Jumpstarting California's Low Carbon Economy

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Keywords: climate change, climate policy, greenhouse gas, abatement, mitigation, feebate, cap-and-trade, market-based mechanisms

Figures

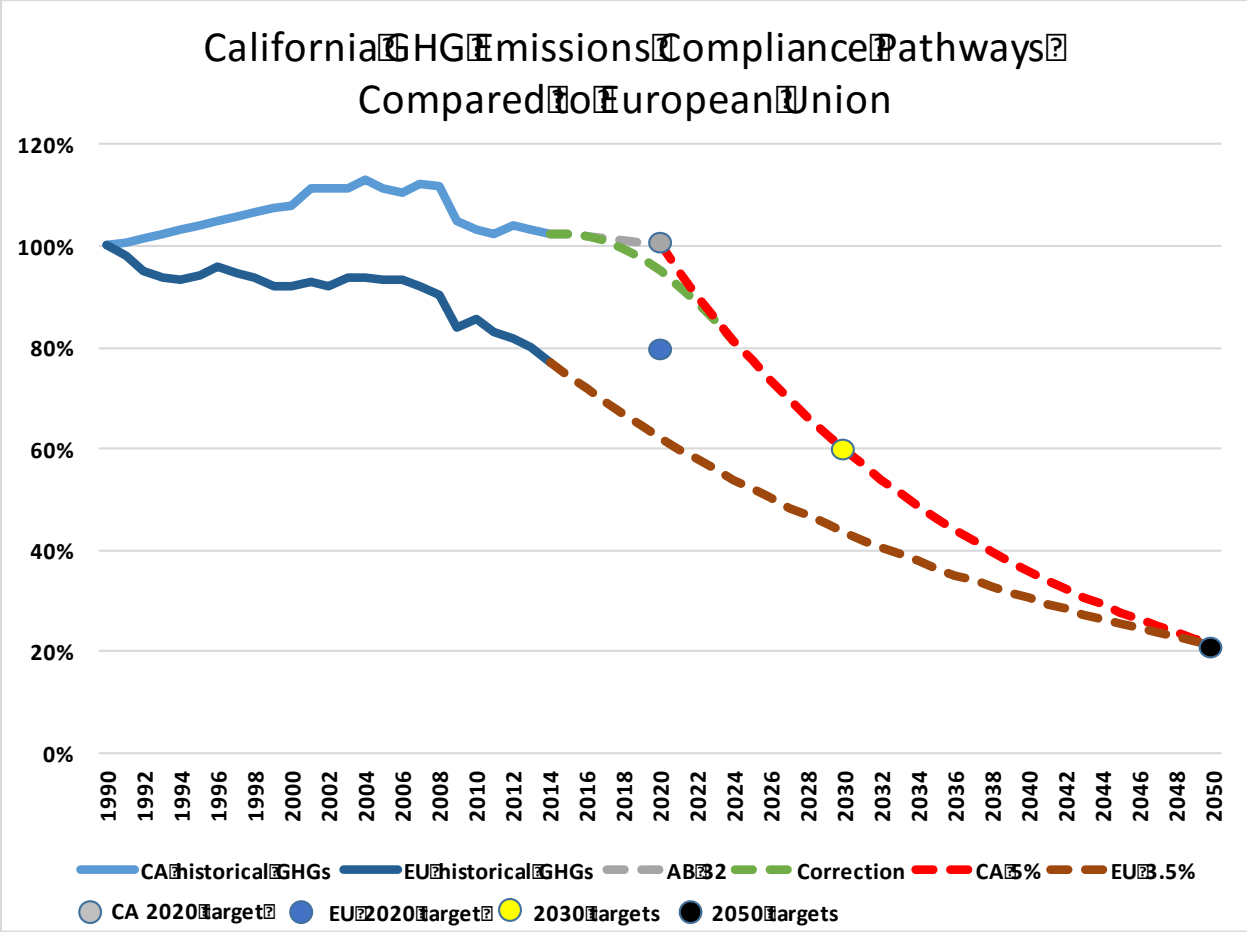

Figure 1. California GHG Emissions Compliance Pathways Compared to European Union. "CA historical GHGs" is the California GHG inventory in 1990, interpolated linearly through 2000, and from 2000 through 2014. "AB 32" assumes linear pathway to meeting 2020 target. "CA 5%" assumes 5% annual reduction starting in 2020 (meets 