so we look at the potential negative impacts and potential positive impacts of the program's implementation between 2013-15. This assessment measures the economic dynamics in the region as impacted by cap and trade. It is not a survey of actual job gain or loss. There is no evidence of actual job loss as a result of cap and trade, and in fact total employment, personal income, and household incomes rose over the period (See Table 16). This is because, as noted in the section on compliance costs, more general economic trends have likely overwhelmed the very small impact of cap and trade. For example, actual employment in the carbon-intensive industries likely grew during the 2013-15 period due to a fracking boom in the San Joaquin Valley, very low costs of crude oil, and record-high gasoline sales. The slight negative impact of climate regulation is miniscule by comparison.

IMPLAN's input-output analysis measures the direct, indirect, and induced effects associated with changes in spending and reports impacts in terms of additional economic activity, employment, and tax revenue within a region.[80] The impacts of high-speed rail and other climate investments are reported in Tables 17 and 18. We make the assumption that the

TABLE 13 Distribution of Implemented Auction 2013-15 Revenue, by Industry within the San Joaquin Valley (net of high speed rail)

Category	Investment spending	Distribution
Construction Activity*	$36.0 million	60%
Vehicle Purchase Incentives	$13.2 million	22%
Irrigation Modernization	$8.4 Million	14%
Waste Diversion	$1.2 million	2%
Forestry and Ecosystem Restoration	$1.2 million	2%
TOTAL	**$60 million**	**100%**

Source: Authors' analysis of 2015 County and Legislative District List of Implemented GGRF Projects.[73]

**Construction Activity includes the building of new affordable housing, solar panel installation, weatherization, transit improvements, and construction work on digesters and composters.*

***For detailed information on the inputs and assumptions used in IMPLAN, including industry codes, please contact the authors*[74]

TABLE 14 Distribution of Expected Auction 2013-15 Revenue, by Industry within the San Joaquin Valley (net of high speed rail)

Category	Investment spending	Distribution
Construction Activity[1]	$103.6 million	35%
Vehicle Purchase Incentives	$91.8 million	31%
Ecosystem Restoration and Urban Greening	$47.4 million	16%
Irrigation Modernization	$38.5 million	13%
Waste Diversion	$14.7 million	5%
TOTAL	**$296 million**	**100%**

Source: Authors analysis of 2015 County and Legislative District List of Implemented GGRF Projects.

TABLE 15 Total Expected Distribution of 2013-15 Revenue, by Program within the San Joaquin Valley

Category	Share of total investments*	Investment spending *
High Speed Rail	25%	$907 million
Other Climate Investments	10%	$296 million
TOTAL	**35%**	**$1203 million**

direct spending of $882 million -1.145 billion for high-speed rail will be entirely applied to construction and related activities in the Valley, which may be an overestimate if spending on out-of-region goods of services has also been significant.[81] This level of spending is expected to generate approximately 2,000-2,600 construction jobs.[82] The economic impact of this new spending will generate an additional $1.3-1.7 billion in economic activity, 5,200-6,800 new jobs, and $38-49 million in state and local tax revenue in the Valley.[83]

The implied spending and employment multipliers are useful in measuring the impacts of future investments in the Valley. For example, each additional $1 in construction spending on high-speed rail will generate and additional $1.50 in economic activity in the Valley.[84] Also, the spending of high-speed rail construction workers creates other jobs in local retail and service industries. Specifically, each new rail construction job supports another 1.6 jobs (for a total of 2.6 jobs).[85] Each $1 spent on other climate investments generates $1.4 in economic activity, and each new job creates 1.8 total jobs.

Table 17 and Table 18 show the impacts of the 2013-15 cap-and-trade funds so far implemented and the impact of the funds expected to be implemented in the near future.

Overall, the new spending on high-speed rail and other climate investments will increase economic activity in the Valley by approximately $1.7 billion, create over 7,800 jobs, and generate approximately $55 million in state and local tax revenue.

While construction of high-speed rail and other climate investments have a positive effect on economic activity, complying with cap-and-trade requirements has a negative effect in the region. These effects are reported in Table 19.[88] According to data reported above in Table 12, the direct impact of cap-and-trade regulations decrease non-local demand for oil, electricity, and gasoline by a total of $202 million. The total impact of this reduction in sales is $269 million, including $9.7 million in reduced state and local tax revenue. These data indicate that with another $1.00 reduction in sales and production of oil, electricity, and gasoline due to cap-and-trade compliance costs, economic activity in the Valley decreases by $1.33.

For each million dollar negative impact, 0.8 direct jobs are lost. This is low because the industries most impacted by cap and trade are capital, not labor, intensive. The negative impact of cap-and-trade compliance from 2013-15 is 153 direct jobs.[89] The corresponding employment multiplier indicates that a total of 2.8 jobs are lost for each direct job lost due to cap-and-trade compliance (434 total jobs from 2013-15 compliance). These multipliers are the weighted averages for the three sectors combined for the Valley region.[90]

For each million dollar investment in the region from the GGRF, 2.7-3.2 jobs are created, depending

TABLE 16 Economic Indicators for San Joaquin Valley 2013, 2014, 2015

Year	2013	2014	2015
Gross Regional Product	$149 billion	$165 billion	$157 billion
Total Personal Income	$139 billion	$147 billion	$154 billion
Total Employment	1,789,624	1,824,908	1,858,254
Average Household Income	$110,883	$116,282	$120,878

TABLE 17 Economic Impacts of Implemented 2013-15 Cap-and-trade Revenue, San Joaquin Valley

Expected auction proceeds	Direct Impacts	Impact on economic activity	Impact on employment	Impact on state & local tax revenue*
Construction of high speed rail	$259 million 600 jobs	$391 million	1550 jobs	$11.0 million
Other climate investments**	$60 million 260 jobs	$76 million	490 jobs	$3.3 million
Total impact	**$319 million 860 jobs**	**$467 million**	**2040 jobs**	**$14.3 million**

TABLE 18 Economic Impacts of Expected Cap-and-trade 2013-15 Revenue, San Joaquin Valley

Expected auction proceeds	Direct Impacts	Direct Jobs	Impact on economic activity	Impact on employment	Impact on state & local tax revenue*
Construction of high speed rail	$907 million	2090 jobs	$1373 million	5400 jobs	$38.8 million
Other climate investments**	$296 million	1300 jobs	$376 million	2440 jobs	$16.1 million
Total impact	**$1203 million**	**3390 jobs**	**$1750 million**	**7840 jobs**	**$54.9 million**

Source: Authors' IMPLAN Analysis. Results reported in 2016 dollars.

**Excludes property tax revenue.*

*** The impact of other climate investments is based on the expected allocations reported in Table 13 and Table 14.*

on the sectors in which funds are invested. For each job created, an addition 2.4 are created in the region. So far, revenue from the cap-and-trade program has created over 2000 jobs in the region, with over 7800 expected once funds collected in 2013-15 are fully implemented. This does not include projections of spending of funds collected after 2015.

The overall net impact of compliance costs and expected auction proceeds are reported in Table 19. The net impact is the difference between the negative effects of compliance with cap and trade and the positive effects of the investment of cap-and-trade revenue. These results show both impacts from the cap-and-trade revenue already implemented in the region as well as revenue collected in 2013-15 that is expected to be implemented in the region.

Both the costs and benefits of cap and trade are small compared to overall economic activity in the region. For perspective, the Valley had 1.8 million people employed and a GDP of $165 billion in 2014.[91] The net employment impact of 7412 jobs represents less than 0.4 percent of the total employment, and the economic impact represented about 0.1 percent of the Valley's GDP in 2014.[92] The program is neither a major job killer, nor is it a major engine of job growth. It will not destroy the regional economy, nor will it be enough to completely eliminate the region's socioeconomic vulnerabilities.

Our most significant caveats should be kept in mind when considering these results. First, our estimates of the impact costs of compliance assume that increased costs lead to some level of decline in production of the covered entities. Whether or not this is actually true depends both on the behavioral choices of firms, and other forces in the economy that are affecting their industry. For businesses involved in gas and oil production, refining, and electricity generation, where the costs of compliance are largest, the decline in the world price of oil far outweighs the very small increase in costs due to cap-and-trade.

Our estimates of declines in jobs and economic activity are therefore probably exaggerated. On the benefits side, the lag between collection of allowance revenues and the spending on specific activities in the Valley makes it necessary to estimate how much that spending will be in the near future and what activities will be stimulated. Looking only at funds already spent will severely underestimate

High Speed Rail

In addition to the cap and trade funded portion of high-speed rail, these spending and employment multipliers may be used to measure the economic impact of the entire "initial operating section" of the rail system from Madera to near Bakersfield. This first section is estimated to cost $6 billion in federal funds ($3.3 billion) and Proposition 1A bond proceeds ($2.6 billion).[86] Each $1 billion in high-speed rail construction requires approximately 2,300 construction jobs.[87] The economic impact of each $1 billion in rail construction will increase economic activity in the Valley by approximately $1.5 billion ($1 billion x 1.5) and increase employment in the Valley by about 5,900 jobs (2,300 direct jobs x 2.6). The total economic impact of the initial operating section of $6 billion will increase economic activity in the Valley by approximately $9 billion ($6 billion x 1.5) and create an additional 35,800 jobs (13,800 direct jobs x 2.6). These impacts are in addition to the cap-and-trade impacts summarized in Table 18.

TABLE 19 Summary of Costs and Benefits of Cap-and-trade Implementation in the Period 2013-15 in the San Joaquin

Category	Direct Effects ($ and jobs)	Total Impact on Economic Activity	Total Impact on Employment	Impact on State & Local Tax Revenue*
Cost of Compliance (2013-15)	($200 million) (151 jobs)	($265 million)	(428 jobs)	($9.6 million)
Implemented GGRF Revenue (2013-15)	$319 million 860 jobs	$467 million	2040 jobs	$14.3 million
Expected GGRF Revenue (2013-15)	$1203 million 3190–3800 jobs	$1750 million	7840 jobs	$54.9 million
Net Impact (to-date)	**$119 million 709 jobs**	**$202 million**	**1612 jobs**	**$4.7 million**
Expected Net Impact	**$1003 million 3039- 3649 jobs**	**$1485 million**	**7412 jobs**	**$45.3 million**

Source: Authors' IMPLAN analysis. Results reported in 2016 dollars. **Excludes property tax revenue.*

the full benefits of cap and trade in the Valley. We therefore report both implemented funds and allocated funds so that the reader can consider both. In addition, making assumptions is part of the art of modeling economic impacts. We tried to the full extent possible to explicitly identify our assumptions. We hope that this transparency helps economists and policy makers devise alternate approaches to regional economic analysis of the state's climate policies.

Potential Economic Impacts of an Extended Cap and Trade through 2030

Should California decide to extend the cap-and-trade program through 2030, the range of potential economic impacts on the San Joaquin Valley will depend on a number of factors, mostly relating to law and policy decisions but also due to technological and market-driven changes. This section describes the factors that will likely determine both the costs and benefits for Valley entities and residents from an extended cap-and-trade program through 2030.

FUTURE NEGATIVE IMPACTS

Valley sources that continue to emit high levels of greenhouse gases will likely experience ongoing costs to comply with the cap-and-trade program. These costs could result from multiple methods of compliance, such as from on-site emissions reductions, purchase of allowances in the cap-and-trade auctions, purchase of less-expensive offsets to avoid needing to purchase allowances, or reduction in or relocation of business activity to avoid compliance obligations. These costs in turn may result in higher prices for electricity (depending on the use of investor-owned utility allowance revenue to offset these increases) and transportation fuels, and these higher prices will have some negative impact on demand for these products produced in the Valley. The price elasticities of demand for these products is relatively low in the short-run, so the effects on production will continue to be small.

Determining the likely costs of compliance through 2030 requires an assessment of the various ways that covered entities will attempt to comply with the emissions reduction requirements. While these decisions will be particular to each firm and will depend on a range of policy, business and technology factors, firms will likely assess their options at least in part based on the anticipated cost of purchasing allowances.

To determine the cost of allowance purchases, we estimate the total number of allowances the California Air Resources Board will issue from 2016 through 2030, based on the California Air Resources Board's existing projections through 2020 and proposed amendments to extend the program through 2030.93 We estimate 4,407 billion total allowances will be issued statewide from 2016 through 2030. If we assume that Valley sources will continue emitting about 21 percent of the emissions covered by the statewide cap, Valley entities would have a compliance obligation equal to approximately 940 million allowances over that period.

To calculate the cost of this compliance, we assume the auction reserve price is a proxy for the compliance cost. We multiply the auction reserve price by the total allowances available over the period to get a total statewide compliance cost of $56.1 billion (in 2016 dollars). (The minimum auction reserve price is based on the $12.73 price in the May 2016 auction94) With Valley sources responsible for 21 percent, as discussed above, these entities would have compliance costs of $11.8 billion from 2016–30.

A number of factors will influence the actual cost of compliance and the negative economic impact of complying with cap and trade.

- **The price of allowances**
  As the cap declines, there will be fewer allowances. Economic logic relates the cost of a commodity to the supply and demand of that commodity. If demand remains constant while supply dwindles, the cost of allowances will increase. The price of allowances is related to the costs of reducing emissions. Lower costs of actual emission reductions will reduce demand for purchased allowances and compliance costs will stay low. The inverse is also true.
- **Free allowance allocations**
  The California Air Resources Board has allocated free allowances to many covered entities to prevent leakage and assist with transition. These free allowances are designed to decline slowly.[95] Because free allowances offset compliance costs for the entities receiving them, the decline of free allowances will increase compliance costs.
- **Amount of utility allowances auctioned and corresponding climate credits**
  Under the rules of the cap-and-trade program, investor-owned utilities must auction their free allowances and redistribute the revenue to electricity customers. Municipal, or publicly owned, utilities also receive allowances and have discretion over how to use them. The redistribution of this allowance revenue to customers is intended to mitigate the price increases (and corresponding demand reduction) for sensitive customers. It will be important to pay attention to the sale of utility-owned allowances.[96]
- **Available offsets**
  California's program rules allow capped entities to meet 8 percent of their compliance obligation through offsets. If the cost of offsets remains less than the allowance price, the total cost of compliance will also be less.
- **Cost of emissions reduction technologies**
  As the market for emissions-reducing technology improves, both from demand from California industries affected by cap and trade and other environmental regulations and from demand from firms in other jurisdictions with similar carbon limits, the cost of these technologies will likely decrease.

Ultimately, as the numbers to date indicate, these compliance costs (not including benefits) through 2030 could lead to job loss and reduced economic activity in the fossil fuel sector between 2016 and 2030. However, the range of these impacts will depend on the policy and market factors described above, and they will continue to be offset by the benefits of the cap-and-trade program in the Valley, should the program continue.

