A Health Impact Assessment of California's Proposed Cap-and-Trade Regulations

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Objectives. To identify unintended health effects of California's controversial cap-and-trade regulations and establish health-promoting policy recommendations, we performed a health impact assessment.

Methods. We used literature reviews, public data, and local health surveys to qualitatively assess potential health risks and benefits related to changes in employment and income, energy costs, effects of emission offset projects, and cobenefits from the allocation of program revenue. We examined case studies from various communities to find existing social, economic, and environmental health conditions.

Results. We found that policy implementation will minimally impact job creation (< 0.1% change) and that health effects from job sector shifts are unlikely. Fuel prices may increase (0%–11%), and minor negative health effects could accrue for some low-income households.

Conclusions. Offset projects would likely benefit environmental health, but more research is needed. Allocating some program revenue for climate change adaptation and mitigation would have substantial health benefits. Health impact assessment is a useful tool for health agencies to engage in policy discussions that typically fall outside public health. Our results can inform emission reduction strategies and cap-and-trade policy at the federal level. (*Am J Public Health.* 2012;102:e52–e58. doi:10.2105/AJPH.2011.300527)

Climate change is expected to substantially increase disease burden in California. The projected health impacts in California from climate change include increased exposure to heat and extreme weather events such as floods and storms; changes in the frequency and distribution of vector-borne, food-borne, and waterborne diseases; increases in illnesses related to air pollution and ultraviolet radiation exposure; food and economic insecurity and migration and social disruptions; and consequent mental health effects.[1–3]

The California state legislature passed Assembly Bill 32, The Global Warming Solutions Act of 2006 (AB 32), to reduce greenhouse gas emissions statewide to 1990 levels by the year 2020. AB 32 allowed the implementation of a cap-and-trade program and other complementary measures to reach the emission reduction goal. The legislation also included explicit provisions to ensure that regulatory goals would not disproportionately affect disadvantaged communities, would consider public health impacts, and would direct investments to California's most disadvantaged communities.[4] The California Department of Public Health (CDPH) undertook a health impact assessment (HIA) to describe the potential health effects of a cap-and-trade program, including recommendations to minimize health risks and maximize potential health cobenefits. An HIA is

> a combination of procedures, methods and tools by which a policy programme or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population.[5(p4)]

Based on potential health impacts, an HIA should propose policy adjustments to minimize the negative and maximize the positive health impacts.

California's cap-and-trade program is a market-based approach to control emissions using a variety of economic incentives to achieve greenhouse gas emission reductions. Although a cap-and-trade program would account for less than 20% of all emission reductions under AB 32,[6] the cap-and-trade program in California is highly controversial. Many environmental justice advocates have remained critical of market-based emission reduction strategies, particularly because of the potential for variable reductions in copollutant emissions in specific locations and the development of small geographic areas with relatively high concentrations of particulate pollution within the larger pollution control region. Although cap-and-trade is being implemented within the context of existing air regulations that limit many increases in toxic air contaminants and regulated pollutants, differing views exist on the role of cap-and-trade as a tool for broader pollution control and cap-and-trade's potential to increase pollution in some communities.[7–10]

In fall 2009 the Climate Action Team Public Health Workgroup decided that an HIA of cap-and-trade in California would be useful and relevant.[11,12] The HIA was a voluntary, nonregulatory assessment carried out in parallel to the regulatory processes of the California Air Resources Board (CARB), the agency implementing AB 32. The HIA, led by CDPH staff, was the first HIA led by a state agency in California. HIA stakeholders included environmental, economic, health, and industry professionals.

CDPH assessed the potential health effects that may stem from changes in employment, energy costs, and community investments funded by cap-and-trade revenue and various offset projects. Although many environmental justice stakeholders were most concerned about local air impacts, the CDPH HIA did not assess local health impacts related to changes in emissions. As part of the regulatory process, CARB was required to assess changes in copollutant air emissions with regard to the

cap-and-trade rule.[13] Thus, CPDH did not quantitatively assess air emissions but focused its resources on assessing other health pathways.

