Assessing the Health Co-benefits of San Francisco's Climate Action Plan

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Background

In 2004, the City of San Francisco's Department of Environment and Public Utilities Commission released the City's Climate Action Plan (CAP), quantifying the City's greenhouse gas emissions and identifying actions required to achieve a reduction commitment of 20% below 1990 levels by 2012. Many of the proposed actions to reduce the City's greenhouse gas emissions also have significant co-benefits for health. Improved air quality, a reduced heat island effect, more active transportation, and other effects brought on by climate mitigation efforts can bring significant improvements to the health of San Francisco's residents. Many of the proposed CAP actions also have the potential to lessen many of the environmental and health inequalities with which some San Francisco communities are burdened. Likewise, some of these health co-benefits will not accrue equality to everyone, particularly to those who are most vulnerable to the impacts of climate change and stand to benefit the most. In addition, some of the proposed climate actions, while appropriate for reducing GHG emissions, may have negative health impacts. This report assesses the health co-benefits of the City of San Francisco's Climate Action Plan, the potential negative health consequences of proposed actions, and identifies communities that may be disproportionately impacted by these actions. This report also provides recommendations that can be used to inform future updates to climate plans to ensure our City's climate change action achieves emission reductions targets while improving the health and wellbeing of all of San Francisco's residents.

Climate Change and Health Impacts in San Francisco

Climate change is expected to increase temperatures, change precipitation patterns, increase the frequency and severity of extreme weather events, and increase sea-level rise—all of which will have significant impacts on the health of San Francisco's residents.

Climate change will affect health in a number of ways. In San Francisco, daily weather in the next few decades will see overall warmer temperatures. While San Francisco will still experience winter cold spells, summertime heat waves will become more common and intense (SFCAP 2004). Increasing severity and frequency of heat waves will increase heat-related illness and death, particularly impacting the elderly, children, those with pre-existing conditions, and those living in neighborhoods and homes that are maladapted. In addition, the risk factors for heat-related illness and death are higher among low-income families and people of color (Morello-Frosch 2009).

Increasing temperatures are also expected to exacerbate air pollution in California. Concentrations of air pollutants, and in particular ozone and fine particulate matter (PM), will likely increase (IPCC 2007). For instance, the Bay area is expected to experience an increase in the severity and frequency of ozone episodes. Modeling efforts also suggest that for the Bay area, the sensitivity of ozone to increases in temperature is relatively large compared to other regions in the state, suggesting the Bay area may be particularly sensitive to climate change (Steiner, Tonse et al. 2006). In addition to increasing air pollutants directly, higher temperatures will also likely increase and intensify wildfires in the state, exacerbating regional air quality (Drechsler 2006). An increase in air pollution can increase incidents of asthma, allergies, cardiovascular and respiratory diseases, cancer, neurological and reproductive disorders, and premature death (CARB 2009). These impacts are especially felt among populations most vulnerable to air pollution, including children, elderly, people with respiratory diseases, low-income communities and people without access to health insurance. In addition, some groups are exposed to higher levels of air pollution than others. In San Francisco, low income residents and residents of color are more likely to live near high traffic areas where air pollution levels are the highest, and as a result, they suffer from higher asthma rates (see transportation section for discussion of health inequality of air pollution). Without action, this health disparity will only worsen with climate change.

Changes in climate can affect the prevalence and geographic location of food-, mosquito-, and vector-borne diseases. While hard to predict, it is possible for infectious diseases like West Nile Virus and Lyme disease to become more prevalent in California (Drechsler 2006).

Climate Change and Health Impacts in San Francisco

Surrounded on three sides by water, San Francisco is also vulnerable to rising sea levels. As global temperatures increase, sea level is expected to continue to rise, and the rate will likely increase (IPCC 2007). It is predicted that along the California coast sea level may rise between 1.0-1.5 meters by 2100 (Cayan 2009)—an estimate that is based on emission scenarios that are being outpaced by current emission rates. With a conservative 1.4 meter rise in sea level, it is estimated the number of San Franciscans at risk to a 100-year flood will increase from 190 to 3,800 (Heberger 2009). In addition to residences, sea level rise threatens to increase risk of flooding hospitals, schools, the San Francisco Airport and other infrastructure, coastal wetlands, and even hazardous material sites, the latter of which can increase the risk of exposure to toxic chemicals of nearby residents and ecosystems (Heberger 2009).

Climate change is also expected to increase the price of basic necessities, which can indirectly impact the health of San Francisco residents. Both the cost of freshwater and energy are expected to increase and the cost of food may rise as well (Ackerman 2008). Low income families already spend a larger proportion of their income on basic household needs, like food, water, and energy than do higher income families (Morello-Frosch 2009). As climate change increases the cost of these basic necessities, low income families will have to spend even more on these basics, increasing their financial stress. Living in poverty is arguably one of the strongest factors of ill-health. While San Francisco is a relatively affluent county, 11.7% of the county's residents still fall below the federal poverty line—a measure that does not likely fully capture financial stress as the cost of living is much higher in San Francisco. As a result, many San Francisco residents will be greatly impacted by rising prices of basic necessities.