FUTURE POSITIVE IMPACTS

The benefits of the cap-and-trade program will mostly flow from spending in the Valley from statewide auction proceeds, via the Greenhouse Gas Reduction Fund (GGRF). This spending will create Valley jobs and boost economic impacts, as well as potentially reduce some resident costs for transportation and utilities, such as through supporting more transit, high-speed rail, and housing near jobs and services. In addition, to the extent that greenhouse gas emissions reductions also mean reduction in other harmful pollutants, the region may experience public health benefits that contribute to economic activity, such as reduced asthma rates.

The amount of auction proceeds through 2030, however, could vary greatly, as well could the amount of statewide proceeds that the state may spend in the Valley. The following factors directly influence the potential economic benefits to the Valley of cap and trade.

- **The price of allowances and percentage sold**

  As discussed above, the potential range in auction price means a corresponding range in the amount of auction proceeds that the state could spend in the Valley. In addition, the percentage of allowances auctioned, versus freely allocated, will greatly impact the amount of proceeds to spend. The amount of auction revenue dedicated to investor-owned utilities and publicly-owned utilities also determines how much of the proceeds is available to spend in the Valley. For example, we estimate that total auction revenue from 2016 through 2030, with 75 percent of the allowances auctioned at a minimum price, could be $58.918 billion, with approximately 24 percent ($14.14 billion) for investor-owned utilities. In this scenario, the state would therefore have over $44 billion in proceeds to spend. And if 90 percent of the allowances are auctioned at the minimum price, using the same calculations (but a relatively smaller percentage in revenue directed to investor-owned utilities), the state could have over $56 billion in auction proceeds to spend. Similarly, if the allowance price is twice the minimum, that figure could be over $113 billion. These ranges indicate the extent of variability in benefits from auction prices and percentages.

- **The percentage of greenhouse gas reduction funds spent in the Valley (particularly high-speed rail investments)**

  To date, 35 percent of the program's implemented funding has been spent in the Valley, largely due to investments in high speed rail construction.[97] Given high-speed rail's initially significant and then ultimately declining role through 2030, as construction completes in the Valley region and possibly across the state, this percentage could diminish through 2030. In addition, the high speed rail program faces some uncertainty due to litigation over the legality of dedicating cap-and-trade auction proceeds to it,[98] as well as uncertainty related to the construction timeline and route and availability of other funds for construction. However, if the region continues to receive approximately 35 percent of the auction proceeds (likely the most optimistic scenario), the Valley could potentially receive between $16 billion (minimum allowance price and 75 percent auction) and $20 billion (90 percent auction) and as much as $40 billion, assuming allowances sell for twice the minimum allowance price.

- **Amount of utility allowances auctioned**
  As discussed above, the amount of auction proceeds available depends on investor-owned utility auctions of their free allowances (as well as municipal utility decisions related to their allowances) and how they redistribute the proceeds to electricity customers.

Overall, the Valley could potentially have positive net economic impacts from the extension of cap-and-trade through 2030, given the high levels of investment in the region, which would lead to jobs and improved economic activity. The higher the auction proceeds and the greater percentage of those funds that are spent in the Valley, the more the region will benefit overall, continuing the net positive impacts of the program to date.

POTENTIAL ECONOMIC IMPACTS OF NOT EXTENDING CAP AND TRADE THROUGH 2030

If policy makers do not extend cap and trade beyond 2020, the California Air Resources Board would likely replace this market-based mechanism with direct regulation of existing sources (command-and-control), as prioritized by AB 197 (Garcia). Under this scenario, regulated entities would no longer have the option of purchasing allowances or offsets to comply with the emissions reduction targets and would either have to invest in on-site emissions reductions (creating jobs) or reduce or relocate their business activity, with accompanying job losses in the Valley. As a result, many of the costs described above would likely increase.

The primary benefit of more traditional command-and-control approaches compared to cap and trade is greater site-specific certainty of actual emissions reductions. This is important not only for guaranteeing GHG reductions, but also for neighboring communities and other residents concerned about emissions from particular facilities. In addition, these greenhouse gas emission reductions at regulated facilities could also include reduction in harmful co-pollutants. The decline in co-pollutants could offer significant public health benefits to the region. Finally, direct emissions reductions in the Valley will produce local jobs, as long as abatement rather than plant closure occurs, whereas purchase of offsets or allowances from outside the region will not have this stimulating effect on the local economy.

Without cap and trade, Valley residents might see higher prices for goods and services from regulated entities, if the cost of complying with direct regulation is greater than the cost of complying with cap and trade. Residents could also suffer job losses from businesses that relocate or reduce activity based on higher compliance costs under direct regulation instead of cap-and-trade. In addition, residents would lose the benefits of spending from the greenhouse gas reduction fund, as well as "climate credits" to reduce their electricity bills.

RENEWABLES PORTFOLIO STANDARD

Few places in the state have been as overwhelmingly affected by the clean energy boom, and have in turn spurred that boom, as the San Joaquin Valley. According to the California Energy Commission, the Valley accounts for almost 31 percent of the energy capacity of renewable projects online as of October 2015 and 46 percent of renewable projects that had received environmental permits but were operational as of that same date.[99] This share totals 5,607 MW of renewable capacity, generating enough electricity to power over 4 million homes. Planned projects will add an additional 5,434 MW of renewable capacity.

California has been increasing the stringency of its renewable energy requirements since 2002. That year, SB 1078 established the state Renewables Portfolio Standard (RPS) to require retail electricity sellers, with the exception of municipal utilities, to procure 20 percent of their electricity from eligible renewable energy resources by 2018, a goal that was later accelerated. In 2011, Governor Brown signed legislation to increase the RPS to 33 percent by 2020.[100] He set clean energy goals as part of a plan to help rebuild California's economy, with an overall goal of adding 20,000 MW of renewable generation by 2020, comprised of 8,000 MW of large-scale renewable generation and 12,000 MW of renewable distributed generation. California is ahead of schedule for meeting the 2020 RPS target.[101] In 2015, SB 350 increased the RPS again, by requiring that 50 percent of the retail electricity come from renewable sources by 2030.

The California RPS is unique in its design. There are three categories of qualifying renewable energy, and as the state progresses toward the goal, a greater share of renewable energy has to be procured from Category 1 and a smaller share from Category 3. Category 1 refers to renewable energy from a facility whose connection to the grid is controlled by a California balancing authority, and Category 3 refers to "unbundled" Renewable Energy Credits (RECs), which are certificates of renewable energy that can be purchased separate from the actual renewable energy generated. By 2017, 75 percent of RPS-qualifying energy must be from Category 1 and only ten percent can be from Category 3. Category 2 energy is typically from a neighboring state. This design means that most of the employment and related economic benefits from the construction of renewable energy to meet the RPS will be captured in state.

As a result of these policies and the corresponding decrease in technology and deployment costs, the state has made significant strides on renewable procurement. Large-scale renewable capacity (greater than 20 MW) has steadily increased from 6,600 MW in 2010 to nearly 14,300 MW in 2015. Since the end of 2010, 7,700 MW of large-scale renewables have become operational within the state.[102] As of October 31, 2015, more than 7,200 MW of distributed generation (less than 20 MW in size) capacity was operating or installed in California, with nearly 900 MW of additional capacity pending.[103]

BEYOND 2020

In fall 2015, SB350 called for a research study to explore the creation of a regional grid. Gov. Jerry Brown and state regulators say a regional grid would help the state's transition to clean energy by allowing the import and export of solar and wind energy, which would lower costs and increase generation. The plan would allow the California Independent System Operator (CAISO), which manages electricity markets and transmission for about 80 percent of the California grid, to merge its portion of the grid with PacifiCorp, another grid operator that covers most of Wyoming and Utah as well as small parts of Northern California, Washington, Oregon, and Idaho. Under such integration, during midday in California, when solar energy production is at its peak, electricity could be exported to other states, while at night, California could import power from Wyoming wind, which is typically strong at night. As of August 2016, planning for a regional grid was postponed until early 2017 because of concerns that any flaws in the new system could weaken California's RPS or reduce the state's regulatory control.[104]

A recent study commissioned by CAISO estimated a regional grid could increase state GDP by as much as $1.7 billion and create as many as 19,300 jobs over and above than projected levels for current state policies.[105] However, all the net new income and new jobs were projected to be created indirectly by lowered electricity rates for consumers and businesses. While lower electricity rates would benefit Valley consumers, who spend higher than average shares of their incomes on electricity, integration could reduce the growth of renewables in the Valley, and some people earning good wages and benefits working on renewable construction projects would have to look elsewhere for work.

As long as renewable energy developers continue to build in California, solar PV will continue to play a vital role in the economy and the energy future of both California and the Valley. The cost of solar technology has decreased dramatically in the past half decade, and renewables developers view the Valley as an opportunity area due to its abundant sunshine, geographic proximity to demand and existing transmission, and large parcels of suitable land. A recent stakeholder-led study identified 470,000 acres of land in the Valley that may present the fewest land-use conflicts available for solar development, amounting to roughly 5 percent of the 9.5 million acres studied in the Valley.[106]

Economic Impact of Renewables Portfolio Standard in the San Joaquin Valley

METHODOLOGY

The data source for MW of energy capacity by location is the California Energy Commission.[107] We used the Jobs and Economic Development Impact (JEDI) models developed by the National Renewable Energy Laboratory (NREL) to calculate jobs and economic output figures and determine the associated multipliers. Results are reported in 2016 dollars. The JEDI model allows for user alteration of some inputs. We altered the assumed hourly wage rate for utility-scale PV construction from $21.39 to $36.55 and increased the benefits rate to 48.8 percent to better reflect California construction costs.

We did not attempt to estimate regional economic costs of the RPS because doing so would require a challenging technical task of determining a business-as-usual scenario. We know that the costs of meeting the RPS have been reasonable because there was a safety valve built into the program to reduce the targets should it be too costly. We also know that the costs of wind and solar electric generation have declined dramatically and are competitive with fossil fuels.

Furthermore, solar and wind generation resources do not simply replace fossil fuel generation. Without large-scale energy storage options, the state must maintain its fossil fuel infrastructure to provide power when the wind isn't blowing or the sun isn't shining. Because of this, there is no evidence that the RPS has triggered any actual job loss in the San Joaquin Valley. Because the costs are negligible, the gross economic benefits presented will be close to the overall net economic impact of the RPS in the Valley.

Statewide, natural gas is 59 percent of the state's total electricity generation capacity, but only 16 percent of it is located in the Valley. The Valley has 24 percent of the state's solar generation and 54 percent of the state's wind generation.[108] As Figure 8 and Figure 9 show, all new generation capacity built in the Valley in recent years has been in renewables.

FIGURE 8 Renewable construction in the 8-county San Joaquin Valley region, 2002-15

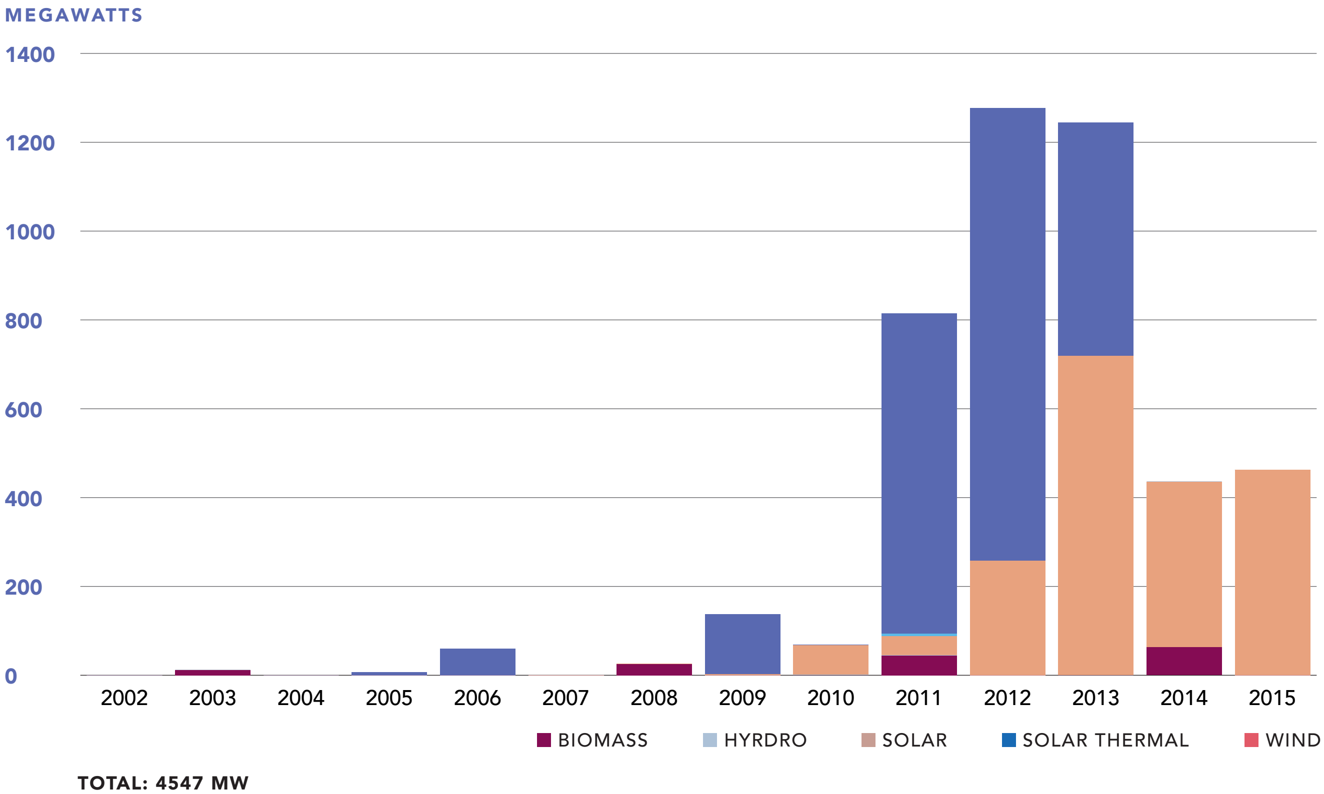


FIGURE 9 Natural gas power plant construction in the 8-county San Joaquin Valley region, 2002-15