METHODS

We followed CDPH's "A Guide for Health Impact Assessment" and the 5 stages common to most HIAs—screening, scoping, assessment, recommendations, and reporting.[14] At the end of each stage, stakeholders reconvened to incorporate feedback and begin discussions on the subsequent stage.

Screening

Screening can filter out HIAs for which there is no decision to be affected or assessments beyond the practitioners' capabilities. Stakeholders in the Public Health Workgroup expressed a desire to perform an HIA with an emphasis on the distribution of health effects in different communities. At the outset, the purpose of the HIA was not

> to provide exhaustive documentation of all potential health impacts of a cap-and-trade rule, nor to quantify the majority of potential impacts . . . the purpose . . . [was] to highlight aspects of the cap-and-trade program most likely to influence public health.[12(p3)]

Scoping

In the scoping stage, we researched potential health impacts of interest, established analytic boundaries, and considered appraisal methods and data sources. We limited the HIA to assessing the cap-and-trade framework as described in the scoping plan; we did not address alternatives to cap-and-trade (e.g., carbon tax, direct regulation) because the rule-making process for cap-and-trade was under way as the HIA was being developed. Stakeholders helped narrow the analysis to a manageable set of decision points and health pathways relevant to regulatory decisions under consideration.

Stakeholders identified 5 core health determinants to be assessed:

1. Air pollution (assessed by CARB during the regulatory process),
2. Changes in employment and income,
3. Changes in residential energy costs,
4. Offset project impacts, and
5. Cobenefits associated with allowance revenue distribution.

The *Updated Economic Analysis of California's Climate Change Scoping Plan*[15] provided the modeling results for changes in stakeholder-identified health determinants. The final health impact pathways stakeholders identified are shown in Table 1.

Assessment

We obtained quantitative data on economic changes from the CARB economic analysis. A detailed methodology of CARB's model is available in the *Updated Economic Analysis of California's Climate Change Scoping Plan*.[16] Our analysis relied on 3 scenarios from the CARB analysis:

1. Reference case: a business-as-usual baseline scenario in which AB 32 is not implemented.
2. Case 1: the entire AB 32 scoping plan is implemented, including a cap-and-trade program with 49% of total emission reductions from emission offsets.
3. Case 2: the entire AB 32 scoping plan is implemented, including a cap-and-trade program, but offsets are not allowed.

The frameworks for cases 1 and 2 are shown in Table 2.

We used literature reviews and existing data from the US Census, the Bureau of Labor Statistics, the Environmental

TABLE 1—Stakeholder-Identified Health Impact Pathways: Health Impact Assessment of a Cap-and-Trade Framework, California, December 2010

Policy Change	Intermediate Policy Impact	Health Determinants	Intermediate Outcomes	Health Outcomes
A cap-and-trade program	Create a market for and price on greenhouse gas emissions	Emissions and pollution	Changes in air pollutants (air resources board assesses as part of the regulatory process)	Air-related health impacts
		Employment impacts	Employment shifts by sector	Changes in workplace morbidity
			Jobs created or lost	Health care access
			Change in income	Stress and well-being
				Income or expenditure shifts
		Energy costs	Change in air conditioning or other energy use	Heat-related mortality
			Encourage energy efficiency	Air quality–related health outcomes
			Household spending shifts	Stress and well-being
				Income and expenditure shifts
	Emission offset projects	Offset project environmental impacts	Highly variable, depending on offset protocols approved	Wide range of health impacts, depending on the specific offset project and its location
	Generation of program revenue	Distribution of allowance revenue	Broad, depending on revenue distribution and use	Wide range of health impacts, depending on revenue use and distribution

Protection Agency, the US Energy Information Administration, and local health departments to describe potential health risks and benefits in a qualitative manner. Local health, demographic, and environmental data highlighted potential health risks and opportunities that may be associated with cap-and-trade in several community case studies. Because of data limitations, we could not quantitatively project health impacts. Therefore, we have described health effects largely in terms of potential health risks and health benefits, not as enumerated health outcomes. Recommendations focused on minimizing health risks and increased monitoring to better assess future outcomes.

