A Gold Standard for Equity in Climate Cap-and-Trade Programs

by John Motsinger, Steven Moss, and James Fine

Cap-and-Trade in California

California's Global Warming Solutions Act, known as AB 32, calls for reducing statewide greenhouse gas emissions to 1990 levels by 2020.[1] This ambitious goal demands that California explore every opportunity to reduce emissions throughout the economy and in every community, while being sensitive to potential adverse impacts on the state's most vulnerable citizens.

While the rest of the nation debates pathways to an efficient and equitable climate policy, California's Air Resources Board (ARB) is tasked with detailing a cap-and-trade program that will cover 85 percent of statewide emissions by 2020. Cap-and-trade and a portfolio of complementary measures are expected to yield reductions of 150 $MtCO_2e$ in 2020 compared to status quo conditions.[2]

In the near term, global climate policy is likely to increase the costs on businesses and consumers. The poorest communities that are already spending a greater portion of their income on basic household expenditures will be hit hardest by even small increases on utility bills and higher prices at the gas pump and grocery store.

California has the opportunity to avoid those disparate impacts by de-

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signing a cap-and-trade system that can reward historically polluted and low-income communities that take action to mitigate climate change. Such a mechanism would empower existing networks in California's hard-pressed communities to deliver carbon-reducing, cost-saving services and reap the benefits through the cap-and-trade market. Though not without technical challenges, this program could chart a new course for climate policy that looks to the most vulnerable communities as an integral part of the global solution.

Existing Inequalities

Growing evidence indicates that low-income communities have a high concentration of inefficient technologies and suffer from some of the worst air quality. For example, a University of Tennessee study found that median vehicle age was 10.8 years in the state's lowest-income counties compared to a median vehicle age of 5.9 years in its highest-income counties.[3] That disparity in vehicle age resulted in "average mobile-source emissions factors 63% higher for nitrogen oxides, 73% higher for carbon monoxide, and 104% higher for volatile organic compounds in the lowest-income counties than in the highest-income counties."[4]

The technology gap extends beyond personal automobiles to myriad household appliances, as well as building structures themselves. For example, a survey of refrigerators in selected low-income neighborhoods in San Francisco found that approximately 20 percent of households could save money within a reasonable time period by replacing their inefficient refrigerators with new ones.[5] In 2008, Southern California Edison replaced 17,069 inefficient refrigerators with more efficient models across 54,635 homes that were served by the Low-Income Energy Efficiency program.[6] Another effort sponsored by the San Francisco Public Utilities Commission helped identify more than 2,000 water-wasting toilets in low-income communities that were eligible to be replaced with a free high-efficiency model.[7]

Though existing utility programs are available in low-income and historically polluted communities, their penetration rates are typically low. Phase 2 of the California Public Utilities Commission Low Income Needs Assessment Study found that while more than 4 million households in California are eligible for utility-run Low-Income Energy Efficiency programs, average annual penetration rates were in the range of 2 to 4 percent.[8]

Whereas wealthier areas steadily adopt new beneficial technologies, low-income communities often lag behind. The 2003 Residential Appliance Survey, for example, found that only 15 percent of low-income households had programmable heating thermostats compared to 55 percent of high-income households.[9] Data from the 2006 Consumer Expenditures Survey indicates that U.S. households in the lowest income quintile spent 22 percent of their income on energy-intensive goods and services, whereas the richest quintile spent just 4 percent.[10]

Community-based organizations are well-situated to address the efficiency gap in low-income communities. Utility companies serve a broad territory and cannot easily tailor their services for working in a particular community. Local organizations, on the other hand, have intimate knowledge of their immediate community, share a vested interest in its long-term future, and can become a trusted resource for climate education and emissions-reducing services.

Setting Aside Allowances for At-Risk Communities

Setting aside emission allowances could benefit California's poor and overburdened communities by enabling third-party "aggregators" to be credited for pooling small, dispersed emission reductions, while still avoiding double-counting and maintaining the integrity of the emissions cap. For example, a pool of allowances could be set aside at the beginning of each compliance period in proportion to anticipated reductions from energy efficiency and other improvements across a community. Organizations that help households and small businesses reduce their emissions would be able to claim allowances equal to the amount of greenhouse gas pollution reduced through their combined efforts. Those allowances could then be sold to regulated entities that

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Emission reduction kits included a compact fluorescent light bulb, power strip, occupancy sensor light switch, Kill-A-Watt energy meter, low-flow spray nozzle and sink faucet aerator, stainless steel water bottle, reusable canvas bag and a transit pass worth $20.

seek additional allowances to meet their compliance obligations.