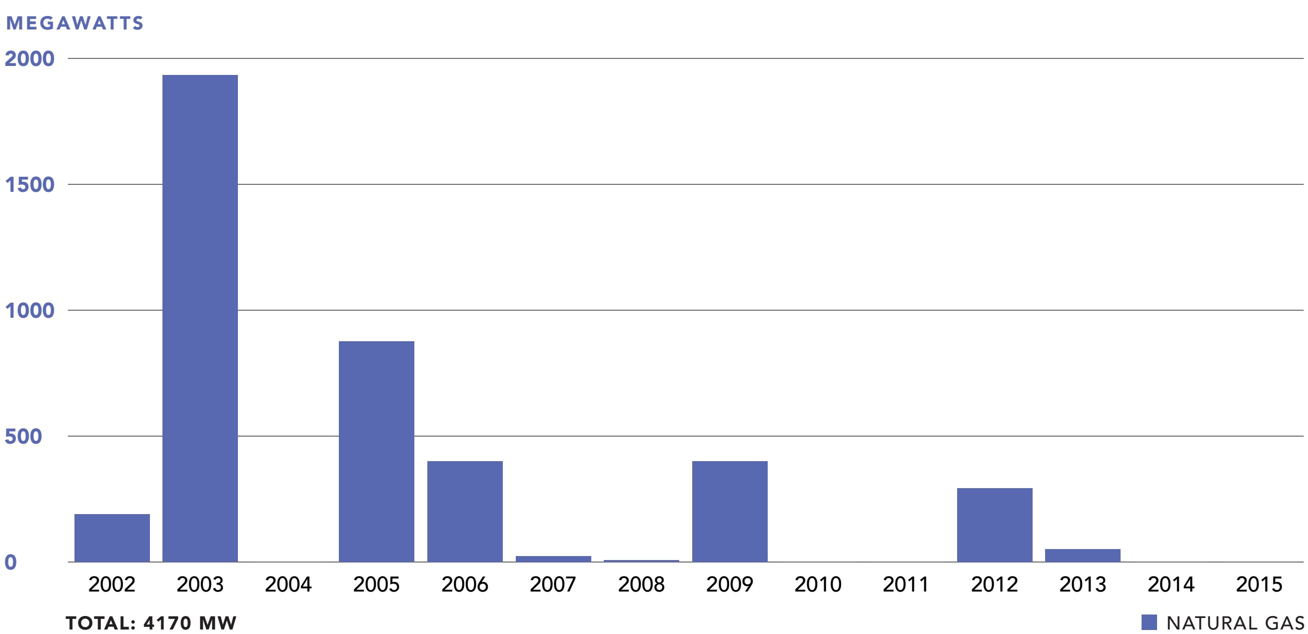
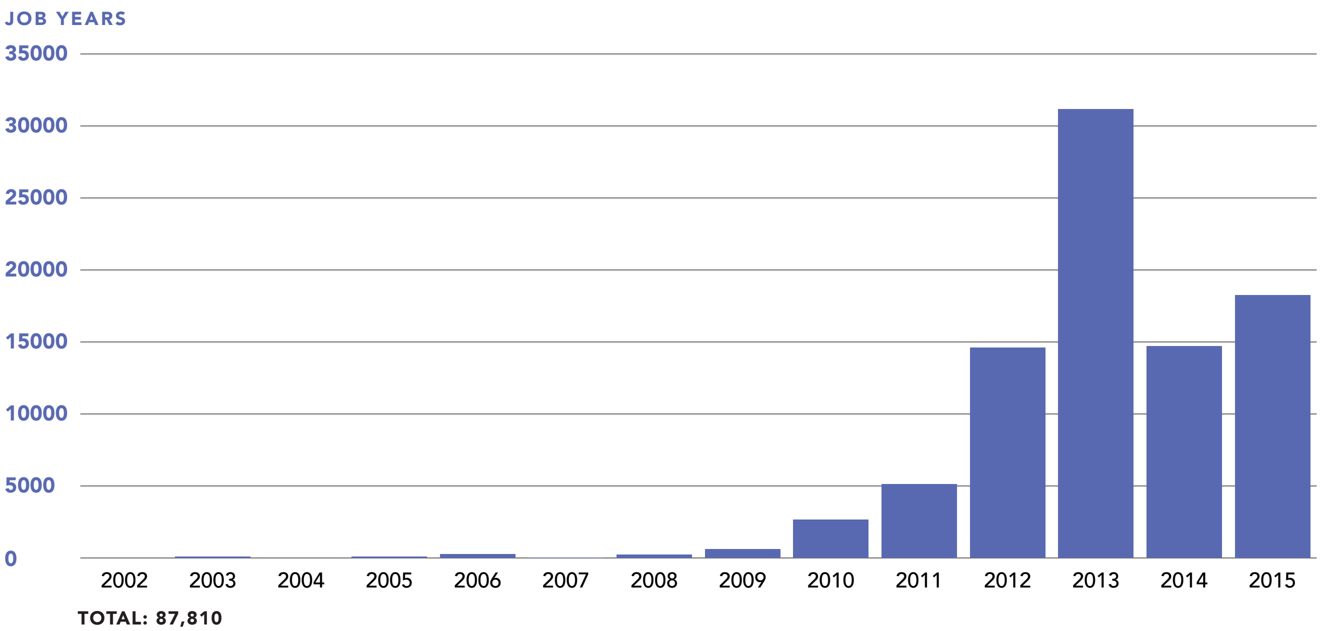


FIGURE 10 Renewable energy construction measured in total jobs in the San Joaquin Valley, 2002-15



ESTIMATED ECONOMIC IMPACTS OF THE RPS THROUGH 2015

From the time the first RPS passed in 2002 until the end of 2015, 4547 megawatts (MW) of RPS-qualifying renewable energy projects were built in the eight San Joaquin Valley counties, three-quarters of which was built after January 1, 2012. Most of these projects are in eastern Kern County's Tehachapi region, which has the highest wind and solar potential in the state. Construction workers frequently have to travel long commutes to work at these project sites, with some workers coming from surrounding counties. Therefore, the employment and economic impacts of the significant economic and employment benefits of the Tehachapi wind and solar development likely benefitted the wider Valley economy.

In total, this construction created about 88,000 direct and indirect jobs,[109] of which 80,000 were created since 2012. 31,000 of these were "direct jobs" including jobs associated with the on-site development. These include project developers, environmental and permitting consultants, road builders, concrete-pouring companies, construction companies, tower erection crews, and crane operators. Of the total direct jobs, approximately 9,532 were construction jobs, including about 7,440 blue-collar construction jobs.[110] As shown in Figure 10, most of this employment has been created since 2012.

Every new MW of solar energy capacity (in projects greater than 250 kW) creates on average of 15 direct jobs in onsite construction and construction related activities. For every direct job created in solar construction, there is an additional 1.6 jobs created offsite, so each new MW of solar in the San Joaquin Valley has created 40 total jobs. To date, large-scale solar development has created over 76,000 jobs in the Valley.

Every new MW of wind creates on average of 0.6 direct jobs in onsite construction and construction related activities. For every direct job created in wind, there is an additional 6.6 created offsite, so every

TABLE 21 Job multipliers for construction of renewable energy in the San Joaquin Valley

Renewable technology	Direct jobs per MW Construction	Employment multiplier (construction phase) *	Total employment impact per MW construction*
Solar	15.0	2.6	39.6
Wind	0.6	6.6	4.2
Biomass	3.8	1.7	6.4
Small Hydro	13.2	3.6	23.8
Solar Thermal	9.7	2.5	24.7

**these multipliers should not be used to project future jobs*

TABLE 22 Job multipliers for operation and maintenance of renewable energy in the San Joaquin Valley

Renewable technology	Annual direct jobs per MW Operations	Employment multiplier (operating years)	Total annual employment impact per MW operations*
Solar	0.1	1.9	0.2
Wind	0.1	2.5	0.1
Biomass	0.8	4.2	3.5
Small Hydro	0.4	4.4	1.8
Solar Thermal	4.0	1.3	5.3

**may not multiply due to rounding*

new MW of wind power has created an average of 4.2 total jobs. To date, wind power development has created over 10,000 jobs in the Valley.

Development of other renewables in the Valley (biomass, landfill gas, small hydro, and solar thermal) has created an additional 1100 total jobs.

In addition to direct benefits to workers, the development of renewables creates other jobs: white collar construction jobs, construction-related jobs, indirect jobs associated with the supply chain (manufacturing, transportation, etc.) and induced jobs created when workers spend money in the local economy. Table 21 shows the total employment impact per MW of construction by different renewable energy. The construction of solar PV has the greatest total employment of any renewable technology, creating almost 40 on-site and off-site jobs per MW. Wind has the lowest employment impact, creating just over four on-site and off-site jobs per MW. We

TABLE 23 Total economic output (in 2016 dollars), San Joaquin Valley renewables, built 2002-2015

Renewable technology	Total economic output (construction phase)	Annual economic output (operating phase)
Solar	$9,708 million	$47 million
Wind	$1,726 million	$57 million
Other (Solar thermal, Biomass, and Small Hydro)	$166 million	$84 million
TOTAL	**$11,600 million**	**$188 million**

TABLE 24 Average economic output multipliers by MW of renewable energy

Renewable technology	Total economic output per MW (construction phase)	Annual economic output per MW (operating phase)
Solar	$5.0 million	$25K
Wind	$0.7 million	$23K
Biomass	$0.9 million	$600K
Small Hydro	$3.8 million	$300K
Solar Thermal	$5.3 million	$600K

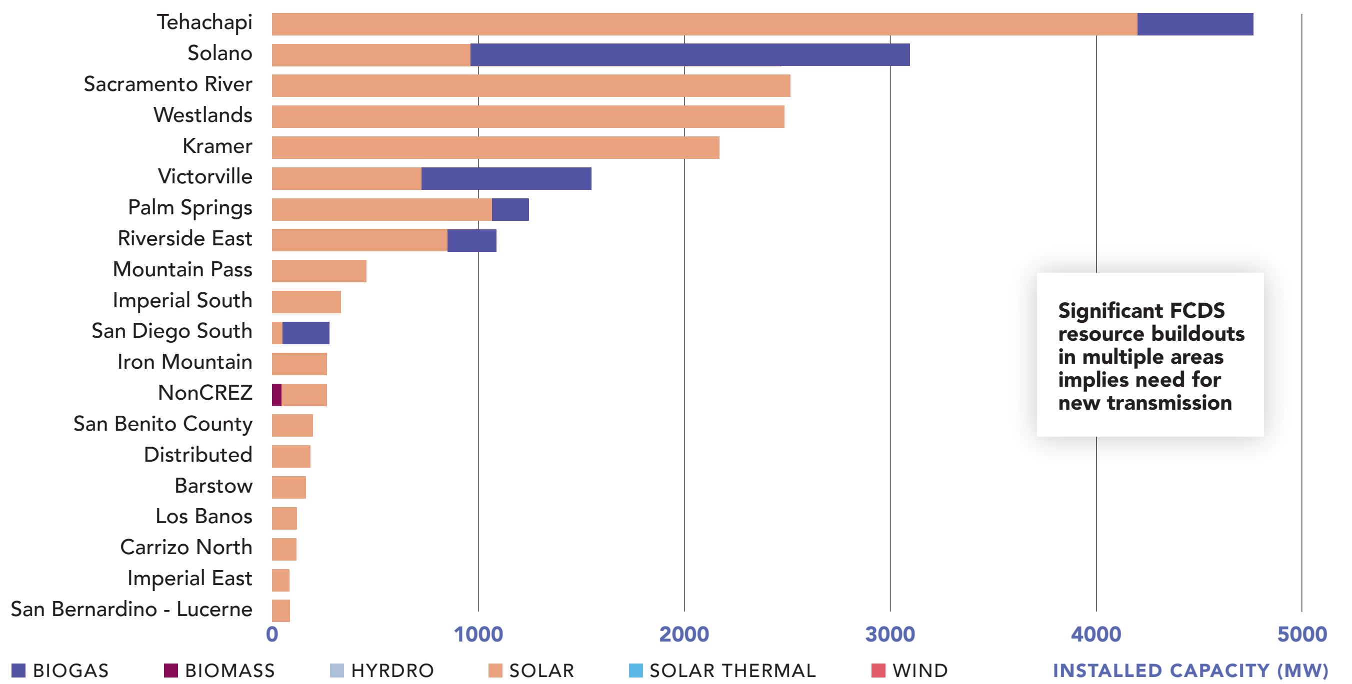
caution that these solar PV multipliers in JEDI are significantly higher than other assessments of solar employment.[111, 112]

Once these facilities are operational, they require additional workers for ongoing operations and maintenance. These jobs are ongoing and permanent, and the number of workers needed varies by technology. Of all the technologies, solar thermal has the greatest overall employment impact. Wind and solar require very little onsite maintenance, as shown in Table 22.

Table 23 shows the total economic output from the construction and operation of renewable energy in the Valley. In total, the construction of renewable energy has generated $11.6 billion in total economic output, 84 percent of it in solar PV. The operation and maintenance of these renewable facilities continues to generate $188 million annually.

Table 24 shows the economic output multipliers by MW for each renewable technology. In this case, solar thermal has the greatest economic output multiplier for both construction and operations/maintenance.

FIGURE 11 2016 RPS Portfolio: Default Scenario (New Capacity by 2026) Solar Resources



Source: RPS Calculator.

** The amount of new renewable deployment that occurs in-state versus out-of-state or in other regions of the state*

POTENTIAL ECONOMIC IMPACTS OF RENEWABLES PORTFOLIO STANDARD THROUGH 2030

The potential range of economic and job impacts in the Valley from renewable deployment will depend on a number of factors, related to policy, market and technology developments. As a threshold matter, the impacts will largely depend on the how much renewable energy is built in the Valley. The RPS Calculator allows for different "build-out" scenarios based on a range of variables presented by the California Public Utilities Commission. The build-out projections for the default scenario are presented in Figure 11. The results are presented by SuperCREZ boundaries, which are used to organize renewable energy potential and transmission costs represented in the RPS Calculator Version 6.0+. In order to incorporate renewable resource potential throughout the state, SuperCREZs were developed by expanding the CREZs created in the RETI (Renewable Energy Transmission Initiative) stakeholder process.

The San Joaquin Valley includes a small part of the Solano CREZ, and most of Los Banos, Westlands, and Central Valley North. The Tehachapi region encompasses the eastern part of Kern County. Figure 11 shows potential throughout the state with the Valley topping the list in Tehachapi and Solano, and additional potential in Los Banos, Westlands, and Carrizo North.