Climate change will also increase mental health and stress disorders such as depression and suicide caused by displacement, impoverishment, loss of livelihood, and Post-Traumatic Stress Disorder associated with extreme weather events (McMichael, Woodruff et al. 2006).

Climate Change and Social Equity

The impacts of climate change will not affect everyone the same way. Climate change is expected to more seriously affect the health and wellbeing of the communities in our society that are the least able to prepare for, cope with, and recover from the impacts of climate change. For instance, low income communities and communities of color are expected to be hit harder by extreme heat, extreme weather events, worsened air pollution, and are more sensitive to the economic stresses associated with climate change, like increased prices for basic needs and threat of job loss in the agricultural and tourism sectors (Morello-Frosch 2009). If this "climate gap" is not addressed, climate change will exacerbate many of the health and social disparities among San Francisco residents. Fortunately, many of the actions that address climate change also improve the health and wellbeing of these vulnerable communities. If done right, addressing climate change can also address many of our current environmental and health disparities.

Integrating Public Health Considerations into Climate Change Planning

The interactions between climate change and health are numerous. Not only with climate change have significant health impacts, but how we prepare to mitigate and adapt to our changing climate will also influence health. Many climate change mitigation and adaptation efforts also achieve significant public health co-benefit that in many cases, can improve health disparities. Responding to climate change is a powerful opportunity to improve the health of our city's residents. In addition, some climate planning actions may have unintended negative health or equity consequences that if identified in advance, can be prevented. As a result of the considerable interface between climate planning efforts and health, our City's strong commitment to addressing climate change can be leveraged to simultaneously address longstanding health and equity problems. Partnering with the Department of Public Health (DPH), the Mayor's Office of Economic and Workforce Development, and other city agencies to address climate change also has the added benefit of increasing the efficiency and cost-effectiveness of agency efforts. It may also expand available funding sources for projects that simultaneously tackle health outcomes. Further, for many Americans, health is an important value; framing climate change as a health issue can engage more residents and build support for action (Maibach 2010). The public health community can further help in this endeavor by utilizing its strong public outreach infrastructure and drawing on its relationships with community-based organizations.

Health Implications of San Francisco's Climate Action Plan

This section assesses the health co-benefits and potential negative health impacts of San Francisco's 2004 Climate Action Plan, organized by the CAP's four emission reduction areas: Transportation, Energy Efficiency, Renewable Energy, and Solid Waste. For an outline of these proposed actions, see Appendix A. In addition to exploring the links between the proposed actions and health consequences, it also discusses if any of the proposed actions result in health outcomes that disproportionately benefit or burden our city's most vulnerable populations. As a supplement, this information is visually displayed in matrix form (See Appendix B). Finally, recommendations are made to help the City prioritize climate actions that have health co-benefits, particularly for vulnerable populations.

Transportation Actions

In an effort to reduce transportation-related greenhouse gas emissions, the City of San Francisco plans to increase the use of active transportation (public transit, bicycle use, and walking), and ride sharing as alternatives to driving by improving services and providing financial incentives. Their plan also calls for actions to discourage driving using market mechanisms such as pricing and a gas tax as well as actions to increase the use of clean air vehicles.

Health Co-Benefits

The health benefits of high quality public transportation systems are significant. Accessible, affordable public transportation can provide improved access for physically and economically disadvantaged people to basic needs, including healthy food, health care, education, and jobs. Public transportation can also reduce individual transportation expenditures by reducing the need to own and operate a vehicle and by providing mobility to non-drivers. This frees up household income that can be used to purchase health- related necessities and reduces poverty-related stress (Litman 2011).

A switch from vehicle traffic to other modes, including public transit, walking, and bicycling reduces air pollutants and their negative health effects (WHO 2000; Litman 2011). Air pollution has been linked to asthma, allergies, cardiovascular and respiratory diseases, cancer, neurological and reproductive disorders, and premature death (CARB 2009). In San Francisco, approximately 102,000 children and adults are currently diagnosed with asthma, with children and the elderly having significantly higher rates of asthma (CDPH 2011). In addition, people with lung or heart disease are particularly vulnerable to air pollution (EPA 2010). There are also significant disparities in exposure to and health impacts from air pollution among black and low income residents. The health impacts of air pollution are sensitive to proximity to roadways (WHO 2000), and in San Francisco (BAEHC 2011), as is the case in general for California, ethnic minorities and lower income households are disproportionately represented among populations living in areas of high traffic density (Gunier 2003). This disparity in exposure is mirrored by a disparity in health outcomes. In San Francisco, asthma hospitalization and ED visit rates for Blacks are around four times higher than the next highest race/ethnic group (CDPH 2011). Actions that

Vehicle traffic is also one of the primary sources of community noise pollution, which has been linked to many negative health outcomes, including annoyance, sleep disturbance, hypertension, cardiovascular disease, mental disorder, and impaired child cognition (Passchier-Vermeer 2000). While some residents may be able to move to areas that have lower levels of noise, many cannot. Noise is one of the many physical and psychosocial stressors that when combined, are thought to stunt the socioemotional development of children living in poverty (Evans and English 2002). In addition to those living in poverty, noise also has a greater affect on children and the elderly. In San Francisco, it is estimated that currently around 17% of residents have the potential to be highly annoyed by traffic noise, with risk varying dramatically among neighborhoods, and Chinatown and Civic Center being the neighborhoods with the highest population densities of people annoyed by noise (Seto, Holt et al. 2007). A reduction in this traffic and traffic-related noise can reduce noise exposure and subsequent noise-related health impacts to City residents.