2030 & 2050 targets). "Correction" assumes gradual reductions starting in 2015 increasing by 0.5% per year until peak of 5% in 2025. "EU historical GHGs" is annual domestic GHG emissions from 28 European Union Countries. "EU 3.5%" assumes 3.5% annual reductions to meet the 2050 target.

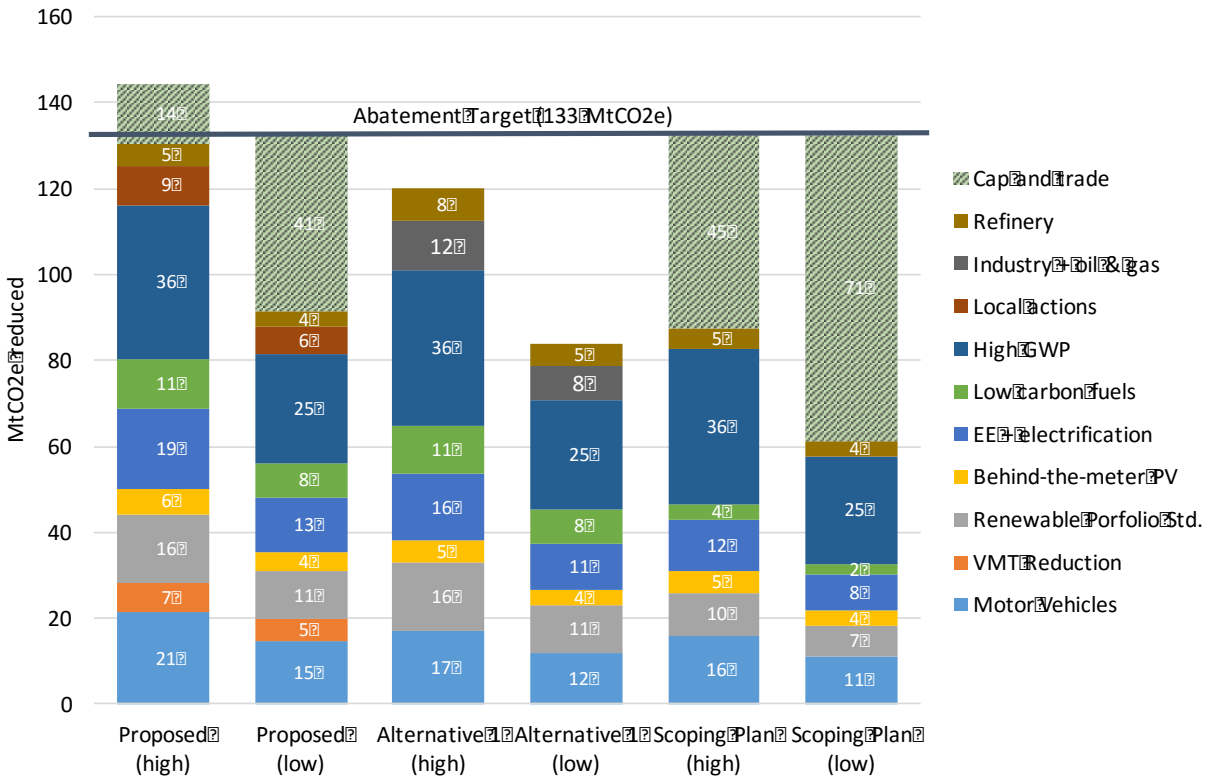

Figure 2. GHG abatement in 2030 under different policy scenarios. "Scoping Plan" and "Alternative 1" are scenarios developed by the California Air Resources Board. "Proposed" is a scenario developed for this paper. Low values are 70% of high values (bounding estimates).