FACTORS AFFECTING BUILDOUT OF RENEWABLES IN THE VALLEY

A number of factors will continue to impact the future of renewables development in the San Joaquin Valley. These factors include:

- **The amount of new renewable deployment that occurs in-state versus out-of-state or in other regions of the state**
  If California decides to more aggressively expand its grid footprint throughout the western region, either through expanded renewable markets or through merging with other grid operators (as CAISO recently proposed with PacifiCorp), more of the renewable energy may be generated out-of-state. These facilities could provide energy at different times, given differing times of solar insolation and wind availability across the west. California may also identify new, inexpensive renewable resources in other regions of the state, which would lessen the demand to build in the Valley. A recent CAISO study indicated that the results of a multi-state grid could be largely positive for the San Joaquin Valley as long as the current renewable procurement rules (categories 1, 2, and 3) stay intact. The three categories refer to minimum and maximum renewable energy products that utilities draw from to comply with the RPS. The first category requires renewable energy delivered to a California balancing authority without substituting electricity from another source (utilities must acquire 75 percent of their total RPS products from this category after 2016); the category bucket covers renewable resources that cannot be delivered to a California balancing authority without substituting electricity from another source (limited to not more than 10 percent after 2016); and the third category allows other eligible renewable energy products, such as unbundled renewable energy credits (RECs) (limited to no more than 10 percent after 2016). According to the study, if procurement rules change that result in higher imports of renewables from out-of-state, California in general, and the San Joaquin Valley in particular, would see far fewer direct jobs and far less regional investment associated with renewable energy development.[113]

- **The ability of California to export surplus renewables out of state**
  As the flip side of grid integration across the western region of the United States, coupled with more states adopting renewable energy policies, California renewable generators may provide market opportunities to export surplus renewable energy to out-of-state markets. At certain times of the year, the state already generates surplus solar power, beyond in-state demand. Barring increased in-state demand or cost-effective energy storage to harness that surplus power, the state may seek ways to export that power out-of-state.

- **Potential technology improvements and cost decreases**
  If solar panel developers greatly improve the efficiency of solar panels or invent new, cheaper renewable energy technologies (or improve existing ones), the amount of money invested in renewables in the Valley could change significantly. This potentially reduced investment could entail reduced per megawatt job hours and economic impacts (while also saving ratepayers in the process). Otherwise, in terms of technology mix, the current trajectory indicates that approximately 95 percent of new renewable deployment is likely to be solar PV (discussed below).

- **Increased future energy efficiency savings**
  With California committed to doubling the energy efficiency of buildings, the state could potentially see less demand for electricity by 2030, particularly if new financing models are

introduced and new technologies help improve energy consumption on common appliances and structures (as LED bulbs improved the energy consumption of lighting). However, population increase and the increase in consumer goods requiring electricity may make this goal elusive.

- **Electrification of transportation increasing energy demand**
  As the state moves to electrify most of its transportation, including primarily passenger vehicles but also more goods movement and rail transit and high speed rail, the shift from petroleum to electricity as a fuel will add to the state's overall electricity demand. Meeting this demand may require much more renewable deployment than currently projected.

- **Cost decreases and greater deployment of energy storage technologies**
  Given that much of the state's renewable energy is intermittent (since the sun does not always shine nor the wind always blow), energy storage technologies could capture surplus power for later dispatch. Currently, while the price of many energy storage technologies like batteries is decreasing, it may not be cost effective to store bulk amounts of renewable power for long time periods. But as costs continue to fall and technologies improve, the state may be able to rely on these technologies to meet significant portions of the demand. As a result, renewable power could become more cost-effective and able to penetrate at greater percentages than 50 percent, and sooner than 2030. The effect could result in potentially more in-state renewables in the Valley.

Despite the multitude of factors that could affect deployment through 2030, we can make rough estimates of the potential Valley deployment of renewables by 2030. Statewide, the California Public Utilities Commission RPS calculator has a range of approximately 26,000 MW to 33,500 MW of installed capacity expected (and needed) by 2030. Taking the average, we can envision 29,750 MW of installed in-state renewable capacity by 2030.[114] The additional in-state capacity that would therefore be built under this assumption is 11,850 MW (above the existing 17,900 MW in-state at the end of 2015, based on California Energy Commission data showing 23,100 MW by Dec 31, 2015 with 5,200 MW out-of-state).[115]

We also assume, based on the California Public Utilities Commission RPS calculator, a predominate mix of solar PV with some wind to meet this 2030 goal. Comparing the default RPS calculator mix from 2016 to 2030, solar PV is projected to constitute more than 95 percent of the technology deployment going forward through 2030, with wind at about 4 percent and biogas at 1 percent.[116] We therefore assume 95 percent solar PV deployment and 5 percent wind, while acknowledging that other technologies may play a much more significant role in the future deployment (as discussed above).

To determine the potential range of megawatt deployment in the Valley by 2030, we calculate a baseline of 3,673 additional megawatts of renewable energy from 2016 through 2030, assuming the current deployment trajectory continues. This number represents 31 percent of the additional 11,850 MW needed statewide to reach the 29,750 MW total to meet the 50 percent RPS.[117] This percentage is the same ratio of renewables currently deployed in the San Joaquin Valley (5,607 MW out of the current 17,900 MW cumulative statewide deployment through 2015).[118] Of those, this scenario assumes 3,489 MW will be solar PV and 184 MW will be wind.

If we assume the Valley receives a mid-range estimate of 60 percent of the additional 11,850 MW needed statewide to reach the 29,750 MW total, up from 31 percent under business-as-usual, the Valley could potentially receive an additional 7,110 MW through 2030. Of those, 6,754 MW would be solar PV and 356 MW will be wind, under the projected technology mix described above.

If the Valley receives an ambitious estimate of 90 percent of the additional 11,850 MW potentially needed statewide to reach the 29,750 MW total, the Valley would therefore receive an additional 10,665 MW through 2030. Of those, 10,132 MW would be solar PV and 533 MW will be wind.

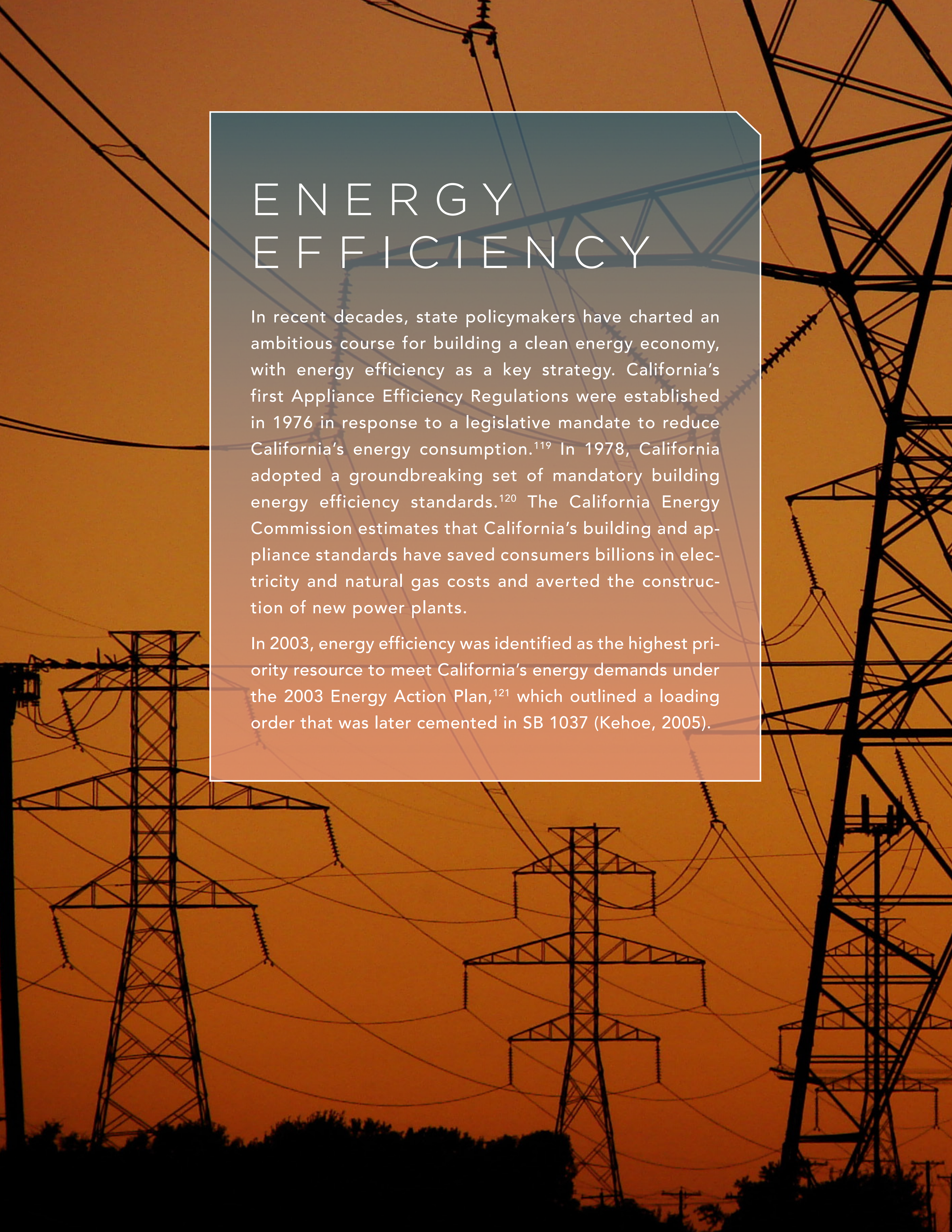
The cost of this deployment to the Valley, in terms of economic impacts, jobs, and ratepayer impacts, will depend on a number of factors:

- **The increase in electricity costs for Valley consumers as a result of costs of renewable technologies**
  While solar PV prices continue to decline, the cost compared to traditional generation assets from fossil fuel-based power will ultimately determine much of the ratepayer impacts. In addition, given the intermittency issues described above, ratepayers may face increased costs (higher utility bills) if the state is not able to integrate this energy smoothly through demand shifting, energy storage, and an expanded grid. Furthermore, these costs will vary depending on whether the renewable resources are located in-state versus out-of-state. Meanwhile, because Valley residents generally use more energy per capita than residents of other parts of the state, these price increases will likely affect them more.
- **Reduced demand from fossil-fuel-based power plants in the Valley**
  As the Valley and California shift to renewable energy, natural gas plants in the Valley may decrease output or shut down completely, leading to job losses and reduced economic output. Notably, any reduction would not likely be on a "one-to-one" basis, given the intermittent nature of renewables compared to natural gas-fired power plants' output.

The benefits of this renewable deployment also depend on a number of factors:

- **The amount of renewables and related transmission infrastructure built in the Valley compared to the rest of the state and the region**
  As discussed above, a significant percentage of renewables in the state is poised to be built in the Valley, or close enough to it to benefit the region economically. However, to the extent that future does not materialize, or that the jobs created tend to benefit out-of-region workers more, these benefits will diminish.
- **The number and quality of jobs**
  As described above, renewable technologies are becoming less expensive and potentially less job rich. While deployment will likely increase, the payoff per megawatt may not be as great, or significant enough to offset job losses in fossil fuel industries. We do not expect direct construction labor costs to decline much, however.
- **Public health and other co-benefits**
  The increased reliance on clean energy sources may decrease localized air pollution in the Valley, resulting in public health improvements and economic cost savings from reduced health care expenditures and loss of productivity.

Overall, given the region's prime location for solar exposure ('insolation') and wind resources (particularly in eastern Kern County), the low transmission costs from the region, the state's ambitious renewable goals and the likely increasing need for electricity for the transportation sector, the Valley is likely better positioned than other parts of the state to benefit economically from renewable deployment through 2030. The RPS-caused jobs and economic benefits to-date are likely to continue and increase as the state deploys more renewable energy through 2030.



ENERGY EFFICIENCY

In recent decades, state policymakers have charted an ambitious course for building a clean energy economy, with energy efficiency as a key strategy. California's first Appliance Efficiency Regulations were established in 1976 in response to a legislative mandate to reduce California's energy consumption.[119] In 1978, California adopted a groundbreaking set of mandatory building energy efficiency standards.[120] The California Energy Commission estimates that California's building and appliance standards have saved consumers billions in electricity and natural gas costs and averted the construction of new power plants.

In 2003, energy efficiency was identified as the highest priority resource to meet California's energy demands under the 2003 Energy Action Plan,[121] which outlined a loading order that was later cemented in SB 1037 (Kehoe, 2005).

A major component of California energy efficiency programs has consisted of utility rebate and incentive programs. Financial support for these programs began in 1996 with a "Public Goods Charge" on investor-owned utility (IOU) bills,[122] but since 2012 funding has been provided through energy procurement funds from IOU ratepayers.[123] The more Californians are able to reduce energy usage through efficiency, the less we will have to pay for the generation and transmission of electricity. IOU revenues are decoupled from sales, so that the IOUs have no incentive to sell more energy, and in fact, they have an incentive to increase savings from their efficiency efforts due to the Energy Savings Performance Incentive, where utilities can earn a profit based on efficiency performance. The state's IOUs, directed by the California Public Utilities Commission, administer about $1 billion per year state energy efficiency incentives and rebate programs serving the residential, commercial, industrial, and agricultural sectors.[124]

The success of these efforts is unambiguously evident throughout the state. Combining efficiency gains from codes and standards, efficiency programs, and market and price effects, the cumulative annual efficiency and conservations savings for electricity were estimated to reach nearly 70,000 gigawatt hours (GWh) by 2013.[125] Building on this success, SB 350, passed in 2015, mandated a doubling of energy efficiency by 2030.

The San Joaquin Valley is one of the hottest regions of the state, and per capita electricity use is higher than the California average. Therefore, the requirements in SB 350 and other statutes and regulations to promote energy efficiency have special significance for the Valley, where there remains enormous efficiency potential.

BEYOND 2020

AB 758 (Skinner, 2009)[126] addressed the need to lower emissions through reduced energy consumption in existing buildings and directed the California Energy Commission to adopt the Existing Buildings Energy Efficiency Action Plan (EBEE Action Plan). The goal of the September 2015 plan is to double energy savings in California's buildings, which is equivalent to a 17 percent reduction in statewide building energy use by 2030 compared to projected levels of usage. The plan predicts that implementation of the energy efficiency program will stimulate an $8 billion per year efficiency marketplace.[127] The plan should help achieve SB 350's goal of doubling energy efficiency by 2030. What remains unknown is the pathway California will take to achieve these goals. Where will the state direct its energy efficiency investments? Who will benefit? What types of jobs will be created from those investments?

Economic Impact of IOU Energy Efficiency Programs in the San Joaquin Valley

About three quarters of San Joaquin Valley's electrical load is served by the two largest investor-owned utilities (IOUs). Pacific Gas and Electric (PG&E) provides service in the northern part of the region, and Southern California Edison serves the southern portion. Most of the region receives both gas and electric service from these two utilities. The region is also served by four publicly owned utilities (POUs). These include Lodi Electric Utility, Merced Irrigation District, Modesto Irrigation District, and Turlock Irrigation District.[128] These POUs also administer energy efficiency programs, but they are small and we didn't include them in this analysis.

This section estimates the effects of the investor-owned utility energy efficiency programs in the San Joaquin Valley. The IOUs represent the largest consolidated source of funding for energy efficiency in the state. Restricting our analysis to the IOU programs allows for a closer look at the regional impacts of the state's efficiency efforts.

Energy efficiency is the gift that keeps on giving. Investments made in energy efficiency equipment save energy and money over the life of the equipment, which is typically 12-15 years, with some lighting measures lasting fewer years and some insulation and HVAC measures lasting longer. Many efficiency investments save more money than they cost. The IOUs manage a portfolio in which the avoided costs (or a narrowly defined suite of benefits) of efficiency exceed the upfront investment. This "cost effectiveness" has been a guiding principle of California's energy efficiency programs.