Using bicycling and walking (active transportation) as travel alternatives increases physical fitness and improves mental health (Atkinson 2008; Ewing, Schmid et al. 2008). The health benefits of physical activity are extensive and well documented. A 2008 comprehensive review found that physical activity—even in modest amounts—has been linked with a decrease risk of cardiorespiratory diseases, type 2 diabetes, breast and colon cancer, depression, cognitive decline, all-cause mortality and improved musculoskeletal health (PAGAC 2008). The health benefits of physical activity are particularly strong for youth, the elderly, and the physically and cognitively disabled (PAGAC 2008). Further, increased walking, cycling, and public transit can provide social and community engagement, increasing overall safety and reducing crime rates (Leyden 2003).

Potential Negative Impacts

Vehicle injuries and fatalities, which are a significant and avoidable health burden, are also expected to change with changes in travel modes. While a reduction in driving will reduce the volume of vehicles on the road and could reduce the frequency of collisions, the expected increase in walkers and bikers increases the number of people who are exposed to hazard (SFDPH 2011). Thus, while it is likely vehicle-vehicle collisions will decrease, it is currently unclear whether the actions proposed by the SF CAP will have the cumulative effect of increasing or decreasing vehicle-pedestrian and vehicle-cyclist injuries. In a recent analysis of the health impacts road pricing would have in San Francisco, it was estimated that with the implementation of a road pricing policy in a downtown cordon zone alone, vehicle-pedestrian and vehicle-cyclist injury collisions would decrease compared to a future based on current growth and without additional policies and funding to manage population growth (SFDPH 2011). However, the study suggested that the policy was not sufficient to decrease collisions below current levels, suggesting road pricing alone is not sufficient to deal with the increase in traffic-related injuries that will result from population growth. While road pricing is one of the many actions being pursued to encourage more active transport, the cumulative impact of the City's climate actions on vehicle-related injuries remains unclear. Expanding safety actions beyond infrastructure improvements to include speed limit policies, increased rule enforcement, and education can help moderate any increase in these injuries.

Improved transportation systems that are accessible and affordable are one of many factors that make an area more attractive, and in some cases, may increase local property values and rents, increasing housing unaffordability. An analysis of the impacts of the Bay Area Rapid Transit (BART) system on housing prices over a twenty-year period concluded that homes closer to the system were valued 38% higher than similar homes not located near any BART stations (Landis 1995). A study focused on the impact of BART on rent found that rents were 10-15% higher for rental units within ¼ mile of BART (Cervero 1996). Given the historical impact access to regional transportation has had on property values in the Bay, it is likely improved services will also increase housing prices, which can cause financial strain, housing insecurity, and displacement.

Unaffordable housing is strongly linked with poverty, one of the largest determinants of poor health. The financial strain of unaffordable housing can lead to more families spending excessive amount of their income on housing, leaving insufficient funds to meet other basic needs, including nutrition, medical insurance, and health care. These tradeoffs impact children the most; research indicates children of low- income families that do not receive subsidized housing are more likely to suffer from iron deficiency, malnutrition, and underdevelopment than children in similar families receiving housing assistance (Meyers 1993; Meyers 2005). Frequent moves, eviction, foreclosure, and living in doubled-up housing are related to elevated stress levels, depression, and hopelessness (Guzman 2005). Even less-severe manifestations of instability, such as difficulty keeping up with payments or home repairs, may be linked to lower levels of psychological well-being and a greater likelihood of seeing a doctor (Cohen 2007). Many families may be forced to pool resources and live in crowded conditions. Residential crowding has been linked both with physical illness, including infectious diseases such as tuberculosis and respiratory infections, and with psychological distress among both adults and children; children who live in crowded housing have been found to have poorer cognitive and psychomotor development or be more anxious, socially withdrawn, stressed or aggressive (CHIWG 2005). In extreme cases, families may be forced to move, which can erode neighborhood social cohesion, a long-established health-protective factor (Patrick 1995). A lack of affordable housing stock can also lead to homelessness, which contributes to a number of physical, behavior, and mental health problems in adults and children (Guzman 2005).

Recommendations

Account for population growth
It is expected that both population density and vehicle ownership in the Bay Area will grow over the next few decades (MTA 2005), increasing the health burden associated with our transportation system. While many of the CAP actions also have the co-benefit of moderating this increase in health burden, it may not be sufficient to deal with the excess air pollution, noise, vehicle collisions, and potential impacts on housing affordability that the projected growth in population and vehicle ownership will bring. This suggests that more aggressive actions may be necessary.

Protect pedestrian safety
While a reduction in driving will reduce the number of vehicles on the road, the simultaneous increase in bicyclists and pedestrians has the potential to increase the number of vehicle-cyclist and vehicle- pedestrian collisions. The CAP recognizes the need for roadway safety actions; however, expanding these to include both infrastructure improvements and other measures like speed limit policies, increased rule enforcement, and education can help moderate any increase in vehicle collision injuries.