Setting aside allowances would help maintain the integrity of the statewide emissions cap by removing allowances from the auction/allocation pool that correspond to emissions reduced by third-party aggregators. It would also prevent double-counting of indirect emission reductions that could otherwise result from electric utilities and community organizations both taking credit for the same reductions. Instead, community aggregators would be rewarded for demonstrated reductions, but electric utilities would be relieved of a portion of their compliance burden.[11]

A related method has already been proposed as a way to account for voluntary renewable energy projects that have an indirect effect on electricity sector emissions by reducing overall demand for fossil fuel–based generation. Under this approach, a portion of allowances equal to the yearly projection of voluntary renewable energy generation would be retired so that electric utilities cannot benefit from selling allowances for emissions that have already been reduced by someone else.

An analogous crediting mechanism is well suited for returning allowance value to community organizations that achieve emission reductions instead of just retiring the allowances. A set-aside mechanism would thus give low-income communities and the aggregators who serve them the opportunity to access carbon revenue by selling the allowances they earn into the marketplace. While not sufficient to pay for the measures themselves, the additional carbon value could augment the services provided by community aggregators and subsidize future investments.

Aggregating Emissions Reductions

Any community organization that provides emissions-reducing services could act as an aggregator by delivering services, tracking and reporting compliance, quantifying reductions, and interacting with state regulatory agencies. Organizations already working with disadvantaged communities and with expertise in energy efficiency and resource conservation would be particularly well suited to help households and businesses reduce greenhouse gas pollution. Third-party energy service providers, nonprofit and religious organizations, chambers of commerce, homeowners associations, and other community groups are all likely candidates to become aggregators if given the proper incentives and regulatory structures.

San Francisco Community Power (SF Power) is an example of an organization that provides services that could be aggregated for carbon market crediting. Working with city agencies and other nonprofit organizations, SF Power has replaced inefficient refrigerators, installed high-efficiency toilets, reduced small business peak energy demand, and delivered household emissions-reduction kits.[12] All of these actions could potentially be quantified and converted to allowances in the state's emerging cap-and-trade market.

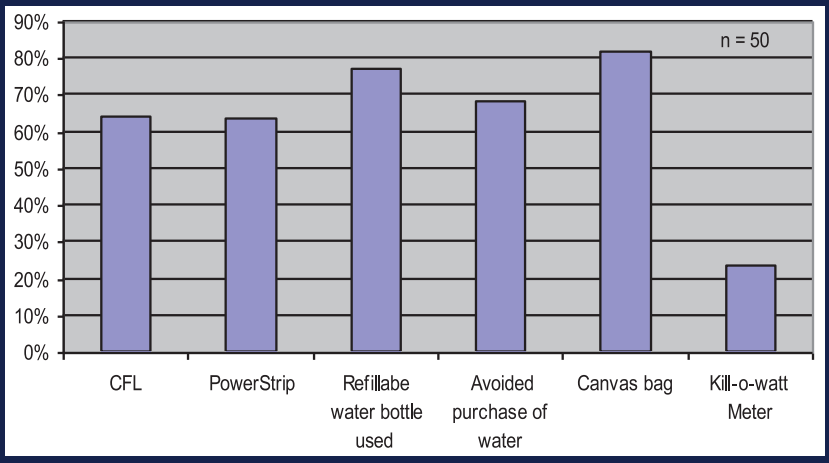
Interfaith Power and Light (IPL) is another example of an organization that delivers energy-saving information and devices to its constituents across the country. In addition to providing a Web resource with links to municipal energy efficiency and rebate programs, IPL maintains an online storefront that provides partner congregations with wholesale discounts on energy-efficient appliances and other devices.[13] Again, this type of activity could be readily quantified and credited as saleable emissions allowances.