Cost effectiveness is measured in several ways. The "Total Resource Cost" (TRC) test measures the costs and benefits from the perspective of the Program Administrator (IOUs) as well as the customers. However, the costs and benefits are not balanced in California's test, which is the subject of current discussion at the CPUC. In 2010-15, the TRC for the IOU portfolio was 1.32, meaning that for every dollar spent, ratepayers saw $1.32 in avoided costs. From 2010-2015, the IOU statewide portfolio of programs spent $6.2 billion, resulting in combined gas and electric benefits of $8.6 billion.[129]

COSTS AND BENEFITS OF ENERGY SAVINGS IN THE SAN JOAQUIN VALLEY

From 2000 to 2011, the IOU efficiency programs were funded primarily by a Public Goods Charge (PGC)—a surcharge on customer bills. Since 2012, electricity procurement dollars (PEEBA) and a gas public purpose charge fund these efforts. To estimate a net economic impact of the IOU efficiency programs, we need to estimate what share of this funding is collected from customers in the Valley.

Because of the complex rate structure, it is not easy to estimate the funds collected by region. Instead, we assume that the Valley contributes as much to the IOU energy efficiency programs as its share of IOU energy use (14.3 percent combined electricity and natural gas) ,[130] and compare that to the share of benefits coming back to the Valley from the programs, in the form of financial incentives for

TABLE 25a California Investor Owned Utility Energy Efficiency Programs, Costs (2010-15)

Region	Sum of TOTAL IOU energy consumption (GWh)*	Share of IOU Energy Consumption (combined gas and electric)	Estimated Funding Collected from Ratepayers ($ million)*	Total Customer Costs*^ ($ million)	Total Costs (Ratepayer + Customer) ($ million)	Share of Total Costs
CENTRAL COAST	203,317	6.8%	$307	$145	$452	6.5%
DESERT	352,351	11.7%	$528	$418	$947	13.6%
NORTH COAST	54,098	1.8%	$81	$33	$115	1.7%
SACRAMENTO VALLEY	125,524	4.2%	$190	$91	$281	4.0%
SF BAY	733,636	24.4%	$1,102	$473	$1,575	22.7%
SIERRA NEVADA	44,524	1.5%	$68	$35	$103	1.5%
SAN JOAQUIN VALLEY	430,416	14.3%	$646	$288	$934	13.5%
LOS ANGELES	1,059,522	35.3%	$1,594	$936	$2,530	36.5%
(BLANK)	–	0.0%	$-	$66	$66	1.0%
TOTAL STATEWIDE	**1,177**	**100.0%**	**$4,516**	**$2,486**	**$6,936**	

efficiency. Over the period 2010-15, the IOUs collected a total of $4,635 million. Assuming then, that the Valley contributed 14.3 percent, they would have collected $662 million from Valley customers for IOU energy efficiency programs. Over that period, program expenditures totaled $4516 million. Unspent funds were applied to future programs or returned to ratepayers.[131,132] So, Valley customers were responsible covered approximately $646 million of the $4516 portfolios from 2010-15.

Based on CPUC data from 2010-15 program years, the Valley received about 12 percent of the total rebates and incentives, totaling $257 million. This $257 million, however, doesn't represent all of the spending coming back into the region. The CPUC reports that the region received $558 million in total program expenditures.[133] The difference between the total expenditures and the incentive expenditures include the implementation, administrative, marketing, and other expenses associates with administering these programs. While the $257 million is tracked by specific project and customer, the non-incentives expenditures are calculated rather than tracked. The CPUC allocates these non-incentive expenditures to projects based on the electric and gas benefits they deliver, so a project with higher lifecycle energy savings shows higher expenditures. In effect, location, sector, and lifecycle of each measure will skew the expenditure calculation: the higher the estimated lifecyle savings, the greater the calculated expenditures for that project.[134]

TABLE 25b California Investor Owned Utility Energy Efficiency Programs, Benefits (2010-15)

Region	Sum of Total Incentives** ($million)	Share of IOU Incentives	Total IOU Expenditures (Incentives + Program Costs) ($million)	Total Customer Investment ($million)	Total IOU + Customer Investment ($million)	Share of Total Investment
CENTRAL COAST	$141	6.6%	$266	$145	**$411**	6.3%
DESERT	$380	17.7%	$696	$418	**$1,114**	17.1%
NORTH COAST	$31	1.5%	$74	$33	**$107**	1.6%
SACRAMENTO VALLEY	$66	3.1%	$144	$91	**$235**	3.6%
SF BAY	$384	17.9%	$836	$473	**$1,309**	20.1%
SIERRA NEVADA	$27	1.3%	$61	$35	**$96**	1.5%
SAN JOAQUIN VALLEY	$257	12.0%	$558	$288	**$846**	13.0%
LOS ANGELES	$796	37.0%	$1,450	$936	**$2,386**	36.7%
(BLANK)	$67	3.1%	432	$66	**$498**	7.7%
TOTAL STATEWIDE	**$2,149**	**$2,367**	**$4,516**	**$2,420**	**$6,504**	

**^ This is the incremental customer cost, calculated as the difference between the total resource cost and the program administrator cost*

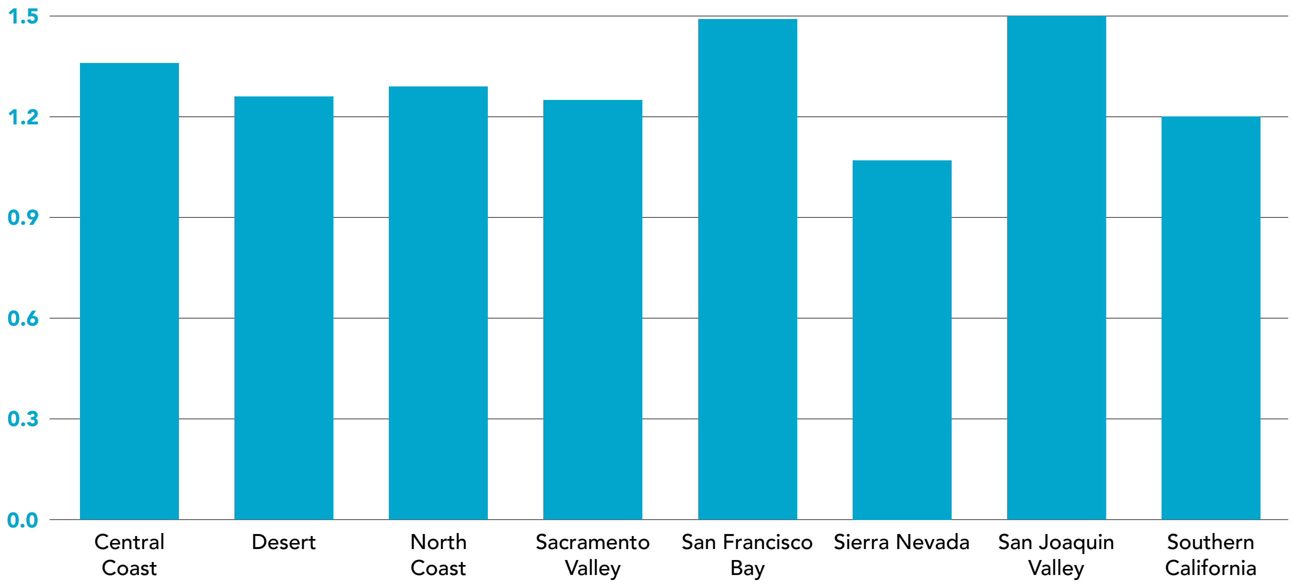
*** Estimated based on region's share of IOU energy (combined electricity and gas) consumption*

**** Total incentive paid including rebates, direct install labor costs, direct install materials, and incentives to others.*

***** Program-level costs are allocated based on the avoided costs (i.e. the ElecBen + GasBen). This includes Market&Outreach, Implementation, Administrative, Overhead, and EM&V.*

****** Total ratepayer funds incurred to run the program. Total expenditure = Weighted Program Costs + Incentives. This is different from (higher than) the reported Program Administrator Cost (PAC).*

FIGURE 12 Total Resource Cost Test (Avoided Costs/Total Costs)



Source: Authors' analysis based on data from the California Public Utilities Commission

To evaluate the costs and benefits to the San Joaquin Valley of the IOU energy efficiency programs, we compared the percent of annual IOU electricity use in the Valley to the percent of annual energy savings and expenditures in the region (See Table 25).

We also calculated the cost effectiveness ratios for the region and compared to other regions in California (see Appendix A: California Counties by Region for our categorization of regions). In 2010-15, the Total Resource Cost (TRC) for the IOU portfolio was 1.32, meaning that for every dollar spent, ratepayers saw $1.32 in avoided costs. For the San Joaquin Valley, the TRC was 1.50. Over that period, the region realized $993 million in electricity benefits and $190 million in gas benefits. The total resource cost test is shown in Figure 12.

The Program Administrator Cost (PAC) test measures the ratio of benefits to total program administrator costs and is the best comparison to understand the cost of EE as compared to the cost of the equivalent amount of conventional power the utility would have had to purchase to serve its customers. In 2010-15, the PAC for the Valley was 2.37.

Comparing the TRC and PAC for the San Joaquin Valley to other regions shows that investments in the Valley are more cost-effective than average. In fact, in a region-to-region analysis, the Valley is the most cost-effective region in the state for saving energy. For total combined IOU and customer spending of $788 million, energy efficiency investments in the region resulted in benefits and avoided total costs of $1,183 million, for net benefits of the Valley efficiency projects of $311 million.

Residential energy sales in the Valley were 10.3 percent of the IOU total residential gas and electricity sales, but the Valley accounted for only 8 percent of the residential efficiency expenditures. In both the residential and non-residential sectors, the Valley region uses a slightly higher share of the IOU energy than it receives back in efficiency program expenditures.

However, the energy efficiency program expenditures do not reflect the low-income efficiency pro-

TABLE 26 Cost Effectiveness Tests and Net Benefits of IOU EE programs by Region, 2010-15

Region	Total Electric and Gas Avoided Costs ($million)	TRC	PAC	Net Benefits (Total Avoided Costs minus Total Costs) ($million)
CENTRAL COAST	$521	1.36	2.19	$18
DESERT	$1,201	1.26	2.24	$136
NORTH COAST	$128	1.29	1.93	$1
SACRAMENTO VALLEY	$276	1.25	2.13	$68
SF BAY	$1,831	1.49	2.44	$453
SIERRA NEVADA	$97	1.07	1.77	$(33)
SAN JOAQUIN VALLEY	$1,182	1.50	2.37	$311
LOS ANGELES	$2,607	1.20	2.11	$385
(BLANK)	$269	1.23	1.76	$(229)
TOTAL STATEWIDE	**$8,113**	**1.32**	**2.21**	**$1,177**

TABLE 27 IOU Energy (combined electricity and natural gas) Sales and Efficiency Expenditures in the San Joaquin Valley, as a percent of IOU total (2010-15)[135]

Sector	Valley sales as a percent of statewide IOU sales*	Valley as a percent of statewide IOU efficiency expenditures**
Residential	10.3%	8%
Non-Residential	17.1%	16%
Total	**14.3%**	**12.4%**

**based on 2010-15 data provided by the California Energy Commission*

*** based on 2010-15 data from California Public Utilities Commission*

TABLE 28 San Joaquin Valley as a Percent of Eligible and Served Households, Low-Income Energy Efficiency (Energy Savings Assistance Program), 2015

Percent of Statewide Households Eligible for ESAP	Percent of Statewide Households Served by ESAP
26.5%	35.4%

Source: Authors' analysis based on ESAP monthly reports submitted by the IOUs

grams. Residential customers in the region have been served disproportionately well by the low-income energy efficiency programs. In 2015, the Valley was home to 26.5 percent of the households eligible for the Energy Savings Assistance program (ESAP) in 2015, but received far more (35.4 percent) of the statewide service (see Table 28).[136] The disproportionately low residential expenditures in the main energy efficiency portfolio, are at least partially offset by the relatively high penetration of service delivery for low-income residents.

In the PG&E service area, 7.2 percent of eligible households in the Valley provided ESA services in 2015, compared with only 5.4 percent PG&E-wide.[137] In 2015, almost 35,000 households in the PG&E part of the San Joaquin Valley were served by the ESA program, and the average first year bill savings for these households was $66.22, totaling $2.3 million in savings in 2015, and an estimated $22.2 million over the life of the installed measures ($636.75 per household).

Low-income households in the Southern California Edison (SCE) part of the Valley were also served better than average, 3.5 percent of eligible households received services compared to 3.2 percent for the utility's region as a whole. In 2015, about 3700 SCE households in the Valley were provided ESA services, and the average first year bill savings for these households was $76.89, totaling close to $300K in bill reductions in 2015, and an estimated $3.5 million over the life of the installed measures ($945.66 per household).

If we look at both regions combined, 6.6 percent of eligible customers in the Valley were served by ESA, compared to 4.4 percent of eligible customers in the PG&E and SCE regions as a whole. These programs saved almost 40,000 Valley low-income households about $2.6 million in 2015.

ESTIMATED EMPLOYMENT IMPACTS OF IOU ENERGY EFFICIENCY PROGRAMS THROUGH 2006-2015

The money saved, and re-spent on non-utility purchases, induces employment benefits in the local economy. In addition, efficiency investments create direct installation and indirect supply chain jobs. These workers spend money they earn thus inducing even more jobs in the local economy.

Based on a wide review of literature on energy efficiency job impacts[161], and research calculating total cost of saved energy from the Lawrence Berkeley National Lab[151], we found that these energy efficiency programs in the Valley created up to 6,660 direct job and 10,730 indirect and induced jobs in the region, for a total of 17,390 jobs created between 2006-2015.