Prioritize strategies that reduce vehicle-miles traveled and increase physical activity
According to the 2000 Census, 40.5% of SF residents drive alone to work (SFCAP 2004). Prioritizing actions that encourage these residents to switch from this mode to active transport (bicycling, walking, and public transport) over actions that encourage a switch to carpooling or increased fuel efficiency can greatly reduce GHG emissions but with the added benefit of increasing physical activity and improving the City's burden of disease. For instance, the emphasis of the city to increase the use of ridesharing, while an alternative to driving alone, misses the opportunity to increase active transportation and its subsequent health benefits. Further, the inclusion of the Safe Routes to School Program in the next CAP can increase the use of alternative mode use, bring health co-benefits to children, and increase community cohesion.

Target transportation improvements to reach the most vulnerable populations

From air pollution to noise to cost, many of the health-related burdens associated with our transportation system affect some populations more than others. In order to balance the burdens of our transportation system with the benefits placed on certain communities, special efforts should be made to target service improvements to particularly benefit low income residents, communities of colors, the elderly, and neighborhoods that have a historical legacy of dealing with higher levels of environmental exposures. The addition of bus lines and transit improvement can be more heavily prioritized in low-income neighborhoods and neighborhoods that lack access to transportation during an extreme heat event. Further, efforts to ensure public transit is affordable to all of the City's residents should be prioritized. While the CAP cites the price of a one-way base fare compared to that of other major transit systems in the country as evidence of the system's affordability, a more detailed analysis of transportation affordability in the Bay Area suggests that transit costs remain unaffordable for some low-income households (Rice 2004). To ensure transit remains affordable after the expansion and improvement of services, it is important to pursue policies that increase affordability for low income communities, such as discount transit fares or allowing low-income households to locate near places of employment or transit hubs.

Strengthen efforts to create sufficient affordable housing in San Francisco

The loss of affordable housing is a long-standing issue for San Francisco. To ensure this problem is not maintained or exacerbated by proposed transportation improvement projects, public policies aimed at combating affordable housing loss should be augmented. Including support for mixed-use and transit- oriented development with affordable housing provisions in future CAP revisions can help reduce demand for vehicle travel, while improving the health of individuals, and helping ensure the benefits of a quality transportation system accrue to all of our City's residents (see overall recommendations).

Key Agencies and Partners: San Francisco Municipal Transportation Agency, Mayor's Office of Housing, San Francisco Redevelopment Agency

Energy Efficiency Actions

Increasing the energy efficiency of San Francisco's buildings has large potential to significantly reduce greenhouse gas emissions. To improve energy efficiency, City Actions focus on increasing energy efficiency incentives, direct installation, and technical assistance for residential, commercial, and municipal buildings; expanding education; and strengthening legislation, codes, and standards.

Health Co-Benefits

The indoor environment has a significant impact on health. We spend about 90% of our time indoors, and yet indoor air quality can be worse than outdoors (EPA 2011). Indoor health hazards can include biological contaminants like mold, viruses, allergens, pet dander, dust, and pests; toxic chemicals from household cleaners, pesticides, and products that off-gas; and second hand tobacco smoke. These hazards can then become concentrated without proper ventilation. A building's indoor humidity, temperature, and lighting can also affect how individuals respond to their indoor environment (CDC 2011). These indoor health hazards can result in a range of health problems, including acute respiratory illness, asthma, infectious diseases, mental health disorders, impaired cognitive development and cancer (Jones 1999; Fisk 2000; Younger 2008; EPA 2011). These negative conditions, which are characteristic of substandard housing, particularly effects vulnerable populations, and specifically low income and people of color (Younger 2008).

Many energy efficiency actions, like replacing household appliances, including HVAC systems and lighting fixtures, and requiring LEED certification in new municipal buildings, will impact the indoor environment of these buildings. Many of these changes can affect the air quality, dampness, presence of pests and infectious agents, and temperature inside a building—all of which can impact our health (IPMVP 2002). Many energy efficiency practices and design characteristics that increase thermal control, improve ventilation, decrease moisture, and improve lighting can improve indoor environmental quality, minimizing acute respiratory diseases, asthma, allergies, non-specific health outcomes (sick building syndrome symptoms), and building-related illness (IPMVP 2002). Green building techniques that improve natural daylighting in homes and offices have other co-benefits besides energy savings, including improvement of eye strain, stress, seasonal affective disorder (SAD) and overall psychological wellbeing, and productivity (Edwards 2002).

Low income populations stand to benefit the most from energy efficiency, retrofit, and weatherization programs. They are more likely to live in older, sub-standard housing that is unhealthy and inefficient.

Not only do inefficient buildings increase energy bills (CEC 2010), low-income populations spend a disproportionately higher amount of their household income on energy expenditures (CEC 2004). Improved household energy efficiency can reduce home utility bills, providing extra resources for food, education, health care and other health-improving expenditures. Reducing energy costs for low income households is particularly important as climate change is projected to increase the cost of basic necessities, including electricity, which will disproportionately impact low income households (Shonkoff 2009).