Many organizations already provide energy services and education funded through private or government grants, but they don't have a reliable income source to maintain those services over time. Aggregating reductions for the carbon market could provide the kind of sustainable, dynamic financing necessary to provide ongoing services and relieve the burden and uncertainty of reapplying for new grants year after year. Having long-term predictability enables organizations to make financially sustainable changes rather than one-time investments.

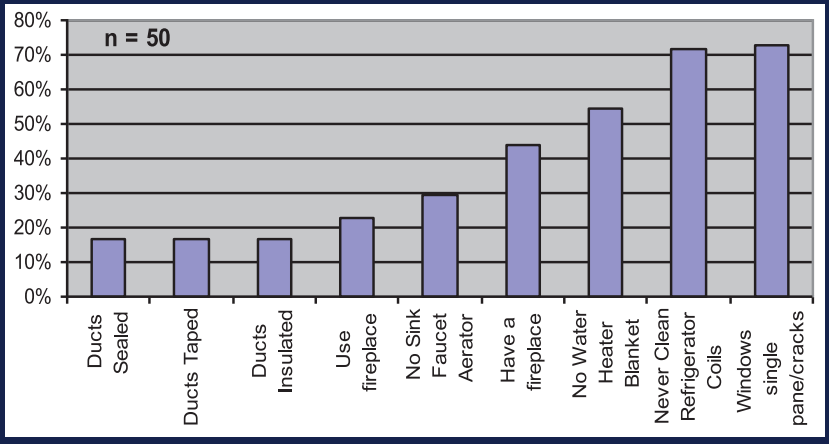
Setting the Standard for Community Reductions

A proper framework is needed to credit community-level emissions reductions in a way that acknowledges both the inherent uncertainties and distinct advantages in working with large, diverse populations. We propose a "Gold Standard for Equity," analogous to the Gold Standard developed to recognize high-quality offsets projects

Summary of Household Survey Data-Kit Item Usage Rates Two Months After Delivery.



Efficiency and Conservation Opportunities in Pilot Study Population.



under the United Nations Framework Convention on Climate Change's (UNFCCC) Clean Development Mechanism (CDM). A Gold Standard for Equity would balance the need to rigorously quantify emission reductions with the importance of returning benefits to California's poorest and most polluted communities.

The CDM Gold Standard provides a model for thinking about how to distinguish a particular class of reductions, such as those achieved in low-income communities. The Gold Standard was developed to designate "end-use energy efficiency projects that actively promote sustainable development."[14] Similarly, a Gold Standard for Equity would establish criteria for crediting high-quality, community-based emissions-reduction projects that promote environmental justice and community development. Adopting such a standard would allow community reductions to stand apart in the marketplace, potentially fetching a higher price or receiving priority regulatory treatment.

The Gold Standard for Equity gives priority to community actions by providing flexibility to project developers in demonstrating that reductions are real, while maintaining a high-integrity level. Potential methodological approaches include the following:

- Establishing performance benchmarks and project-specific baselines to estimate emission reductions that go beyond "business-as-usual"
- Pre-certifying specific measures and emissions-reduction strategies to provide greater predictability of anticipated carbon market rewards
- Using statistical sampling methods to evaluate program outcomes by surveying participants in ways that reflect variation across the population and that provide data to revise credit awards based on pre-certification
- Allowing for the delivery of a portfolio of services to minimize transactions costs and provide holistic solutions

Inherent to the Gold Standard for Equity approach is an acknowledgment that not all emissions reductions are of equal value. While a ton of carbon reduced has the same atmospheric implications no matter where it occurs, the co-pollutant reductions and economic benefits of actions can be highly localized.

The Gold Standard for Equity recognizes this reality and creates an incentive to achieve reductions that provide significant co-pollutant reductions and economic benefits in the poorest and most polluted communities. For example, driving fewer miles or using less heating oil will result in a direct reduction of air toxins and criteria pollutants, as well as a reduction in fuel expenditures. Energy efficiency improvements, on the other hand, may result in indirect pollution reduction at nearby power plants, which lowers overall health risks and saves money on utility bills.

Prioritizing investment in vulnerable communities can create new job opportunities where unemployment is particularly high. Household energy audits, efficiency retrofits, appliance replacements, vehicle scrappage, and other services can be performed by a workforce of green professionals. These are well-paid jobs that improve the en-

vironment, keep money in the community, and prepare workers for the emerging clean energy economy.