TABLE 29 San Joaquin Valley, Estimated Electricity Energy Efficiency Savings (in Annual GWh), 2006-2015

Sector	Valley IOU electricity energy savings (Net GWh)	Total IOU electricity energy savings (PG&E, SCE, SDG&E) (Net GWh)	Valley savings as a percent of statewide IOU EE Expenditure
Residential	208	3758	5.5%
Non-residential	1,483	8560	17%
Biomass	*750*	*6,521*	*11.5%*
Small Hydro	*377*	*1,405*	*26.8%*
Solar Thermal	*357*	*634*	*56.3%*
Total	**1,691**	**12,318**	**13.7%**

TABLE 30 Energy Efficiency Employment and Economic Impact, San Joaquin Valley, 2006-2015

Sector	**Net GWh**	**Direct jobs**	**Indirect + induced jobs**	**Total jobs**	**Estimated investment in EE projects ($ Million)**
Residential	207	940	810	1,750	$114
Commercial	750	2,890	4420	7,310	$842
Industrial/Ag	734	2,830	5500	8,330	$420
Total	**1,691**	**6,660**	**10,730**	**17,390**	**$1,376**

METHODOLOGY

To estimate the direct (installation) job creation of energy efficiency, we estimated total upfront investment in efficiency relying on levelized cost of saved energy data reported by the Lawrence Berkeley National Lab (LBNL).[138] The total cost of saved energy is a useful metric to assess costs across different program types and different program sectors as it captures the full cost, i.e. the full system-wide investment in the efficiency resource by all parties, and controls for the different lifespans of different energy efficiency equipment.[139] To translate this investment into job estimates, we reviewed a wide range of literature including both bottom-up job studies on energy efficiency programs, and top-down (input-output models) estimating efficiency jobs per million dollar investment.[140] We organized these findings by sector. Using cost and savings data, we calculated employment multipliers by sector to estimate jobs per gigawatt hour (GWh) saved.

To calculate the GWh savings in the Valley, we used California Public Utilities Commission data on the energy efficiency programs undertaken by the investor-owned utilities.[141] We used the net electricity saved (GWh), which captures the energy savings attributable to the investor-owned utility efforts. For the years prior to 2010, geographical information was not readily available, so we projected backward based on 2010-15 geographic distribution to estimate savings in the Valley from 2006-2009. We also referenced program cycle evaluation reports available from the California Public Utilities Commission.[142]

EMPLOYMENT RESULTS

Between 2006 and 2015, the investor-owned utilities saved 12,300 annual GWh throughout their service area.[143] The total annual electricity savings, by sector, in the Valley from investor-owned utility programs between 2006-2015 are shown in Table 29.

We estimate that from 2006-2015, 6,660 direct job years and 10,730 indirect and induced job years were created in the Valley, for a total of 17,390. We estimate that the total ratepayer and private investment in energy efficiency projects achieved in the San Joaquin Valley between 2006-2015 was $1.4 billion. This is based on the total cost of saved energy estimates.[144]

Over the past 10 years, the investor-owned utility efficiency programs have saved San Joaquin Valley businesses and residents 1691 annual GWh. Given average effective useful lives, this will save the region about 20,500 GWh in total.

POTENTIAL ECONOMIC IMPACTS OF ENERGY EFFICIENCY INVESTMENTS THROUGH 2030

Generally, economists consider energy efficiency investments to be among the most cost-effective carbon-saving measures at our disposal. This effectiveness is due to the relatively quick payback from these investments, as up-front investments in more efficient technologies result in reduced utility bill payments. For ratepayers, the reduced energy usage can translate to less need for utility investment in new energy generation assets, with those avoided costs accruing to ratepayers. As long as these avoided costs continue to exceed up-front costs, efficiency efforts will continue to provide positive economic benefits in the Valley and throughout California. Factors that would influence future impacts include:

- Amount of energy use reduction achieved by the efficiency investments and the extent to which those savings will be re-spent in the local economy (with corresponding attention to the differential in multipliers between money spent on energy bills and money spent in the local economy);
- Number and quality of jobs created in the Valley from energy efficiency investments
- Amount of outside, capital market investment that could flow to the Valley for efficiency investments, particularly based on SB 350's directive to encourage more pay-for-performance energy efficiency finance;
- IOU and POU efficiency programs serving Valley customers and the pay and benefits associated with those jobs, which effect economic multiplier impacts;
- Potential public health benefits associated with decreased emissions from Valley generation assets.

Estimating the potential energy efficiency savings in the Valley through 2030 with precision requires additional information and analysis, particularly as California's energy agencies are still determining how to implement SB 350 and what target savings are needed by 2030 to achieve the law's goals. If the rate of annual energy savings from efficiency projects in the Valley were to remain constant through 2030, the Valley would continue to see job and economic benefits. A doubling of energy efficiency in the Valley would presumably increase these benefits, particularly if investments from outside the Valley increase.

JOB QUALITY

When evaluating regional costs and benefits of climate policy, it is important to consider not only job numbers, but the quality of those jobs. As climate policy leads to shifts in spending, there could be a negative impact on employment in carbon-intensive industries and a positive impact on employment in low-carbon industries. It is important to consider the job quality implications of these direct employment impacts and to design policy to reduce the loss and increase the creation of good-paying jobs. This is particularly important for climate policy because in general, the carbon-intensive industries have higher average wages and benefits than emerging "green" industries, like rooftop solar.

In addition, broadening access to career-track jobs for workers from disadvantaged communities is a critical policy and political concern. The most common form of successful initiatives to increase access to good career track jobs for workers from disadvantaged communities are project labor agreements which include local or targeted hire provisions, commonly known as community workforce agreements (CWAs).[145] Such interventions are dependent on the engagement of contractors whose workers participate in the state-certified apprenticeship system, which provides specific hiring mechanisms and a defined job ladder, so workers move up the pay scale as they develop skills. In the low-carbon industries, this approach is being promoted in the manufacturing sector via procurement policies for rail and transit capital equipment.[146]

Cap and Trade Employment

Due to the large investment in high-speed rail and other construction activities, the construction industry stands to gain the most from California's cap-and-trade policy. When construction activities are funded by state public money, the work is governed by the state's prevailing wage law which covers blue collar construction jobs.[147] California's prevailing wage laws ensure that the ability to get a public works contract is not based on paying lower wage rates than a competitor and that public investment does not lead to downward pressure on area construction wages. California public labor code also requires that a minimum specified share of the workers be apprentices enrolled in state-certified apprenticeship programs. This system ensures that the public works construction jobs resulting from cap and trade will provide family-supporting pay and benefits to workers. The apprenticeship requirement ensures that a future generation of skilled construction workers will receive training hours on these projects.

In general, the negative effects of cap and trade are contained to a small number of industries, whereas the benefits are more widespread throughout the regional economy. Still, the quality of the jobs in these industries should be considered. In general, jobs associated with fossil fuel extraction, refining, and power generation have higher wages and benefits. If they decline in number, their loss will inflict hardship for the workers and their families. Overall, there is a significant net gain in jobs due to cap and trade, and continued investment in communities of state revenue from the public auction will help ensure that many of the jobs created are good family-supporting jobs.

Renewable Energy Employment

Because most of the large-scale renewable energy projects were built under negotiated Project Labor Agreements (PLAs), the blue-collar construction jobs compensated workers with union-scale (often equal to the prevailing wage) wages and benefits.[148] To estimate these benefits for the Valley, we assume that all of the projects greater than one megawatt and only the public projects (community colleges, universities, municipalities, etc.) were built under PLAs. A recent paper exploring the job quality of these blue-collar renewable construction jobs reports that in addition to union-wages of almost $37 per hour, the value of benefits is more than $18 per hour.[149]

These benefits include comprehensive training through state-certified apprenticeship programs for entry-level workers. Registered apprenticeship training includes several years (varies by trade) of classroom and paid on-the-job training. Using the same methodology, we estimate that renewables projects in the Valley were responsible for the graduation to journey status of 360 apprentices between 2002-15, as shown in Table 31. The robust apprenticeship training increases lifetime earnings of workers, as they advance in their careers as union journey workers[150] This is significant in a region with higher rates of poverty and lower median income than the state average.

Table 32 shows the value of worker benefits from these renewable projects built in the Valley. These Valley projects have helped fund $13.5 million in apprenticeship training, pension contributions totaling $98 million to workers in the Valley, and health insurance contributions totaling $115 million for workers and their families.

TABLE 31 Estimated graduated apprentices from renewable energy construction projects in the San Joaquin Valley, 2002-15

Projects	Blue-collar construction job-years	Apprentices	Apprentice job-years	Years to complete apprenticeship	Number of apprentices in training	Number who graduate
Solar PV (1 MW)	172	9%*	15	4.5	3	2
Solar PV (>1 MW)	5,805	33%	1,916	4.5	426	298
Wind, Biomass, Hydro, and Solar Thermal	1,463	20%	293	3.5	84	59
TOTAL	**7,440**		**2,224**		**513**	**359**

**28 percent of the solar PV projects under 1 MW were on public facilities, so we are assuming those jobs utilized union labor and apprentices.*

TABLE 32 Estimated contributions to benefits of renewable energy projects in the San Joaquin Valley, 2002-15

Projects	Union job hours (2080 hours per job-year)	Training contribution (2015 dollars)	Pension contribution (2015 dollars)	Health insurance contributions (2015 dollars)
Solar PV	12,174,000	$10,780,000	$78,442,000	$92,328,000
Wind	2,264,000	$1,997,000	$14,530,000	$17,103,000
Biomass, Hydro, and Solar Thermal	779,000	$687,000	$4,998,000	$5,884,000
TOTAL	15,217,000	$13,464,000	$97,970,000	$115,315,000

Energy Efficiency Employment

The state's energy efficiency programs also support significant employment gains in the construction sector. Two-thirds of energy efficiency jobs are in construction activities.[151] For the energy efficiency sector, there is very little specific information on wages and benefits for workers engaged on retrofit projects, as government construction industry data does not differentiate energy efficiency work, and in general, energy efficiency programs do not track job quality. Energy Efficiency investments in the public sector, including IOU funded programs, Prop. 39 programs and others, are subject to prevailing wage laws and apprenticeship standards, ensuring the creation of career-track jobs. We expect that residential energy efficiency in the SJV has similar conditions as other residential construction, which tends to have low wages and some underground economy characteristics.[152]

Currently, there are no labor standards governing the investment of ratepayer energy efficiency funds. The CPUC charged the IOUs with considering appropriate labor standards for the energy efficiency programs, and in 2013, it hired the UC Berkeley Donald Vial Center (also a co-author of this report) as an expert entity to provide recommendations for improving workforce outcomes in the energy efficiency programs.[153] In considering the most likely costs and benefits of a wide range of labor standards, a series of practical recommendations that would improve both workforce and efficiency outcomes were provided to the IOUs.[154]

There remains significant opportunity to improve job quality in California's energy efficiency efforts. Consolidating program revenue to address key sectors, such as the municipal, university, school, and hospital sector would help, as would a responsible contractor policy, required by SB350 (deLeon, 2015) to ensure that companies participating in this work meet basic criteria in regards to labor law compliance and workforce skill.

As the energy savings opportunities require more advanced knowledge of building systems and how systems interact, a higher skill requirement could help ensure California is on track to double the efficiency of buildings by 2030.

CONCLUSION AND RECOMMENDATIONS

The Valley is a microcosm of California's climate opportunities and challenges. The cap-and-trade program is young, but the economic impact from its first three years is promising for the Valley. The region has undoubtedly benefitted from California's renewables portfolio standard. The net impact of the energy efficiency programs is also positive, yet there is potential for greater benefits from future efficiency investments in the region. California's primary climate laws and policies have created well-paying jobs in construction and other sectors, particularly in the San Joaquin Valley, and the ripple effects of these jobs are significant.

While these data and their underlying trends are complex, they are relatively straightforward to analyze. Far less easy to measure or diagnose, either for academic analysts or state policymakers, are the region's deep vulnerabilities, which reflect and amplify those of California as a whole.

High rates of concentrated poverty, energy and housing affordability affect people throughout the state, but more so in the San Joaquin Valley. In addition, greenhouse gas and co-pollutant emissions disproportionately affect already vulnerable communities. Below are some specific recommendations to further improve the outcomes of California's climate policies in the San Joaquin Valley and beyond.

Remove uncertainty regarding key climate programs like cap and trade beyond 2020. Much of the uncertainty around the net economic and jobs impacts for the Valley from the state's cap-and-trade program stems from policy indecision related to the program's status beyond 2020, particularly the auction mechanism for distributing allowances. State leaders can address the key factors that underlie the uncertainty by resolving the question of cap-and-trade's continued existence beyond 2020, as the California Air Resources Board has recently proposed. Should the state wish to continue the program, the legislature should consider codifying these goals with a two-thirds majority to avoid Proposition 26 challenges to the use of the auction. Otherwise, while the California Air Resources Board may be able to continue the current program via existing statutory authority or a majority legislative vote, these options will likely entail years of litigation and uncertainty. A two-thirds approval would remove that uncertainty immediately. In addition, should the program continue beyond 2020, the state should ensure that auction proceeds are disbursed in a timely and predictable manner to benefit regions like the Valley that are most harmed from climate impacts and to help offset the costs of compliance.

Ensure cap-and-trade auction proceeds are spent on Valley programs that further greenhouse gas reduction benefits and reduce co-pollutants, particularly in environmental justice communities. Should the program continue beyond 2020, state leaders should focus these dollars on infrastructure or construction projects that support the state's climate goals. Policy makers should also ensure that cap-and-trade compliance does not exacerbate pollution problems in disadvantaged communities, as per SB 535 (de Leon), governing auction proceeds spending, by allowing pollution "hot spots" in poor communities around facilities that purchase allowances to avoid reducing emissions. In addition, as discussed above, the state should ensure that the money is disbursed in a predictable and timely fashion, to minimize the lag between collection of the funds and disbursement.

Improve the economic and job benefits of renewable energy and energy efficiency projects by maximizing the creation of local and career-track jobs. To the extent that policy makers want to ensure that the clean energy jobs discussed in this report are well-paying and high-quality, they could consider developing labor standards that could apply to public and ratepayer investments in low-carbon sectors for renewable energy, energy efficiency, and other low-carbon construction projects. There is a large and highly-skilled construction workforce in California that can help drive implementation of many of the state's climate policies and programs.

Expand energy efficiency incentives in the Valley where per capita energy use is higher than average in cooler coastal areas. Given the Valley's greater energy consumption due to its warmer climate, the state should ensure that utilities direct a proportional amount of energy efficiency incentive programs to this region to help ensure greater cost-effectiveness of these funds and increase economic benefits in the region. EE programs could also prioritize facilities based on both their efficiency potential and their location in disadvantaged communities.

Develop job training and transition programs for workers and communities affected by the decline of the Valley's greenhouse gas-emitting industries. State leaders should identify a lead state agency and a funding source to address transition issues for workers and communities potentially impacted by industrial decline due to climate policy, such as the oil and gas extraction and refining industries. They should initiate a planning process that analyzes risks of industry decline and involves both labor and disadvantaged communities in planning workforce transition strategies, assistance to workers and communities, and environmental cleanup of fossil fuel industries.

While this report has focused on the key climate programs related to cap and trade, renewable energy, and energy efficiency, California leaders have developed a suite of other policy measures to meet AB 32 and 2030 greenhouse gas goals. For example, the low carbon fuels standard, vehicle electrification mandates and incentives, distributed renewable incentives such as net metering, and land use/housing policies related to SB 375 (Steinberg, 2008) will all play critical roles in achieving state's climate policy goals in a cost-effective – and potentially economically beneficial – manner. Future research should explore the economic impacts of these programs and offer more detailed assessments of how these programs interact to affect jobs and economic activity. In addition, these studies could focus on other regions of California and statewide.