California, the world's sixth largest economy, recently passed the world's most ambitious greenhouse gas (GHG) reduction targets: reach 1990 levels by 2020, and 40% below 1990 levels by 2030. While the state appears on course to meet the 2020 target, there are competing visions of how the 2030 target may be achieved. The California Air Resources Board (ARB), which is responsible for developing the state's climate policy, has released a draft strategy. ARB's primary proposal relies on already committed policies, additional policies on refineries, and extending the state's cap-and-trade system to cover 35% to 55% of additional needed abatement in 2030.

While cost-effective relative to direct regulation, there are challenges to fully implementing cap-and-trade at this pace and scale. An alternative, more costly strategy proposed by ARB that does not include cap-and-trade would nearly meet the target in direct abatement, but fall short if outcomes are not fully achieved. We propose a third strategy that includes cap-and-trade, and adds demand-side market mechanisms in five key areas to limit costs, increase abatement and reduce externalities of cap-and-trade. Regardless of the chosen path, California will serve as an important test bed for advanced economies seeking deep GHG reductions in short timeframes.

Option 1: Known commitments plus cap-and-trade and refinery reductions. ARB's "Scoping Plan" scenario (Figure 2) would achieve between 45% and 65% of needed abatement (62 - 88 $MtCO_2e$) through "complementary" regulatory policies, with cap-and-trade making up the difference (45 - 71 $MtCO_2e$)(*1*). Major policies include 35% reduction in GHG emissions from vehicles, increasing electric vehicles to 4.2M, 50% improvement in energy efficiency of buildings, producing 50% of electricity from renewable sources, increasing the biofuel content of transportation fuels to 18%, reducing emissions from refineries by 20%, and 40% reduction in high global warming potential (GWP) climate pollutants. While all of the policies included in this scenario except for the refinery reductions are considered "committed," abatement is currently based on targets and assumptions about rates of technology adoption, rather than clearly defined policies or programs. Any shortfall in meeting emissions targets would further need to be made up with cap-and-trade.

Expanding the cap-and-trade program at this scale and pace through 2030 faces several important challenges. First, each additional increment of abatement increases marginal costs. If the 2020 target is met, achieving the 2030 target would require 5%/yr annual abatement across the entire California economy (Figure 1). By comparison, if the European Union, which has already reduced its emissions ~20% since 1990, continues abatement at only 3.5%/yr it will be at the same 2030 target by 10 years. Given the scale and speed of needed abatement, caps may soon be lower than best-in-class performance for most industries (*2*). If this happens demand for permits may drive allowance prices to high levels and any price containment mechanisms (such as banking or a price ceiling) could prevent the program from reaching its abatement goals. Additionally, as emission caps are lowered, firms face increasing pressure to move operations out-of-state (leakage). A recent study estimates average industry leakage in California of 5.7% at \$10/tCO_2e, (*3*), which while

technically lowering California emissions, would undermine the objectives of its climate strategy to reduce global emissions.

Carbon offsets present a second major challenge. Extending current rules through 2030 would allow to up to one-third of abatement from offsets from firms outside of the cap. The majority of offsets projects funded under the United Nations Clean Development Mechanism would likely have happened otherwise leading to wildly exaggerated estimates of the effects of the program on emissions and quantity of credits generated (*4*). The estimating the emissions reduced by any offset program involves substantial uncertainty. Uncertainty in the proportion of offset projects that result from the offset program, as opposed to those that would have been built regardless of the program's incentives, is a challenge for any offset program. Also, because offsets pay for reductions instead of charge for emissions, offsets can create the incentive for emitters to increase emissions in order to decrease them for offset sales (*5*).