Quantification: Establishing That Reductions Are Real

Actions taken by households and small businesses will be both diverse and dispersed, and may result in indirect emission reductions across the electrical grid. Yet these challenges aren't insurmountable. Comparable standards exist for assigning emission reduction values to end-use energy efficiency improvements and for pooling the efforts of many individual actors.

There are several ways to rigorously quantify emissions reductions that result from community-level actions. One method is to pre-certify particular emissions reduction strategies based on accepted standards and/or well documented studies. In California, for example, electric utilities are awarded credit for energy efficiency programs based on estimates from the California Energy Commission's Database for Energy Efficient Resources (DEER), which assigns energy reduction values to specific technologies.[15]

Another approach is to establish performance benchmarks. Households could be required to reduce their energy use beyond a predetermined threshold in order for reductions to be credited. Performance benchmarks are commonly used in the building industry to set standards of energy use for a building envelope. The EPA's Energy Star Portfolio Manager, for example, enables commercial building owners to track the energy performance of their properties and compare it against similar buildings nationwide. Buildings that outperform 75 percent of the buildings in the same category qualify for the Energy Star label.[16] Community weatherization measures could apply similar methods, crediting only those emission reductions that reduce household energy use below the community average for similar households.

Households could be required to reduce their energy use beyond a predetermined threshold in order for reductions to be credited

For other measures where some level of direct, ex-post evaluation is feasible, statistical sampling methods can be employed to develop robust estimates of avoided emissions. Household surveys can be taken from a representative sample of program participants to document usage characteristics for various technologies. The resulting data would be used to establish a range of behavioral compliance and measure effectiveness that can then be applied to the entire population of interest. Awarding credits at the low end of the statistical range can increase confidence that only actual reductions will be credited.

Both pre-certification and performance benchmarks can be enhanced through ex-post verification of emission reduction measures that confirm a measure's effectiveness. Follow-up surveys with selected households can determine whether technologies are being properly used and can identify opportunities to revise project parameters or offer new services. This feedback loop will be a critical evaluation tool for community organizations that plan to provide emissions-reducing services and for regulatory agencies that will determine project-crediting criteria.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Managing Uncertainty

Every community-based, emissions-reduction project involves a degree of uncertainty. The goal is not to eliminate risk entirely, but to account for uncertainty as carefully as possible. Pre-certification, performance benchmarking, and statistical sampling are methods to manage the inherent uncertainty of quantifying dispersed, indirect emissions reductions that aren't readily observable.

Discounting offers another method of managing uncertainty by reducing the quantity of credited emission reductions. For example, Australia's Cool NRG is distributing millions of compact fluorescent light bulbs (CFLs) under the CDM's Domestic Energy Efficiency and Program of Activities protocols.[17] Emissions-reduction credits are awarded based on a predetermined formula that substantially discounts expected implementation rates. Over

10 years, Cool NRG will distribute 30 million CFLs throughout Mexico and anticipates achieving 7.5 million tons of avoided emissions—just 25 percent of potential reductions based on standard assumptions of usage and effectiveness. Discounting serves to mitigate shortfalls from those who accept a CFL but never use it, bulbs that break or burn out before their expected 10-year lifetime, bulbs that are used in a new light fixture, and bulbs used in other ways that may be contrary to the intended energy-saving application.

Some federal legislative climate proposals would similarly discount the value of international carbon offsets. One recent proposal would have awarded only four offset credits for every five tons reduced internationally.[18] This ratio effectively makes each international offset credit worth only 80 percent of a compliance allowance, making domestic offsets and on-site emission reductions more attractive. The same discounting principle could be applied, where appropriate, to community reductions.

Finally, any bundle of reductions that is credited in the carbon market must be verified by an independent third party. Similar to offsets project crediting, a verifier would confirm that proper procedures were followed for quantifying reductions, and that the actions taken match those intended to be carried out. Verifiers may conduct surveys of their own to sample reductions achieved and identify noncompliance, helping to improve future iterations of community projects by noting program shortcomings.

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Pilot Interventions

Many of the strategies described above have been tested in different contexts, but not specifically as community-based climate solutions. Therefore, we set out to pilot several interventions and quantify them for potential carbon market crediting. Our work examined three different methodological foils, including refrigerator replacement, toilet replacement, and delivery of a household emission reduction kit, each with a unique set of considerations.