Ultimately, given the huge economic needs and environmental challenges in the San Joaquin Valley, the state's existing policies and the ones recommended here could continue to provide important benefits for residents in the region. While some critics charge that the state's major climate programs are hurting the Valley more than helping, the data in this study suggest the opposite. The benefits are not uniform across all sectors, however, and the state should provide job transition support for the fossil fuel industries and other workers that are hurt by these policies. Nonetheless, policy leaders should continue the positive momentum generated to date for the Valley's economy and environment by considering enhancements to existing policies and adopting these additional ones. If they do so, California's efforts to reduce emissions and grow a cleaner economy will benefit not only the state's most at-risk region, but the state as a unified whole.

APPENDIX A: CALIFORNIA COUNTIES BY REGION

Region	Counties		
Central Coast	MONTEREY	SAN LUIS OBISPO	SANTA CRUZ
	SAN BENITO	SANTA BARBARA	VENTURA
Desert	IMPERIAL	SAN BERNARDINO	SAN DIEGO
North Coast	HUMBOLDT	MENDOCINO	SONOMA
	LAKE	SISKIYOU	TRINITY
Sacramento Valley	BUTTE	SACRAMENTO	TEHAMA
	COLUSA	SHASTA	YOLO
	GLENN	SUTTER	YUBA
San Francisco Bay	ALAMEDA	NAPA	SANTA CLARA
	CONTRA COSTA	SAN FRANCISCO	SOLANO
	MARIN	SAN MATEO	
Sierra Nevada	ALPINE	LASSEN	PLUMAS
	AMADOR	MARIPOSA	SIERRA
	CALAVERAS	MONO	TUOLUMNE
	EL DORADO	NEVADA	
	INYO	PLACER	
San Joaquin Valley	FRESNO	MADERA	STANISLAUS
	KERN	MERCED	TULARE
	KINGS	SAN JOAQUIN	
Los Angeles Region	LOS ANGELES	ORANGE	RIVERSIDE

ENDNOTES

1. In 2015, a group of centrist Democrats led by Assemblymember Henry Perea of Fresno forced the removal of transport fuels reduction measures from SB 350 (de Leon), the landmark climate bill, claiming they would damage the region's economy. In 2016, members of the centrist caucus, now co-chaired by Assemblymember Rudy Salas of Bakersfield, played pivotal roles in the debate over another major climate bill, SB 32 (Pavley), reprising the same fears that it will cost jobs. *See* Fresno Bee, "Moderate Democrats are right to press for better California clean-energy plan," August 27, 2015. Available at: http://www.fresnobee.com/opinion/editorials/article32574789.html (accessed August 30, 2016); Sacramento Bee, "How Long Will This Blue State Let Oil Remain King?" September11, 2015. Available at: http://www.sacbee.com/opinion/editorials/article34948194.html (accessed August 30, 2016); Sacramento Bee, "How Oil Won the Battle for SB 350, September 12, 2015. Available at: http://www.sacbee.com/opinion/opn-columns-blogs/dan-morain/article34976295.html (accessed August 30, 2016); Fresno Bee,"Climate retreat? Legislature may ditch plan to radically reduce emissions," August 9, 2016. Available at: http://www.fresnobee.com/news/politics-government/politics-columns-blogs/political-notebook/article94618592.html (accessed August 30. 2016); Los Angeles Times, "Business-friendly Democrats pick new leaders for informal, but powerful Sacramento caucus," December 9, 2015. Available at: http://www.latimes.com/politics/la-pol-sac-moderate-democrats-leaders-20151209-story.html (accessed August 30, 2016).
2. In this context, a "job" is a "job-year," which is a full-time equivalent position for one year. One job-year equals 2080 work hours.
3. David Roland-Holst et al., "Senate Bill 350 Study: The Impacts of a Regional ISE-Operated Power Market on California, Volume VIII, Economic Impact Analysis," July 8, 2016. Available at: https://www.caiso.com/Documents/SB-350Study-Volume 8 Economic Impacts.pdf (accessed August 29, 2016).
4. U.S. Department of Energy, "Energy Incentive Programs, California," March 2015. Available at: http://energy.gov/eere/femp/energy-incentive-programs-california (accessed August 30, 2016).
5. California Assembly Bill 32 (Nuñez, Chapter 488, Statutes of 2006). Available at: http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.html (accessed August 30, 2016).
6. California Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016). Available at: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32 (accessed August 30, 2016).
7. California Senate Bill 350 (De Leon, Chapter 547, Statutes of 2015). Available at: http://www.leginfo.ca.gov/pub/15-16/bill/sen/sb_0301-0350/sb_350_bill_20151007_chaptered.pdf (accessed August 30, 2016).
8. California Partnership for the San Joaquin Valley, "2015 Annual Report," November 2015. Available at: http://sjvpartnership.org/wp-content/uploads/2015/11/2015_PartnershipAnnualReport_post.pdf (accessed August 30, 2016).
9. Data Source: U.S. Census Bureau, "Quick Facts California." Available at: https://www.census.gov/quickfacts/table/PST045215/06 (2015 data) (accessed August 30, 2016).
10. Id
11. Id
12. Author's analysis based on data source: Fisher, Sheehan & Colton, "Home Energy Affordability Gap: Current Year Affordability Gap Data." Available at: http://www.homeenergyaffordabilitygap.com/03a_affordabilityData.html, 2015 data (accessed August 30, 2016).
13. Id
14. U.S. Census Bureau, "Quick Facts: California." Available at: https://www.census.gov/quickfacts/table/PST045215/06 (2015 data) (accessed August 30, 2016).
15. Ibid (2012 data).
16. California Energy Commission, "Second California Climate Change Assessment 2010." Available at: http://climatechange.ca.gov/climate_action_team/reports/second_assessment.html (accessed August 30, 2016).
17. U.S. Department of the Interior, Bureau of Reclamation, "Reclamation: Managing Water in the West. West-Wide Climate Risk Assessment: Sacramento and San Joaquin Basins, Climate Impact Assessment. Available at: http://www.usbr.gov/watersmart/wcra/docs/ssjbia/ssjbia.pdf (accessed December 5, 2016).
18. California Air Resources Board, "California Greenhouse Gas Emission Inventory – 2016 Edition." Available at: https://www.arb.ca.gov/cc/inventory/data/data.htm (accessed December 5, 2016).
19. *See* California Air Resources Board, "Scoping Plan – Agriculture Sector" webpage. Available at: http://www.arb.ca.gov/cc/scopingplan/agriculture-sp/agriculture-sp.htm (accessed August 30, 2016).
20. California Air Resources Board, "Revised Proposed Short-Lived Climate Pollutant Reduction Strategy" November 2016. Available at: https://www.arb.ca.gov/cc/shortlived/meetings/11282016/revisedproposedslcp.pdf (accessed December 5, 2016)
21. Cal. Code Regs. tit. 17, §§ 95800-96023.

22. California Air Resources Board, "Standardized Regulatory impact Assessment (SRIA) Proposed Amendments to the Cap-and-Trade Regulation," April 1, 2016, p. 1. Available at: http://www.dof.ca.gov/Forecasting/Economics/Major_Regulations/Major_Regulations_Table/documents/ARB_Cap-and-Trade_SRIA_2016_Final.pdf (accessed July 20, 2016).
23. Id.
24. Offsets can be used for up to eight percent of an entity's emissions.
25. California Air Resources Board, "California Climate Investments 2016 Annual Report," March 2016, p.13. Available at: http://arb.ca.gov/cc/capandtrade/auctionproceeds/cci_annual_report_2016_final.pdf (accessed July 21, 2016).
26. Senate Bill 1018 (Chapter 39, Statutes of 2012) and the California Public Utilities Commission (CPUC) together require IOUs to return nearly all of the resulting proceeds to their industrial, small business, and residential customers. See California Public Utilities Commission, "Decision Adopting Cap-and-Trade Greenhouse Gas Allowance Revenue Allocation Methodology for the Investor-Owned Electric Utilities, Decision 12-12-033, December 20, 2012. Available at: http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M040/K631/40631611.PDF (accessed August 29, 2016).
27. California Assembly Bill 1532 (Perez, Chapter 807, Statutes of 2012), California Senate Bill 535 (De Leon, Chapter 830, Statutes of 2012), California Senate Bill 1018 (Budget and Fiscal Review Committee, Chapter 39, Statutes of 2012), California Assembly Bill 1550 (Gomez, Chapter 369, Statutes of 2016) and California Assembly Bill 2722 (Burke, Chapter 371 Statutes of 2016).
28. Senate Bill 862 (Budget and Fiscal Review Committee, Chapter 36, Statutes of 2014).
29. Next 10, "California Green Innovation Index," June 29, 2016, p. 24. Available at: http://next10.org/2016-gii (accessed July 20, 2016).
30. California Air Resources Board, "2016 Annual Report, Cap-and-Trade Auction Proceeds," March 2016, p. 1. Available at: http://arb.ca.gov/cc/capandtrade/auctionproceeds/cci_annual_report_2016_final.pdf (accessed July 20, 2016).
31. *California Chamber of Commerce v. Cal. Air Res. Bd.*, No. 34-2012-80001313, 2014 WL 5462661 (Cal. App. 3d Dist.).
32. California Constitution, article XIIIA.
33. *See* Deborah Lambe and Daniel Farber, "California's Cap-and-Trade Auction Proceeds: Taxes, Fees, or Something Else?" Next 10/Berkeley Law, May 2012. Available at: http://next10.org/sites/next10.org/files/Auction%20Proceeds%20Analysis%20May_15.pdf (accessed July 21, 2016).
34. *See* Legislative Counsel Bureau, "Letter from Diane F. Boyer-Vine, Legislative Counsel to Honorable Jean Fuller," April 19, 2016, p.8. *See also* Cara Horowitz, "California's Cap-and-Trade Program After 2020," Legal Planet Blog, UCLA Law. Available at: http://legal-planet.org/2016/07/22/californias-cap-and-trade-program-after-2020/ (accessed July 22, 2016)
35. While Proposition 13 failed to define "tax," Proposition 26 provided a broad new definition that includes any levy, charge, or exaction of any kind imposed by the State. See, Cal. Const. art XIIIA §3(b).
36. Andy Coghlan, and Danny Cullenward, "State Constitutional Limitations on the Future of California's Carbon Market, Working Paper," May 2016, pp. 30-44. Corresponding author: dcullenward@carnegiescience.edu.
37. Id. at 12-13. Summarized, the five exceptions are (1) a charge imposed for a specific benefit, (2) a charge imposed for a specific government service or product provided directly to the payor, (3) a charge imposed for reasonable regulatory costs to the State incident to issuing licenses and permits, performing investigations etc., (4) a charge imposed for entrance to or use of state property, and (5) a fine, penalty or other monetary charge imposed by the judicial branch of government or the State, as a result of a violation of law. See Cal. Const. art. XIIIA §§ 3(b)(1)-(5).
38. Id. at 35. Recent case law involving a $.10 fee imposed by local government on plastic bags indicates that proceeds remitted to a non-governmental entity might not be considered a tax, and thus "…suggests a way around Proposition 26, but its reach is uncertain." In short, the logic of that case "offers a clear pathway for extending the existing cap-and-trade market, but its practical application to multi-billion dollar programs is untested."
39. California Air Resources Board, "2030 Target Scoping Plan Concept Paper," June 17, 2016, pp. 26-27. Available at: http://www.arb.ca.gov/cc/scopingplan/scopingplan.htm (accessed July 20, 2016).
40. California Air Resources Board, "Preliminary Draft Proposed Regulation Order and Staff Report," July 12, 2016. Available at: http://www.arb.ca.gov/cc/capandtrade/draft-ct-reg_071216.pdf (accessed July 22, 2016).
41. California Assembly Bill 197 (Garcia, Chapter 250, Statutes of 2016).
42. California Air Resources Board, "Facility GHG Emissions Visualization and Analysis Tool." Available at: https://www.arb.ca.gov/ei/tools/ghg_visualization/ (accessed December 6, 2016)
43. While some verified offset projects are registered in the Valley, these offsets were not used for compliance in the 2013-15 period.

44. Entities emitting 25,000 or more metric tons of CO2e must comply with the Cap. See, Cal. Code Regs. tit. 17, § 95812 (c) and California Air Resources Board, "Overview of ARB Emissions Trading Program," February 9, 2015. Available at: http://www.arb.ca.gov/cc/capandtrade/guidance/cap_trade_overview.pdf (accessed August 29, 2016).

45. IMPLAN (IMpact analysis for PLANning) was originally developed by the U.S. Department of Agriculture to assist the Forest Service with land and resource management planning. The Minnesota IMPLAN Group (MIG) started work on the data-driven model in the mid-1980s at the University of Minnesota. The software was privatized in 1993 and made available for public use. The software contains an input-output model with data available at the zip code, county, state, and national levels. IMPLAN also reports useful information on the economy of the region analyzed. See IMPLAN. Accessed at: http://www.implan.com/.

46. California Air Resources Board, "Standardized Regulatory Impact Assessment (SRIA) Proposed Amendments to the Cap-and-Trade Regulation," April 1, 2016. Available at http://www.dof.ca.gov/Forecasting/Economics/Major_Regulations/Major_Regulations_Table/documents/ARB Cap-and-Trade_SRIA_2016_Final.pdf (accessed July 19, 2016).

47. California Energy Commission, "Estimated 2016 Gasoline Price Breakdown & Margin Details." Available at: http://energyalmanac.ca.gov/gasoline/margins/index.php (accessed July 29, 2016).

48. California Air Resources Board, "Mandatory GHG Reporting - Reported Emissions," updated December 4, 2014, p.1. Available at: http://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/ghg-reports.htm (accessed July 31, 2016).

49. See California Air Resources Board, "Mandatory GHG Reporting - Reported Emissions," updated December 4, 2014. Available at: http://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/ghg-reports.htm (accessed July 31, 2016).

50. Author's analysis of California Air Resources Board Public Data on Allowance Allocation. Available at: https://www.arb.ca.gov/cc/capandtrade/allowanceallocation/publicallocation.htm (accessed September 30, 2016).

51. California Air Resources Board, "Archived Auction Information and Results." Available at: https://www.arb.ca.gov/cc/capandtrade/auction/auction_archive.htm. (accessed December 7, 2016)

52. California Air Resources Board, "Compliance Instrument Report." Available at: https://www.arb.ca.gov/cc/capandtrade/complianceinstrumentreport.xlsx (accessed December 7, 2016).

53. Data on the allocation of free allowances was obtained from California Air Resources Board, "Allowance Allocation," last reviewed February 29, 2016. Available at: http://www.arb.ca.gov/cc/capandtrade/allowanceallocation/allowanceallocation.htm (accessed July 29, 2016).