Potential Negative Health Impacts

While there are many possible improvements energy efficiency actions can bring to indoor environmental quality and subsequently to health, there may be unintended health consequences. For instance, the introduction of new building materials in the retrofit and weatherization process may introduce toxic chemicals like volatile organic compounds (Levin 1989; Wargo 2010). Many materials like caulks, adhesives, paints/stains, and sealants can emit volatile organic compounds which cause eye, nose and throat irritation, headaches, nausea, damage to organs including the liver, kidney, and central nervous system, and may cause cancer (Jones 1999; EPA 2011). Children and pregnant women are especially susceptible to the adverse affects of these chemicals.

Weatherization efforts that focus on improving the building envelope, like replacing windows and improving insulation, not only reduce the amount of energy needed for heating and cooling, but can decrease the infiltration of pests and allergens. However, excessive "tightening" of a building, without providing an alternative air supply, will concentrate indoor pollutants and worsen indoor air quality (Jones 1999; EPA 2011). Potential negative indoor air quality impacts of energy efficiency actions may be of concern not only for pre-existing buildings, but for new construction as well. In 2008, San Francisco enacted a Green Building Ordinance requiring all newly constructed residential and commercial buildings, and large renovations to existing buildings to acquire LEED or GreenPoint Rated certification (SFDBI 2011). While green building rating systems move us in the right direction when it comes to energy efficiency, the systems do not necessarily mean indoor air quality issues are addressed (Srebric 2010; Wargo 2010). For example, while LEED has in "Indoor Air Quality" category, it is technically possible to get the highest Platinum rating without addressing any of the Indoor Air Quality criteria. While it is unlikely no IAQ criteria will be addressed due to their relative ease of implementation, this certification program—originally designed to green the building process—offers little assurance of health protection of building inhabitants (Srebric 2010; Wargo 2010). LEED certification may not adequately address human health threats from formaldehyde in insulation, environmental tobacco smoke, pesticides, flame retardants, BPA, PVC, and other health threats (Wargo 2010). Indentifying this gap in green building standards, the City of San Francisco passed an ordinance in November, 2011 requiring all new municipal buildings and construction over 5,000 feet to meet seven LEED credits specifically aimed at improving indoor air quality during construction (EQ 3.1) and before occupancy (EQ 3.2), and using low- emitting materials (EQ 4.1-4.5). In addition, the ordinance proposes the DPH, in consultation with the Department of Environment, monitor Indoor Environmental Quality (IEQ) problems, including indoor air pollution, odors, humidity problems, and thermal and acoustical comfort issues in City-owned buildings and City leaseholds. The DPH will use these tracked results to coordinate research and interventions relating to prevention and control of IEQ problems, and will provide outreach and education programs for City Departments and design professionals on the importance of IEQ management.

The City's CAP also plans to increase residential energy efficiency by replacing traditional incandescent lighting with fluorescent lighting. Fluorescent lights contain mercury, largely in the form of elemental mercury, which if inhaled can cause acute symptoms including tremors, emotional changes, headaches, changes in nerve responses and sensations, insomnia, and cognitive performance deficits. At high exposure levels, it can cause kidney effects, respiratory failure and death (EPA 2010). While the amount of mercury in each bulb is very small, chance of acute household exposure from broken bulbs may exist (Tunnessen, McMahon et al. 1987). While household exposure risk is relatively low and overall mercury levels will be lower due to reduced levels released from burning coal (EPA 2011), precautions to dispose of whole and broken bulbs properly should be taken. Although household risk is low, occupational exposures may be higher. Evidence suggests elevated airborne levels of mercury in the vicinity of recently broken bulbs can exceed the EPA's reference concentration of 300 ng/m3, suggesting occupation exposure for sanitation workers involved in recycling fluorescent bulbs may exist (Aucott 2003).

In addition to potential negative health outcomes, some of the benefits of energy efficiency programs will not accrue equally to all residents. Almost two-thirds of San Francisco residents are renters (ABAG 2010). However, one of the qualifications for San Francisco's home upgrade energy efficiency program is that you be a homeowner (SFE 2011). Further, while upgrades can reduce operating expenses and increase property value, landlords may think they lack the financial incentive to participate in energy efficiency programs. As a result, many of the benefits of retrofit and weatherization programs accrue to those who are home owners and those with high incomes. Without an explicit focus on multi-family and rental housing and low income households, the City will miss the opportunity to improve the energy efficiency of the majority of the City's housing stock, while simultaneously improving the health and affordability of housing for the city's most vulnerable.

Recommendations

Use the City's recent update to the Green Building Ordinance requiring new municipal buildings meet indoor air quality criteria as a model for new residential and commercial buildings. While green building rating systems can improve the environmental impact and energy use of new buildings, it does not necessarily ensure those buildings will be healthy for the building's occupants. Recognizing this gap, the City passed a municipal building ordinance in November 2011 that requires specific LEED IAQ requirements during construction and before occupancy to be met for municipal buildings. It also proposes the DPH monitor IEQ problems in new municipal buildings and use that information to coordinate research, intervention, and outreach efforts. This municipal building ordinance should be used as a model for the creation of similar requirements for new residential and commercial buildings.