Refrigerator replacement is one of the more straightforward measures that can be taken to reduce energy use and avoid the related emissions. Working with 150 low-income households in San Francisco, we collected data on refrigerator make, model, year, and annual energy rating. By projecting anticipated operating costs, we compared existing refrigerators to an energy-efficient replacement and found that 20 percent of the sampled population would save money by retiring their old refrigerator and replacing it with a new one.[19] When extrapolated to the entire population of low-income households in San Francisco (nearly 130,000 families), that 20 percent represents an estimated 26,000 refrigerators that could be cost-effectively replaced. The estimate increases to 29,000 refrigerators if modest carbon values are added.[20]

Replacing inefficient toilets also yields predictable savings, even though usage characteristics are more variable than for refrigerators. We identified more than 2,000 pre-1993 toilets in San Francisco that could be replaced with a high efficiency model that uses half as much water per flush. Replacing all 2,000 toilets would save approximately 8 million gallons of water per year, avoid nearly $90,000 in water bills and reduce 25 tons of CO_2 that would have been emitted in water treatment and transportation.[21]

Emission reduction kits presented more complicated quantification challenges, due to the diversity of interventions and significant role of behavior (see Photo of Emission Reduction Kit). This particular intervention involved an initial visit to 150 households to deliver the kit and a follow-up visit with 50 of those same households during which participants were asked to complete a survey to assess the effectiveness of the various kit items. More than 60 percent of households reported using the CFL and power strip two months after the kit was distributed; nearly 80 percent reported using the reusable water bottle, with almost 70 percent reporting that they had avoided purchasing plastic water bottles as a result; and more than 80 percent reported using the canvas bag (see Summary of Household Survey Data).

The household follow-up survey revealed additional opportunities to realize emission reductions, particularly in the area of weatherization. Fewer than 20 percent of respondents had ductwork that was properly sealed, taped, or insulated; more than half didn't have insulation around their water heaters, and

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One project in the city of Cape Town, South Africa, used three different interventions in low-income households to improve energy efficiency, including installing ceiling insulation, solar water heaters, and energy-efficient lighting.

more than 70 percent had single-pane windows or windows that were cracked (see Efficiency and Conservation Opportunities in Pilot Study Population). Each of these presents an opportunity to tighten the building envelope and improve the efficiency of household heating, ventilation, and air-conditioning to reduce energy use and avoid greenhouse gas emissions.

Regulatory Precedence

Other programs have already developed methods to quantify indirect emission reductions from energy efficiency improvements and aggregating small, dispersed actions. For example, the Clean Development Mechanism Program of Activities provides a methodology for crediting diverse activities at multiple sites as a single project.[22] Cool NRG in Australia has applied this methodology for a project to deliver 30 million compact fluorescent light bulbs across Mexico. CDM also allows for building energy efficiency projects such as appliance and equipment upgrades at multiple sites.[23] One approved project in the City of Cape Town, South Africa, used three different interventions in low-income households to improve energy efficiency, including installing ceiling insulation, solar water heaters, and energy-efficient lighting.[24]

The Regional Greenhouse Gas Initiative (RGGI) in the northeastern United States awards offset credits for end-use energy efficiency projects that reduce on-site combustion of fossil fuels such as oil, natural gas, or propane.[25] A similar rubric could apply in California to crediting electricity sector reductions from energy efficiency and weatherization improvements that occur within the capped electricity sector. For example, under the RGGI Model Rule, improvements that enhance residential building energy performance must exceed international standards by 30 percent in order to be eligible for offset crediting.[26] Low-income household weatherization could also be required to go a specified percentage beyond accepted industry standards.

Potential Criticisms and the Role of Local Government

Though there is precedent for pooling small actions and crediting dispersed efforts for regulatory compliance, some believe that this approach to addressing climate change may be too complicated, expensive, and inefficient. While state and local governments may need to increase their capacity as they learn to effectively implement and oversee new climate change solutions, our findings suggest that a program to aggregate reductions in disadvantaged communities can be practical, cost-effective, and complementary to other strategies being considered.