Furthermore, while cap-and-trade is understood to be efficient from a carbon perspective, it is not necessarily efficient for social and environmental outcomes that are not priced, such as local air quality, which disproportionately affects disadvantaged communities. Advocates of environmental justice emphasize the need for direct GHG abatement from facilities that also cause local air pollution (*6*).

Finally, California's cap-and-trade program is currently undergoing legal challenges and its future is uncertain. Overreliance on cap-and-trade, however important, could jeopardize the state's ability to meet the target. A carbon tax is another alternative, but carbon taxes do not provide the certainty of cap-and-trade and such a policy would likely require voter approval. Increasing direct abatement from complementary policies and decreasing reliance on cap-and-trade would minimize the tradeoffs of the Scoping Plan scenario.

Option 2: Expand Committed Policies. A second option ("Alternative 1" in Figure 2) presented by ARB expands existing regulations and programs but does not include cap-and-trade or a carbon tax. Major policies include increasing renewable electricity to 60% (from 50% under current law), electrification of space and water heating, increasing electric vehicles from to 4.5 million, early retirement of 1 million low efficiency vehicles, 25% reduction in energy demand from industry, 30% abatement from refineries and increasing biofuel production. This scenario would nearly meet the target if all policies were fully implemented and achieved the desired outcomes; however, there is considerable uncertainty that this would occur and emissions could fall short of the target by as much as 40% according to ARB (*1*). This approach would be more appealing from an environmental justice perspective, and does not include offsets, but it is also estimated to cost nearly $10 billion cumulatively, compared to $1.7 billion for the Scoping Plan scenario. The funding mechanism is not clear since cap-and-trade funds would not be available; since its inception in 2013 California's existing cap-and-trade program has already raised $3.4 billion for GHG abatement projects around the state.

Option 3: Committed and new policies plus cap-and-trade. We offer a third potential policy scenario that would limit some of the shortcomings of the other two options. The

"Proposed" scenario would achieve the full 40% GHG abatement by 2030 if policies achieved full potential, with making up any difference if the policies fell short of the 2030 target. The scenario includes all policies in Alternative 1, with abatement from industry and refineries included as cap-and-trade, plus additional abatement in five key areas: motor vehicle fuel economy, vehicle miles traveled (VMT), distributed solar, energy efficiency and local action. The proposed policies use market mechanisms to provide a consumer *pull* on demand, to complement the supply-side *push* promoted by other policies.

Improving vehicle fuel economy. Motor vehicles comprise 35% of statewide GHG emissions. A feebate program that includes penalties (fees) on high carbon vehicles as well as incentives (rebates) for low carbon vehicles within the same vehicle classification would increase fuel economy by encouraging manufacturers to offer more efficient options (*7*). A comprehensive study of vehicle feebates for California (*8*) found that a modest feebate program, with fees or rebates up to $700, would save 3 $MtCO_2e$ at a net negative societal cost (not including climate or health-related benefits). The study further found that 76% of Californians would be in favor of a feebate program. Combining feebates with incentives programs for electric vehicles would produce net revenues for consumers, while saving fuel over vehicle lifetimes. Depending on the structure of the program, electric vehicle adoption could increase dramatically. Each million new EVs saves over 1 $MtCO_2e/yr$ in 2030. We conservatively estimate that these policies could add 5 $MtCO_2e$; however, more could be achieved with larger fees and incentives.

It is important to recognize the synergistic benefits of even more aggressive EV strategies because they work between the state's clean air (tailpipe emission), clean electricity and public health goals. Dramatically increasing EV targets and support measures will have compounding benefits. We describe these goals in a paper that is available upon request.