Recommendations

CDPH staff drafted recommendations that were responsive to anticipated health risks, technically feasible, and built on existing programs when possible. When data were too sparse to judge health effects with reasonable accuracy, recommendations included environmental health surveillance to monitor uncertainty. We refined recommendations through an iterative process with stakeholders and content experts.

RESULTS

A report describing the process and results of the HIA and final recommendations was published in December 2010.[17] CDPH staff presented public testimony describing the HIA, its findings, and its core recommendations at a December 16, 2010, public hearing at which CARB took public comments and voted to approve a regulatory framework that will be refined for cap-and-trade implementation. Reporting and dissemination continued through 2011.

Employment and Income

Employment and household income are closely linked, and income is a strong and persistent predictor of health and disease.[18] Job security can positively affect psychological well-being and overall health, and higher rates of unemployment cause more stress, illness, and premature death.[19] Mental health effects such as anxiety and depression can begin when people first feel their jobs are threatened.[20] Employment also affects health insurance status, household budgets, and the risk of occupational injury and illness.[21] Underinsurance and lack of insurance are associated with adverse health outcomes related to delays in getting needed health care or neglect of routine health screenings.[22]

Overall, the rate of employment growth is expected to remain largely unchanged when comparing the implementation of AB 32 and a cap-and-trade program to a business-as-usual scenario. Employment will vary on a sector-by-sector basis (Table 3). Compared with business as usual, implementation of a cap-and-trade program with offsets may result in 6000 fewer jobs being created by 2020 (< 0.1% change) and a shift of jobs from industries with job growth to those with slower job growth. Total job shifts in case 1 represent 90 000 jobs. In case 2, in which offsets are not permitted, 200 000 fewer jobs are created by 2020 (–1.4%) than in a business-as-usual scenario. Statewide, for both case 1 and case 2, changes in income are very small but positive across most income levels (at income levels > $200 000, there is a slight decrease).

Occupational health and safety contributes to variations in workplace-related morbidity and mortality rates between job sectors. Growth in job sectors with low injury and illness rates may result in small decreases in job-related morbidity incidents. Labor shrinkage in risk-prone jobs may result in fewer cases of work-related injury and illness. Assuming that sector-specific morbidity rates remain static, case 1 and case 2 would likely result in negligible reductions in job-related injuries and illnesses because of minor negative job growth (data not shown).

Household Energy Costs

Basic household costs—including residential and other energy costs—are important health determinants, with marked impacts on low-income households. A survey from the California Public Utilities Commission found that 56% of low-income households cut back on basic household necessities to cover their utility bills. Thirty-seven percent of low-income households have reported skipping a payment on their utility bill

TABLE 2—Case 1 and Case 2 Economic Modeling Scenarios Including the Cap-and-Trade Program Design: Health Impact Assessment of a Cap-and-Trade Framework, California, December 2010

Policy Case Scenarios	Case 1	Case 2
Complementary emission reduction measures	Included and assumed 100% effective	Included and assumed 100% effective
Geographical boundary	California only	California only
Pollutants	CO_2, CH_4, N_2O, SF_6, PFC, HF	CO_2, CH_4, N_2O, SF_6, PFC, HF
Sectors covered	2012–2014: narrow scope (electricity production and industrial sources > 25 000 mt CO_2e/y)	2012–2014: narrow scope (electricity production and industrial sources > 25 000 mt CO_2e/y)
	2015–2020: narrow scope sectors and transportation fuels, and fuels used by commercial, residential, and small industrial sources	2015–2020: narrow scope sectors and transportation fuels, and fuels used by commercial, residential, and small industrial sources
Allowance allocation	100% auction	100% auction
Offsets	Limited to 49% of total program emission reductions	No offsets allowed

Note. CO_2 = carbon dioxide; CH_4 = methane; N_2O = nitrous oxide; SF_6 = sulfur hexafluoride; PFC = perfluorocarbons; HF = hydrofluorocarbons.