Regulators are already considering setting aside emissions allowances for several purposes, including to account for renewable energy projects and to encourage local government programs.[27] The additional work required to set aside a small portion of allowances for community-based greenhouse gas (GHG) reduction efforts, either through administrative allocation or at auction, would be modest within the overall context of creating the statewide cap-and-trade program.

Many cities, municipalities, and local governments have noted the significant role they can play in mitigating climate change and often work directly with those communities in greatest need.

Organizations like ICLEI-Local Governments for Sustainabilityand member municipalities in the Local Government Sustainable Energy Coalition (LGSEC) have already begun to implement greenhouse gas reduction programs and have facilitated green investments in their communities. LGSEC, in particular, has highlighted the role that local governments can play in achieving AB 32 goals and it supports setting aside allowances for aggregated community emission-reduction projects.[28]

To a large extent, the municipal monitoring and evaluation edifice to credit those kinds of reductions is already in place to report on Federal stimulus or other public funding programs. And, importantly, creating a set-aside mechanism doesn't *require* that local governments or community organizations take action; it *incentivizes* new opportunities through the carbon market and allows interested parties to pursue emission reductions that make the most economic sense.

Our pilot interventions in disadvantaged communities have demonstrated that there are ample opportunities to realize emission reductions that are cost-effective. In neighborhoods with low utility-program penetration rates that have yet to adopt energy-efficient technologies, substantial reductions can be achieved with investments that pay back quickly. Installing compact fluorescent light bulbs, weather-stripping, power strips, faucet aerators, and low-flow shower heads can yield annual savings several times greater than the cost of the devices. With existing rebates, even replacing larger fixtures and appliances like old refrigerators and toilets can save money over the long-run.

More importantly, enabling community-based climate solutions through aggregation of emissions reductions will be far more cost-effective and equitable than doing nothing at all. The social and environmental costs of failing to address growing disparities in vulnerable communities could have severe repercussions across the state that outweigh any initial savings from delaying further action.

Identifying Priority Communities

Activities that lead to greenhouse gas emissions occur almost everywhere. Yet emission sources tend to be concentrated in particular areas, especially along busy transportation corridors and in industrial zones. Historically, property values are lower in heavily polluted areas, drawing low-income residents who cannot afford to live elsewhere. The result is a high coincidence of low-income communities in highly polluted areas, creating discernible clusters of environmental and economic inequalities.

California Environmental Protection Agency (Cal/EPA) has adopted a definition for "cumulative impacts" that reflects this confluence of demographic and environmental factors.[29] Several attempts to quantitatively assess community risks are already underway. A study conducted by the Bay Area Air Quality Management District (BAAQMD) as part of its Community Air Risk Evaluation (CARE) initiative demonstrated that toxic air contaminants in the Bay Area tend to cluster in geographic and demographic "hotspots."[30] Areas in the top quartile of exposure to toxic air contaminants also encompass geographic areas with higher concentrations of low-income households.[31] Many of these low-income communities abut congested highways, major shipping ports, oil refineries, power plants, and other industrial facilities that put people at greater health risk from poor air quality.

University of California researchers funded by Cal/EPA have developed a way to score cumulative impacts from air pollution by census tract in order to reveal at-risk communities, particularly communities of color.[32] One analysis shows that the top 6.2 percent of tracts in Southern California with the highest cumulative impact scores were composed of more than 95 percent non-whites and with more than 33 percent living in poverty (i.e., median household income of $25,269 or lower).[33]

AB 32 specifically identifies the need to direct investment towards California's "disadvantaged" communities.[34] Efforts to quantify risk factors will provide state lawmakers with the information necessary to identify disadvantaged communities that suffer from the most disparate environmental and economic impacts.

Kurty Photography, kurtyphotography.com

San Francisco Community Power's climate team delivered 150 emission reduction kits to low-income households along with a free energy audit.

Beyond "Business as Usual"

Several proposals have recently emerged to promote climate justice in hard-pressed communities, including a climate rebate or per-capita dividend, community benefits funds generated from allowance auctions, allowance trading surcharges, and expanded utility-based energy efficiency programs. However, the existence of a wide resource gap is enough to demonstrate that a business-as-usual approach is not enough. Existing rebate programs and discounts are still not reaching the most at-risk populations at sufficient rates. Despite their best efforts, utility companies are unable to meet the scale of the need in our most vulnerable communities.