VMT Reduction. The draft Scoping Plan recognizes the importance of VMT reduction as "necessary to achieve the 2030 target," and outlines several potential land-use, public transit, pricing mechanisms and other strategies. Setting a target of 10% reduction in VMT would send clear signal to state and local regulatory agencies. If achieved, 7 $MtCO_2e$ in 2030 would be abated. At the state level, mandatory pay-as-you-drive (PAYD) insurance alone could reduce VMT by 8% (*9*). PAYD rewards drivers who drive less, and who consequently are less responsible for accidents, road construction, fuel consumption and other public costs. Further VMT reduction may be achieved beyond the state's existing commitments by enhancing and interconnecting public transit systems in dense population centers throughout the state.

Distributed solar. Distributed rooftop solar has consistently doubled every 2.5 years in California, reaching 4.3 GW in 2016. ARB estimates 28 GW of capacity in 2030, saving 5 $MtCO_2e$ in 2030; however, a national laboratory study suggests up to 74% of electricity could be produced by solar (*10*). One novel way to encourage more distributed solar is through community choice energy (CCE) entities that procure electricity on behalf of local customers. Most programs offer a minimum of 50% renewable electricity and offer 100% for a premium, while prioritizing investments in local communities. Distributed solar can be further incentivized through rebates and expansion of net metering, which allows solar

producers to sell electricity back to the grid at favorable rates. Programs should be designed to benefit low income households in particular. Just five additional GW would abate 1 $MtCO_2e$ in 2030.

Building energy efficiency and electrification. Deep building retrofits are required to meet California's ambitious efficiency goals. Home sealing could be provided free of charge to homeowners at time of HVAC replacement or home purchase, with contractors receiving incentives to accomplish the work based on the performance of the building over time. Whole home electrification could be encouraged with an aggressive feebate program that encourages ultra-efficient electric heat pumps over gas space and water heating. On-site renewable energy, which is often more cost-effective than many retrofit options, could also be included. Retrofits could be paid with on-bill financing, ensuring building occupants who benefit from savings measures pay the cost. Retrofitting one-third of California residential and commercial buildings would save 8 $MtCO_2e$ in 2030. Feebates on water heaters alone could save over 2 $MtCO_2e$ per year (*11*). Applying feebates to all appliance would easily surpass 5 $MtCO_2e$/yr in 2030.

Change behavior locally. Ultimately, consumers need to adopt low carbon technologies and practices at mass scale. This can only happen by integrating behavioral science insights into policies and programs. A few things can be done: 1) develop an expert behavior team within state government, similar to the White House behavior team, to enhance the effectiveness of polices, 2) increase funding opportunities for cost-effective behavioral projects that increase motivation for low-carbon choices, 3) recognize best-performing programs, e.g., a statewide awards program for local behavioral interventions, and 4) make sophisticated carbon management software tools freely available to all local governments(*12*). Opportunities for GHG abatement vary by community, but also between neighborhoods and population groups within communities. Smart carbon management tools can help tailor interventions and track progress throughout the state over time. With the right incentives in place, communities can leverage the spirit of volunteerism to make meaningful contributions to solving the climate crisis. Greenblatt (*13*) estimates the total potential of location action to save 9 $MtCO_2e$ in 2030. More work is needed to identify savings opportunities for each community.

Jumpstarting the Transformation

California is on the precipice of a major energy transformation. The legislature has made a strong commitment to putting California at the forefront of climate policy; however, this must be backed up with sufficient policy mechanisms to meet the commitment. We outline a comprehensive strategy capable of meeting the 2030 target, arguing that all feasible existing policies must be continued, cap-and-trade should be extended to 2030 or replaced with a carbon tax, and new, market-based policies hold the most potential for deep abatement, at lowest cost, while simultaneously addressing equity and improving innovation. The proposed scenario would provide additional consumer demand for low carbon technologies and practices in order to meet the state's 2030 climate target. However, these new policies are largely outside of the regulatory authority of the ARB. Consumer groups, environmental organizations, businesses, communities and other stakeholders would need to be mobilized to generate support for implementation. A

complete transformation of the state's energy economy should involve all Californians as stakeholders, and the transition must begin almost immediately for California to have a chance of meeting its climate commitments.

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