TABLE 3—Projected Change in Employment by Sector Compared With Reference Case: Health Impact Assessment of a Cap-and-Trade Framework, California, December 2010

	Reference Case	Case 1		Case 2	
Sector	No. Jobs (Thousands)	No. Jobs (Thousands)	Change From Reference Case, %	No. Jobs (Thousands)	Change From Reference Case, %
Agriculture	448.7	453.4	1.0	441.4	–1.6
Mining	25.9	22.2	–14.2	23.3	–10.0
Construction	928.6	920.1	–0.9	893.6	–3.8
Utilities	67.1	61.4	–8.5	47.4	–29.3
Energy-intensive manufacturing	857.6	849.5	–0.9	835.4	–2.6
Other manufacturing	1189.4	1176.2	–1.1	1166.8	–1.9
Wholesale trade	791.4	791.1	0.0	789.3	–0.3
Retail trade	1901.3	1895.2	–0.3	1831.1	–3.7
Transportation and warehousing	503.4	500.1	–0.7	484.1	–3.8
Information	448.4	450.7	0.5	451.6	0.7
Finance	1025.6	1036.5	1.1	1022.3	–0.3
Services	6728.5	6753.4	0.4	6713.9	–0.2
Total	14 916.0	14 910.0	< 0.1	14 700.0	–1.4

altogether at some point, leading to the risk of utility shutoff. Five percent of low-income households had a member with an electrically operated medical device.[23]

Disparities by income and race exist with regard to access to in-home air conditioning, a basic adaptation tool for heat waves. An analysis of heat waves in 4 American cities found that Blacks were half as likely to have air conditioning access and that deaths among Blacks were more closely associated with elevated temperatures.[24] In California, low-income households are less likely to have air conditioning.[25]

From an economic perspective, increases in energy costs are associated with reductions in emissions (the core goal of a cap-and-trade program) and air pollution.[26,27]

Under case 1 and case 2 policy scenarios, most residential fuel prices are expected to increase, with the largest increases for gas. For case 1, in which offsets are limited to 49% of emission reductions in capped sectors, fuel price increases range from 0% to 11% depending on the fuel type, with residential electricity prices remaining static compared with business-as-usual scenarios. All residential fuel types increase in price in case 2, in which offsets are not allowed and costs of compliance would be higher for entities covered under the cap-and-trade program. Under the case 2 policy scenario, residential electricity prices would increase 4%, and residential gas prices would increase 50%, compared with business as usual.

The lowest income quintile households spend the most on household fuel expenditures as a percentage of total income (Table 4). Whereas the lowest income quintile households spend nearly 13% of their total income on residential fuel expenditures, household fuels cost the second lowest income quintile households 6% of their income. The highest income quintile households spend 1.9% of their total income on residential fuel costs.[28]

Potential Health Effects From Economic Health Determinants

Health effects from projected economic impacts—including income, employment, and household fuel costs—are expected to be negligible to minor under the case 1 scenario, in which

TABLE 4—Annual Consumer Unit Fuel Expenditures by Income as a Percentage of 2008 Pretax Income: Health Impact Assessment of a Cap-and-Trade Framework, California, December 2010

Income Quintile	Mean Pretax Income, $	Electricity Expenditures, %	Natural Gas Expenditures, %	Fuel Oil and Other Fuel Expenditures, %	Total Fuel Expenditures, %
First quintile	10 263	8.9	3.0	0.9	12.8
Second quintile	27 442	4.3	1.5	0.6	6.4
Third quintile	47 196	2.8	1.1	0.4	4.2
Fourth quintile	74 090	2.0	0.8	0.3	3.2
Fifth quintile	158 652	1.2	0.5	0.2	1.9

Source. Bureau of Labor Statistics, Consumer Expenditure Survey 2008. Available at: http://www.bls.gov/cex/data.htm. Accessed July 20, 2010.

49% of emission reductions can occur through offsets, and minor to moderate under the case 2 scenario, in which no offsets are allowed. The health impacts include the following:

- Health effects may result from changes in employment, labor demand shifts, and employment transitions that disrupt insurance or access to health services. Net changes in employment are unlikely to create health effects in case 1. Larger changes in employment in case 2 could have minor to moderate health effects.
- Negligible reductions in occupational injuries may accrue from reduced job growth. Minor negative health effects may occur for low-income households from small increases in household energy costs.
- Possible small positive health effects may occur if higher energy costs are associated with aggregate reductions in energy consumption and improvements in air quality.