Southern California Edison prepares an Annual Low-Income Energy Efficiency Report that details the numbers of homes reached and services provided across its territory. In 2008, SCE reached 54,635 homes with a wide variety of programs.[35] While these are admirable results, SCE is reaching just 4 percent of the estimated 1,348,301 eligible low-income households in its territory each year.[36]

In September, the California Public Utilities Commission approved a substantial budget expansion for energy efficiency programs in coming years, including the nation's largest home retrofit program. The California Statewide Program for Residential Energy Efficiency (CalSPREE) is expected to reach 130,000 households by 2012, leaving many more families in need of further assistance.[37]

Even well-established federal programs may reach only a fraction of eligible households. For example, the Low-Income Home Energy Assistance Program (LIHEAP) reached 5.5 million households in 2006—about 16 percent of the 34.4 million households that meet the program's income standard.[38] More importantly, LIHEAP offers financial assistance to those in greatest need, but it does not adequately address the persistent energy efficiency technology gap between low-income and wealthier households. Just 124,930 households in 45 states (less than half of one percent of LIHEAP-eligible households) received a weatherization benefit to provide low-cost residential building improvements that would keep future heating and cooling costs down.[39]

Furthermore, recent analysis of hand-out programs like the California Alternative Rates for Energy (CARE) program suggests that cash payments may not be the most effective way to mitigate energy expenditures. Through the CARE program, low-income households receive a 20 percent discount on their monthly energy bill to help reduce their financial burden.[40] In 2008, PG&E and SCE spent nearly $600 million on the CARE program. Yet this discount does nothing to actually reduce energy use and, in many cases, has the perverse effect of subsidizing inefficient, highly polluting technologies.[41]

Per-capita dividends or consumer rebates may have similar effects as existing utility bill subsidies. In theory, households could use dividend or rebate monies to make energy efficiency investments and other emission-reducing improvements. But households may be more likely to use the extra money in ways that will maintain their existing energy use or even increase it. Enabling communities to invest it in their own homegrown climate solutions would prompt a better environmental outcome and guarantee permanent cost savings through energy efficiency improvements. At the same time, investing the money in local emission reduction projects fosters climate education and promotes resource conservation.

As California considers how to implement climate policy in a way that protects and benefits low-income and historically polluted communities, it's imperative that state regulators consider both the costs and potential benefits of specific cap-and-trade design features. Some approaches will perpetuate the existing resource gap and inequitable distribution of the pollution burden; others will help level the playing field. A well designed cap-and-trade market can provide predictable, ongoing incentives for community action that are tied directly to environmental performance, which allows local organizations to take a lead role in combating global warming. By linking local institutions to carbon markets, California can transform the climate crisis into an opportunity for a more equitable future for all.

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NOTES

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3. T. L. Miller, W. T. Davis, G. D. Reed, P. Doraiswamy, and A. Tang, "Effect of County-Level Income on Vehicle Age Distribution and Emissions," *Journal of the Transportation Research Board* 1815 (2002): 47–53.

4. Ibid., see abstract at http://trb.metapress.com/content/61pk447j064387x6/.

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6. Southern California Edison, 2009 Low Income Annual Report, May 13, 2009, available at http://www.sce.com/AboutSCE/Regulatory/eefilings/lowincome.htm.

7. San Francisco Community Power High Efficiency Toilet Program, program description, available at http://www.sfpower.org/subnav10012.php.

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14. Gold Standard Foundation, http://www.cdmgoldstandard.org/Certifying-GS-Carbon-Credits.112.0.html

15. "DEER has been has been designated by the CPUC as its source for deemed and impact costs for program planning." California Energy Commission, Database for Energy Efficient Resources, http://www.energy.ca.gov/deer/.

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19. Moss and Fine, note 6. See data table and NPV calculations.

20. Ibid. We assumed that resulting emission reductions could be credited as allowances and traded in the carbon market at $20 per ton of CO_2e avoided.

21. Estimates for the High Efficiency Toilet Program were derived from original calculations based on residential water rates in San Francisco (sfwater.org) and emission factors from Environmental Entrepreneurs (e2.org). Contact authors for more information.

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