Specifically target energy efficiency and retrofit programs toward renters, low-income homeowners, Single-Room Occupancy (SRO) hotels, and those living in the oldest buildings. By prioritizing these communities, the City will improve the affordability, health, and efficiency of the majority of San Francisco's housing stock. To accomplish this, the City should design financing and outreach strategies specific for renters and low-income populations, with measures to prevent any displacement that may occur during and after construction.

Combine energy efficiency retrofits with health home improvements targeting unsafe housing stock. Developing methods for retrofitting low-income apartments and single-room occupancies (SROs) that achieve energy savings and simultaneous indoor air quality improvements can make low-income residents more resilient to increasing energy prices and improve their health. In addition, combining energy efficiency retrofits with healthy home upgrades, like lead and asbestos abatement, and mold control and prevention, can improve the overall health of SF's housing stock. For instance, identifying and starting with win-win actions, such as window retrofits that can improve building efficiency and remove old window's lead-based high gloss trim and furnace retrofits of existing housing in air quality hot spots, can efficiently improve energy use and indoor environments.
The DPH has already outlined a methodology for identifying neighborhoods at highest risk of poor indoor environmental quality, which can be used to identify those who can benefit the most from these energy and health upgrades. Further, existing programs can be looked to as models for achieving energy and health co-benefits. For instance, the DPH has created a project to perform furnace retrofits for Potrero Hill residents that will both improve energy efficiency and indoor air quality.

Create a comprehensive program that provides energy efficiency retrofits, healthy home upgrades, and green job programs for environmental justice communities. Many communities in San Francisco have a history of being unfairly burdened by the City's transportation, economic, and energy systems and not receiving a proportionate amount of community benefits. These burdens have directly impacted the health of these communities. For instance, many Excelsior neighborhood residents experience higher levels of noise and air pollution and hazardous pedestrian conditions due to their proximity to the Interstate 280. Residents of Bayview Hunter's Point and surrounding Southeast San Francisco—home to the heaviest concentration of industrial uses in San Francisco, a recently shutdown power plant, and one of the most toxic SuperFund sites in the nation—suffer from poor housing quality including asbestos, lead, and mold contamination, traffic-related pollution from Interstate101 and 280 freeways, and poor health outcomes, including the highest rates of asthma hospitalization in the City, and high rates of respiratory disease and cancer (BAEHC, Katz, greenaction).]

While the PG&E and San Francisco Department of Environment joint Peak Energy Program focuses on replacing lighting and coin-operated washing machines in multi- family units and in Bayview Hunters Point (SFCAP 2004), a comprehensive program or series of retrofit projects that combines energy efficiency improvements, healthy home upgrades like lead and asbestos abatement, and a green jobs training program and employment agreements with the City can help begin to mitigate historical environmental health inequities. It will also provide employment opportunities that increase economic stability and help ensure these residents receive the economic benefits of a new green economy. Several efforts already underway can be used as a model for a comprehensive program. For instance, funded by Mirant Power Plant settlement funds, the DPH has created three projects for impacted Potrero Hill residents, including furnace retrofits that will improve indoor air quality and energy efficiency, and community gardens that aim to increase local food access and improve health. These projects can be used as models for future projects and programs that aim to achieve climate change and health co-benefits among vulnerable populations. Another project that attempts to achieve simultaneous economic, health, and energy benefits, is the City's HOPE SF program. While directed at rebuilding public housing in the Bayview Hunters Point neighborhood, it can also serve as a model for achieving climate change, health, and economic co-benefits.

Incorporate air quality outcomes in commercial building commissioning. The city's proposed program to train and certify building operators and building commissioning contractors to better manage a buildings energy usage, including heating, ventilation, air conditioning, lighting and domestic hot water equipment, can also be used to improve indoor air quality conditions. Training building operators on how to maximize energy use while maintaining conditions that promote indoor air quality can ensure improved energy management systems do not lead to poor indoor environments and health problems. Further, efforts to provide individualized energy management services to SF's largest customers should also offer air quality audits.

Ensure building materials containing harmful toxins are avoided in new building and upgrades to existing homes. Recognizing the threat toxins and chemicals in building materials poses, the City passed a municipal building ordinance in November 2011 requiring five specific LEED credit requirements be met to ensure the use of low-emitting materials and the control of indoor chemical and pollutant sources. Using this municipal building ordinance as a model for commercial and residential building ordinances can help protect workers and residents from indoor pollutants.

Regulate the mercury content of light bulbs installed in new residential and commercial buildings and educate residents on proper fluorescent bulb disposal. The City has recently updated their green building standard to include limits for the amount of mercury in luminaire lights installed in municipal buildings. Ensuring a similar standard applies to commercial and residential buildings can reduce potential mercury exposure. In addition, SF Environment, Recology, and DPH can partner in education and outreach efforts to ensure residents properly manage and dispose of broken bulbs.

Key Agencies and Partners: San Francisco Department of Environment, San Francisco Public Utilities Commission, San Francisco Department of Public Health, Recology

Renewable Energy Actions

In addition to demand-side management, the City's Climate Action Plan also plans to develop renewable energy projects in solar, wind, and biomass, conduct pilot projects in tidal power and hydrogen fuel cells, and support green power purchasing.