Potential Health Effects From Offset Projects

We reviewed 4 emission offset protocols the CARB had under review. Based on the best available literature, the 4 emission offset projects—ozone depleting substances, manure management digesters, urban forestry, and forestry—may have negligible to small positive health effects. Promoting urban forestry offsets could have substantial health benefits in communities lacking urban green space with positive effects on air quality, reductions to heat exposure, and improvements in cardiovascular disease.[29–32] There is evidence that the other offset protocols could have beneficial effects on air quality and other environmental indicators, but more research is needed.[33–37] Because most offset projects likely have small beneficial impacts and the potential to spur employment, there is incentive to maintain positive offset projects in California communities. Local impacts are likely to vary on a case-by-case basis.

Potential Health Effects From Distribution of Allowance Revenue

The potential benefits of a cap-and-trade program are not explicitly directed to the communities most affected by stationary emissions (largely low-income communities of color with existing health disparities[38–41]); but allowance revenue could be targeted to affected communities with existing health needs. CDPH reviewed community health initiatives that could reduce community vulnerability and increase a community's adaptive capacity to climate change while also providing substantial health cobenefits.[16] Allowance revenue could also be refunded to regulated entities to fund energy efficiency investments, appointed to state coffers in return for a reduction in taxes, or rebated directly to California consumers (i.e., cap-and-dividend).[42] Each strategy has varied health implications, but a comprehensive evaluation of each strategy was outside the scope of this assessment. Overall, distributing allowance revenue for climate change adaptation and mitigation in communities would likely have substantial positive health effects.

DISCUSSION

Our findings suggest that the potential negative health effects from a cap-and-trade program across California would be negligible to minor, although low-income and vulnerable populations may be more susceptible to negative health impacts. Potential positive health effects are likewise small but can be improved by limiting the use of offsets to no more than 49% of total emission reductions to encourage on-site greenhouse gas reductions, targeting offsets with positive health cobenefits to California's vulnerable communities, and maximizing the auction of emission allowances. Capping offsets at 49% of total emission reductions would mandate that a majority of emission reductions occur at the source of emissions, benefitting local air conditions while maintaining the program's economic efficiency. Directing community health investments from allowance revenues to California's most vulnerable communities can improve community health environments for climate change mitigation and adaptation. We recommend enhanced environmental health surveillance systems to monitor future impacts and to ensure that no population bears a disproportionate health burden from a cap-and-trade program.

This study was the first time, to our knowledge, that a California state agency used an HIA. HIA was a useful methodology for engaging stakeholders in a public forum, assessing distributional health risks and equity, and communicating the potential health risks of a complicated and controversial policy, despite limited staff resources and a limited time frame for the assessment. However, this analysis of aggregate statewide health risks has several limiting factors because of a lack of data, the inherent inability to predict local effects of cap-and-trade, and the limitations of the process as it unfolded.

First, changes in economic health determinants and emissions output will vary from one community to the next under cap-and-trade. Local variations are inherent in a market-based cap-and-trade program that gives emitting entities the flexibility to meet emission reduction goals by improving on-site efficiency, purchasing additional emissions allowances, or purchasing offset emission credits. An aggregate statewide assessment masks the potential for variation and health equity impacts, but local variations in emissions or economic output cannot be accurately predicted.

Second, data and time restraints limited our ability to quantify specific health outcomes. Although unemployment and reductions in income are generally accepted as being a risk to one's health, data on how and to what effect these economic determinants affect health are not readily available. Finally, any inference about health is as limited as the accuracy of the economic models of cap-and-trade. Despite these limitations, the HIA was useful in identifying potential health risks and crafting recommendations to minimize these risks.

Finally, the HIA did not incorporate a quantitative air quality assessment to avoid duplicating the efforts of the CARB assessment of copollutant emissions. CARB did not find significant impacts in that analysis, although CARB did not quantify health impacts in smaller geographic areas because of data and technical limitations.