54. *See* California Air Resources Board, "Mandatory GHG Reporting - Reported Emissions," updated December 4, 2014. Available at: http://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/ghg-reports.htm (accessed July 31, 2016).

55. Author's analysis of California Air Resources Board Public Data on Allowance Allocation. Available at: https://www.arb.ca.gov/cc/capandtrade/allowanceallocation/publicallocation.htm (accessed September 30, 2016).

56. California Air Resources Board, Publicly Available Market Data: Compliance Reports and Market Transfer Summary Table. Available at: https://www.arb.ca.gov/cc/capandtrade/capandtrade.htm (accessed December 16, 2016)

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58. California Air Resources Board. Auction Results. Available at: http://www.arb.ca.gov/cc/capandtrade/auction/results_summary.pdf (accessed September 2, 2016)

59. *See* California Air Resources Board, "Mandatory GHG Reporting - Reported Emissions," updated December 4, 2014. Available at: http://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/ghg-reports.htm (accessed July 31, 2016).

60. Due to modeling constraints, compliance costs over the 2013-2015 period were condensed into a single year (2014), so that they could be evaluated relative to overall costs of producing these products in the Valley in a single year 2014. This is based on the assumption that overall costs for 2013 and 2015 are similar to the reported value of production reported in IMPLAN for 2014.

61. Values derived from 2013, 2014, and 2015 data from IMPLAN for the 8-county San Joaquin Valley Region

62. *See* Keibun Mori, "Washington State Carbon Tax Fiscal and Environmental Impacts," Evans School of Public Affairs, University of Washington, July 2011. Available at http://www.sightline.org/research_item/washington-state-carbon-tax/ (accessed July 29, 2016) and James Hamilton, National Bureau of Economic Research, "Understanding Crude Oil Prices," NBER Working Paper No. 14492, Issued in November 2008. Available at: http://www.nber.org/papers/w14492 (accessed July 29, 2016).

63. California Air Resources Board, "Standardized Regulatory Impact Assessment (SRIA) Proposed Amendments to the Cap-and-Trade Regulation," p. 15. Available at: http://www.dof.ca.gov/Forecasting/Economics/Major_Regulations/Major_Regulations_Table/documents/ARB_Cap-and-Trade_SRIA_2016_Final.pdf (accessed July 19, 2016).

64. As the price of refined petroleum increases in the San Joaquin Valley, consumers spend more on gasoline, but less on other goods and services in the region. While this price change alters spending in the region, it does not alter the flow of spending in and out of the Valley.

65. According to IMPLAN data for the eight-county region, total demand (by local and nonlocal consumers) for refined petroleum was $26.6 billion in 2013-15. IMPLAN provides information regarding the local supply of a commodity that is used to meet local demand (the regional supply coefficient). This coefficient for the refining and distribution of refined gasoline is 45.9 percent. This means that in 2013-15, demand by consumers in the Valley represented about $12.2 billion of the total demand of $26.6 billion. This implies that nonlocal demand was equal to about $14.4 billion in over that period. If demand decreases by 0.83 percent because of compliance costs, nonlocal demand will decrease by approximately $120 million from 2013-15. The information used to obtain these figures can be found in the IMPLAN Study Area Date, Industry Accounts, and Social Accounts. This method was also applied to oil and gas extraction and fossil fuel electric power generation industries to derive the decreases in nonlocal demand reported in Table 11.

66. The widely accepted rule of thumb is that cap-and-trade increased gasoline prices by 10 cents per gallon and diesel prices by 13 cents per gallon.

67. Based on yearly averages of weekly prices in California. See California Energy Commission, "Energy Almanac." Available at: http://energyalmanac.ca.gov/gasoline/retail_gasoline_prices.html. (accessed August 29, 2016).

68. Prices given are for the OPEC Reference Basket. See Statistics, The Statistics Portal, "Average Annual OPEC Crude Oil Price from 1960 to 2016." Available at: http://www.statista.com/statistics/262858/change-in-opec-crude-oil-prices-since-1960/ (accessed July 29, 2016).

69. California Energy Commission, "Estimated 2016 Gasoline Price Breakdown & Margin Details." Available at: http://energyalmanac.ca.gov/gasoline/margins/index.php (accessed July 29, 2016).

70. *See* California Air Resources Board, "Cap-and-Trade Auction Proceeds, 2016 Annual Report, California Climate Investments," March 2016. Available at: http://arb.ca.gov/cc/capandtrade/auctionproceeds/cci_annual_report_2016_final.pdf (accessed July 29, 2016).

71. California Air Resources Board, "2015 County and Legislative District List of Implemented GGRF Projects," Spreadsheet Published on May 9, 2016. Available at: http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/ggrf_project_list_for_2016_annual_report.xlsx (accessed August 29,2016).

72. Id.

73. Betony Jones email: betony.jones@gmail.com or Kevin Duncan email: kcdeconomics@gmail.com phone: 719-359-3271

74. *See* California Legislative Analyst's Office, "Review of High-Speed Rail Draft 2016 Business Plan," March 17, 2016, p.4. Available at: http://www.lao.ca.gov/Publications/Report/3394 (accessed July 29, 2016).

75. "High-Speed Rail Money Risks Come Under Assembly Scrutiny," Fresno Bee, March 28, 2016. Available at: http://www.fresnobee.com/news/local/high-speed-rail/article68731742.html (accessed August 29, 2016). According to the California Air Resources Board's 2016 regional report, high speed rail work within the San Joaquin Valley in 2012-2015 comprised $259 million of a total of $912 million, or 28.4 percent of total implemented cap-and-trade auction funds. *See* California Air Resources Board, "California Climate Investments: 2015 Implemented GGRF Projects by Region, Metropolitan Planning Organization, County, and Legislative District," California Air Resources Board, May 27, 2016. Available at: http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/2016_cci_geographic_breakdown.pdf (accessed August 29, 2016).

76. The Valley may have difficulty maintaining its current percentage or a representative share of total funds awarded for the following reasons: Transition of high speed rail work to portions of the route outside the San Joaquin Valley, lack of local capacity to apply for funds, insufficient inventory of prospective projects, and difficulty competing about well-resourced areas of the state able to leverage more funds.

77. Office of the Governor Edmund G. Brown, "Governor Brown, Legislative Leaders Announce Cap-and-trade Expenditure Plan Agreement," August 31, 2016. Available at: https://www.gov.ca.gov/news.php?id=19515 (accessed September 30, 2016).

78. Specifics on the geographical distribution of funding under the new expenditure plan are not currently available. General information suggests that the share of spending on the purchase of clean vehicles and fleet modernization will increase to over 40% of the total allocation. Also, spending on ecosystem restoration represents about 16%. We expect the changes in spending priorities at the state level to influence the allocation of funding in the San Joaquin Valley.

79. This analysis is based on IMPLAN's regional purchase coefficient set at the social accounting matrix model value to allow for leakage of spending out of the study area. This contributes to a more conservative economic impact.

80. The High Speed Rail Authority reports that as of Fiscal Year 2016-17, $959 million of Cap-and-trade Revenue has been appropriated for construction activities, and $291 million has been appropriated for Project Development. To date, $59 million has been spent on project development and $140 million has been spent on construction. Activities are taking place throughout California. Source: http://www.hsr.ca.gov/docs/brdmeetings/2016/brdmtg_091316_FA_Capital_Outlay_Budget_Summary.pdf (accessed October 3, 2016).
81. Based on output per worker data for railroad construction in California available from the Economic Census of Construction. See U.S. Census Bureau, "Construction: Geographic Area Series: Detailed Statistics for the State: 2012 Economic Census of the United States," Table EC1223A1. Available at: http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ECN_2012_US_23A1&prodType=table (accessed July 29, 2016).
82. Tax impacts are based on direct, induced, and indirect spending and include taxes on households, production, and corporations. Since this impact is not a sustained activity, property tax estimates are not included.
83. Multipliers can be derived by dividing the economic impact figure by the direct effect, or $1.50 = $1,373 million / $907 million. Multipliers will be large or small depending on how much of the new spending stays in, or leaks out of the regional economy. Since construction tends to be a local activity, multipliers for this industry are relatively large. On the other hand, retail purchases, such as those created by incentives to buy clean vehicles, have relatively small multipliers since these vehicles are not produced in the region and the impact is based on the profit and transportation cost mark-ups (margins) of the retailers.
84. IMPLAN multipliers can be applied in this manner due to the underlying assumption of constant returns to scale in the input-output analysis.
85. *See* California High Speed Rail Authority, "Funding and Finance of High-Speed Rail." Available at: http://hsr.ca.gov/About/Funding_Finance/index.html (accessed July 29, 2016).
86. Scaling $907 million in direct spending and 2090 jobs by 1.1025 percent yields 2,304 jobs for each $ 1 billion in direct spending on high-speed rail construction.
87. This analysis is based on IMPLAN's regional purchase coefficient set at 100 percent to insure that the decrease in demand is not allowed to leak from the regional economy, but rather be experienced by the producers located in the eight-county region.
88. IMPLAN calculates the decrease in direct jobs associated with the decrease in demand and production.
89. The industry-specific spending multipliers for electric power generation (with fossil fuels), oil and natural gas extraction, and petroleum refining are 1.27, 1.23, and 1.39, respectively. The industry-specific employment multipliers for the eight-county region are 3.27, 2.41, and 11.56, respectively.
90. This information was obtained from the IMPLAN Model Overview for the combined eight-county region.
91. The overall economic impact reported by IMPLAN is a measure of total revenue generated by the impact. Total revenue is not the same as GDP as the former includes intermediate sales while the latter does not. The value added impact reported by IMPLAN is consistent with the definition of GDP. The net value added impact is approximately $139 million and is about 0.08 percent of regional GDP ($139 million / $165 billion).
92. California Air Resources Board, "Standardized Regulatory Impact Assessment (SRIA) Proposed Amendments to the Cap-and-Trade Regulation," April 1, 2016, p. 15. Available at: http://www.dof.ca.gov/Forecasting/Economics/Major_Regulations/Major_Regulations_Table/documents/ARB_Cap-and-Trade_SRIA_2016_Final.pdf (accessed July 20, 2016).
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94. *See* California Air Resource Board, "Appendix J: Allowances Allocation." Available at: http://www.arb.ca.gov/regact/2010/capandtrade10/capv4appj.pdf (accessed July 21, 2016).
95. *See* California Air Resources Board, "Annual Allocation to Electrical Distribution Utilities (EDU) under the Cap-and-Trade Regulation," February 5, 2015. Available at: http://www.arb.ca.gov/cc/capandtrade/allowanceallocation/edu-ng-allowancedistribution/electricity-allocation.pdf (accessed July 29, 2016).
96. The Valley may have difficulty maintaining its current percentage or a representative share of total funds awarded for the following reasons: capacity to apply for funds, insufficient inventory of prospective projects, difficulty competing about well-resourced areas of the state able to leverage more funds.

97. Ongoing litigation filed in 2014 challenges the use of cap-and-trade funds to support high-speed-rail. *See Transportation Solutions Defense and Education Fund v. California Air Resources Board,*(Fresno County Superior Court, Case No. 14ECG01788; parties stipulated to transfer to Sacramento Superior Court, Case No. 34-2014-8000-1974-CU-WM-GDS.) The case is a challenge under the California Environmental Protection Act (CEQA) and AB 32 to the California Air Resources Board's (CARB's) decision to include high-speed-rail in its AB 32 Scoping Plan Update and challenges the Legislature's appropriation of cap-and-trade proceeds to the high-speed-rail project. The suit alleges CARB failed to acknowledge and study greenhouse gas emissions associated with construction of the rail system when it included high-speed rail in a list of measures intended to reduce emissions in the Update. A hearing on the merits of the case is not expected until 2017.

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99. SB 1X-2 (Simitian, Chapter 1, Statutes of 2011).

100. California Energy Commission, "Tracking Progress-Renewable Energy," December 22, 2015, p.1. Available at http://www.energy.ca.gov/renewables/tracking_progress/documents/renewable (accessed July 20, 2016).

101. Id.

102. Id. at 4.

103. "California's regional electricity grid plan on hold," Los Angeles Times, August 8, 2016. Available at: www.latimes.com/politics/la-pol-sac-jerry-brown-regional-electricity-grid-20160808-snap-story.html (accessed August 29, 2016).

104. California Independent System Operator (CAISO), David Roland-Holst et al., "Senate Bill 350 Study: The Impacts of a Regional ISE-Operated Power Market on California, Volume VIII, Economic Impact Analysis," July 8, 2016. Available at: https://www.caiso.com/Documents/SB350Study-Volume8EconomicImpacts.pdf (accessed August 29, 2016).

105. Center for Law, Energy & the Environment (CLEE), Ethan Elkind et al., "A Path Forward: Identifying Least-Conflict Solar PV Development in California's San Joaquin Valley," May 2016, p. 2. Available at: https://www.law.berkeley.edu/wp-content/uploads/2016/05/A-PATH-FORWARD-May-2016.pdf (accessed August 18, 2016).

106. California Energy Commission, "2015 Annual Statewide Planning Net Short to Achieve 33 Percent by 2020," May 2016. Available at: http://www.energy.ca.gov/almanac/power_plant_data/Power_Plants.xlsx. (accessed April 15, 2016). We cross-checked this data withU.S. Energy Information Commission (EIA), "ELECTRICITY Form E1-A-860 detailed data." Available at: http://www.eia.gov/electricity/data/eia860/ (accessed April 21, 2016). We also cross-checked with the RPS calculator at California Public Utilities Commission, "RPS Calculator Home Page." Available at: http://www.cpuc.ca.gov/RPS_Calculator/ (accessed June 28, 2016). In both cases, we found only minor inconsistencies.

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108. In this context, a "job" is a "job-year," which is a full-time equivalent position for one year. One job-year equals 2080 work hours.

109. Taken from 2012 US Census Bureau Economic Census data for the power and communications construction industry.

110. Don Vial Center on Employment in the Green Economy, Betony Jones, Peter Philips and Carol Zabin, "The Link Between Good Jobs and a Low Carbon Future: Evidence from California's Renewable Portfolio Standard, 2002-2015," July 2016. Available at: http://laborcenter.berkeley.edu/pdf/2016/Link-Between-Good-Jobs-and-a-Low-Carbon-Future.pdf (accessed July 29, 2016).

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118. Cal. Code Regs. tit. 20, §§ 1601-1609.

119. Cal. Public Resources Code §§ 250000 et seq.; Cal. Code Regs. tit. 24. These regulations are mandated by the Warren-Alquist Act, codified at Cal. Public Resources Code §§ 25000 et seq.

120. California Consumer and Conservation Financing Authority, California Energy Resources Conservation and Development Commission, California Public Utilities Commission, "2003 Energy Action Plan." Available at: http://www.energy.ca.gov/energy_action_plan/2003-05-08_ACTION_PLAN.PDF (accessed July 29, 2016).

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