Health Co-Benefits

Increasing the City's renewable energy usage can reduce demand for coal energy generation, reducing greenhouse gas emissions and generation of air pollution. Regional air quality will also improve as the amount of methane gas released into the air is reduced through biogas recovery at waste treatment facilities. In addition, a switch to renewable energy sources can reduce the occupational health injuries associated with fossil fuel energy production (Sumner 2009).

The use of household solar panels not only reduces demand for coal-derived electricity, but also has the potential to reduce household utility bills (USDOE 2009) and increase property value (Hoen 2011). Reducing household utility bills frees up household income while increasing poperty values can contribute to household wealth, both of which lessen financial strain which has myriad health benefits.

Photovoltaic (PV) solar panels generally have few environmental impacts during their use, and do not generate noise or chemical pollutants or radioactive substances during their use (Tsoutsos, Frantzeskaki et al. 2005). In urban environment, modern PV systems, which are architecturally integrated into buildings, are able to provide a direct supply of clean electricity that is well matched to the demand of the building, but can also contribute to day-lighting, and the control of shading and ventilation, improving indoor environmental quality (Tsoutsos, Frantzeskaki et al. 2005).

Potential Negative Health Impacts

While PV solar panels have few environmental impacts during their use, they do contain a small amount of toxic substances and it may be theoretically possible for these to be released in a fire (Tsoutsos, Frantzeskaki et al. 2005). A greater potential risk of the installation of solar PV panels in an urban environment is the potential electrocution or shock to emergency responders during a fire if they come into contact with an inadequately marked high voltage conductor (ODOT 2010).

Wind power produces no air or water pollution and involves no hazardous substances other than those commonly found in large machines (Brower 1992). However, large and small-scale wind turbines do produce aerodynamic and mechanical noise (Alberts 2006). Small-scale wind turbines, while developed for use in an urban setting, still produce noise that may contribute to community noise levels. The human health impacts of noise exposure include annoyance, sleep disturbance, hypertension, cardiovascular disease, mental disorder, and impaired children's cognition (Passchier-Vermeer 2000). As mentioned, noise is one of the many physical and psychosocial stressors that when combined, are thought to stunt the socioemotional development of children living in poverty (Evans and English 2002).

Recommendations

Use renewable large-scale wind energy generation projects as opportunities to improve the environment and health of environmental justice communities. One of the locations the City is monitoring as potential sites for large-scale wind generation is the Hunters Point Shipyard. As discussed in the prior section, this is an environmental justice community comprised of low income communities of color who have a legacy of suffering from environmental, health, and economic inequalities. The development of wind resource infrastructure in this community, without proper consideration of potential environmental and health impacts, may add an additional burden to the residents of Bayview Hunter's Point. Given the potential for noise-related environmental and health risks from large-scale wind turbines, any future plans to build wind generation facilities in traditional environmental justice communities (such as at the considered Hunters Point Shipyard) should include working with the community in a meaningful way, explicitly addressing and planning for any environmental and health impacts, and balancing the burdens with benefits, like reduced electricity rates, community benefits fund, wind facility employment, etc.

Consider potential noise impacts on residents of small-scale wind turbines when determining site location. With a high population density, noise from traffic, construction, HVAC systems, and other sources all contribute to community noise levels. Ensuring that small-scale wind turbines are sited in areas that do not currently have high noise levels can minimize health impacts. To aid in determining the safest site locations, the DPH has data on noise-related complaints and has even modeled the spatial distribution of traffic-related noise levels for the city, which can all be used to determine a neighborhood's noise burden.

Target the placement of solar panels on multi-family buildings, rented properties, and low income housing. While San Francisco provides larger solar installation incentives to low-income homeowners, the City's SolarSF program still requires homeownership and tends to favor those who can afford the initial investment. In addition, statewide programs like the California Solar Initiative's Single Family Affordable Solar Homes program, while providing highly or fully subsidized solar incentives, also only targets homeowners. Since the majority of San Francisco residents are not homeowners, the creation of a solar panel installation program that specifically targets renters and landlords will help ensure the benefits of solar reach all SF residents while augmenting renewable energy use.

Increase awareness of CleanPowerSF as it is rolled out and ensure low-income residents are not restricted in their participation. CleanPowerSF is the City's Community Choice Aggregation Program which allows San Francisco to pool their citizens' purchasing power to buy electricity generated from 100% renewable sources. Currently, all SF residents have to get their power from PG&E, which is derived from coal, natural gas, and nuclear. CleanPowerSF will provide residents with an alternative to PG&E-sourced energy. While energy rates from CleanPowerSF will be higher in the short-term, the program should offer long term rate stability, and low-income discounts will still apply to CleanPowerSF customers. In order to ensure these communities are included as the program is phased in, a continuous monitoring of participation should be made to evaluate if the low-income discount is appropriate for meaningful involvement. This program will allow households and renters unable to purchase their own renewable energy generation technology to participate in the clean energy economy.

Key Agencies and Partners: SF Department of Energy, SF Public Utilities Commission, SF Department of Public Health, Bayview Hunters Point Health and Environment Resource Center

Solid Waste Actions

The City of San Francisco's CAP calls to increase residential and commercial recycling and composting, expand construction and demolition debris recycling, and support alternate collection methods for recyclable materials, including an e-waste recovery program.