Program Recommendations

Based on the findings from the HIA, CDPH drafted program recommendations to

minimize potential health risks and promote health cobenefits associated with cap-and-trade. We refined recommendations with stakeholders to craft measures that were technically feasible, built on existing programs when possible, and related to program design elements for which a decision could still be affected. Core recommendations included the following:

- Mitigate adverse effects owing to labor market shifts: A portion of allowance revenue should be invested in adult education, worker training, and temporary insurance. Targeting investments to vulnerable communities—low-income communities and communities of color, individuals with low educational attainment, and workers in affected, energy-intensive industries—can increase resiliency in these communities.
- Mitigate effects on low-income households owing to rising energy expenditures: A portion of allowance revenue should fund household energy efficiency programs for low-income households. The majority of California households would not be negatively affected by small rises in residential fuel costs; and an overdampening of energy prices across all households may limit the positive health cobenefits associated with energy conservation. Assistance should be targeted to low-income households with the greatest energy cost burden.
- Monitor environmental health risks: Given the uncertainty of local effects, enhanced environmental health surveillance should be part of program implementation. Improving statewide surveillance of environmental health risks will simultaneously serve wide-ranging planning and health needs throughout California.
- Maximize allowance revenue and direct a portion of revenue to investments in community health: The allocation of revenue to investments to improve community health environments ensures that program benefits remain in California and requires further broad-based public discussion. Revenue could be distributed in a manner similar to the highly successful CDPH Tobacco Control Program and used to increase resiliency and improve the adaptive capacity of communities vulnerable to climate change.
- Limit offsets to no more than 49% of total emission reductions: Offsets improve overall program efficiency but also limit incentives to reduce emissions on-site, missing an opportunity to capture health benefits from direct cuts to emissions at the source. Maintaining a majority of emission reductions on-site will encourage the accrual of air quality cobenefits in California. Similarly, incentivizing the development of positive offset projects in California can promote health cobenefits, particularly if targeted to vulnerable communities.

Lessons for the Consideration of Health in Climate Policy

As discussions about climate policy continue, there are several factors for public health advocates to consider:

1. Cap-and-trade is not designed to lower criteria pollutants. It is designed to lower greenhouse gas emissions. Specific aspects of regulatory design (e.g., allowing trading restrictions, linking to criteria pollutant emissions, and using offsets) can affect the ability of cap-and-trade to improve air-related and other health outcomes.
2. Cap-and-trade offers individual entities a high degree of freedom in attaining emission reduction targets. This creates market flexibility for complying facilities but also leads to a "distribution-neutral" program.[7] Under any cap-and-trade system, regional or local effects will vary and health equity should be considered.
3. Cap-and-trade in and of itself is unlikely to have substantial health effects, but any market-based program could be improved to bolster health cobenefits. Attention should also be given to the potential for emission offset projects and allowance revenue to affect health.
4. The largest health benefit of any emissions reductions policy is the potential to mitigate climate change. However, climate change policies should not exacerbate existing health disparities in the same communities that have the least ability to adapt to climate change.[43] Public health should work to protect these communities while taking action to mitigate climate change.

Conclusions

Following the release of the CDPH HIA, the CARB voted to adopt the proposed cap-and-trade rule. A lawsuit filed by several environmental justice organizations expressed concern that the air emissions assessment was inadequate and that there was inadequate analysis of program alternatives. The San Francisco superior court ruled that the emissions assessment was adequate but that CARB had failed to properly assess alternatives to cap-and-trade.[43] That ruling is currently under appeal by CARB, and CARB has simultaneously assessed additional greenhouse gas reduction alternatives (e.g., a carbon tax) and released the analysis for public comment. The board approved the revised assessment on August 24, 2011. ■

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Contributors

M. J. Richardson wrote the first draft of the article. P. English and L. Rudolph contributed substantial comments, edits, and additional language to the draft. All authors contributed to the original research, including stakeholder processes, development of scope of work, research, and follow-up edits and revisions.

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