Health Co-Benefits

San Francisco's progressive recycling and composting program has resulted in significant diversions of waste from landfills. Expanding these programs and decreasing the landfill stream further will reduce landfill gas, including methane, CO2, and VOC emissions, improving air quality. While placing electronic waste in the landfill stream is illegal in the State of California, new programs to recover electronic waste can reduce the amount of illegal heavy metals, including mercury and cadmium that still make it into landfills. These heavy metals and other substances can leach out of landfills and contaminate groundwater (Recology 2011). Reducing the amount of electronic waste in landfills can improve groundwater contamination in the region.

Potential Negative Health Impacts

An increase in sorting and recycling of waste and of composting can increase occupational exposure to microorganisms and toxic products (Poulsen, Breum et al. 1995). Exposure to organic dust at composting workplaces is associated with adverse acute and chronic respiratory health effects (Domingo and Nadal 2009). Exposure to hazardous materials and dangerous objects has already been an issue at the new Pier 96 Materials Recovery Facility in Bayview Hunter's Point, which processes the recycling of industrial materials. In March 2011, an object resembling a smoke grenade was found at the facility resulting in evacuation of the facility (Examiner 3/8/2011). In August 2010, a white powder, later identified as ammonium phosphate, was released into the air requiring the evacuation of the facility, and affecting over a dozen people, including one who was sent one to the hospital (Appeal 8/27/2010).

Workers involved in metal recycling face additional risk from potential exposure to lead. Workers can be exposed to significant levels of lead when torch cutting painted and unpainted metals and new steel. And recycling companies have been found to not recognize potential sources of lead exposure and underestimate the degree of exposure (NYDH 2007). In addition, metal recycling workers are also at risk of exposure to toxic chemicals (CDC 7/22/2010).

Recommendations

Expand e-waste recycling efforts, including creating neighborhood-based drop-off facilities. Currently, residents can dispose of certain electronics by delivering them to Recology in San Francisco; household hazardous materials like paint and chemicals must be dropped off at the Hazardous Waste Collection facility; household batteries can be dropped off at participating locations; and fluorescent lamps can be dropped off at neighborhood drop-off sites established by the City. An e-waste program that coordinated collection locations into a more centralized neighborhood drop-off center or has scheduled e-waste pickup could increase usage of the program, eliminating the amount of e-waste stored in people's homes—a potential health hazard. Further, education and advertising efforts to notify residents of the e-waste recycling program can increase the use of the program.

Require electronics manufacturers to collect and recycle their products. Requiring manufacturers to take back their old electronics is another important option to help augment the City's e-waste recycling efforts without having to shoulder the costs. In 2008, New York City did just that, becoming the first municipality to pass an e-waste recycling bill requiring manufacturers to create a collection program for any New York City resident who wanted to dispose of their products.

Engage with local recycling companies to ensure workers are appropriately protected from hazards. In particular, research conducted by the New York Public Health Department found that recycling companies there did not recognize potential sources of lead exposure and underestimated the degree of exposure during metals recycling. Working with these companies to ensure these and other hazards during the recycling process are recognized can help protect occupational health.

Key Agencies and Partners: Recology, SF Department of Environment, Mayor's Office, SF Department of Public Health

Other Recommendations

Increase tree and vegetation density in areas with low relative tree density. Increasing tree canopy and green space not only sequesters greenhouse gases and reduce need to heat and cool buildings, they can improve local air quality, reduce noise pollution, and in areas of high building density, can improve the city's heat-island effect (Dwyer 1992). Reducing the potency of the heat-island effect can protect neighborhood residents from the impacts of heat waves. While the health benefits of tree canopy are numerous, these benefits do not accrue equally to everyone. Research has shown that in San Francisco, the amount of tree cover in a community is negatively correlated with community poverty level and also with proportion people of color (Morello-Frosch 2009). This suggests low income people and people of color in San Francisco will be disproportionately exposed to heat-island effects and subsequent health impacts. Increasing tree cover in neighborhoods that suffer the most from the urban heat island effect can help the City's most vulnerable neighborhoods and residents adapt to the impacts of climate change.

Ensure land use and development policies easily support transit-oriented development and mixed land use. Transit-oriented development refers to placing homes, jobs, retail and services in close proximity to bus stops, rail stations and other transit service locations. The type of development typically requires compact development, mixing land uses, and pedestrian and bicycle-friendly streets (MTC 2006). By shortening the distance people have to travel to get to work, school, and access other resources, you lessen the vehicle-miles they travel and transportation-related greenhouse gas emissions. These land use policies also have great health co-benefits, including improved air quality and more opportunities for physical activity. On a community level, it has been shown that residents who live in more multi-modal and mixed land-use communities exercise more and are less likely to suffer from obesity and hypertension (Frank 2004; Ewing, Schmid et al. 2008). Incorporating affordable housing provisions into these development projects can ensure the numerous benefits of living in a smart growth community accrue to all residents. This long-term strategy for changing transportation patterns and reducing the need for vehicle travel has more immediate health benefits for those living in these communities. While some transit-oriented development projects have progressed in San Francisco, coordinating plans with the Bay Area Air Quality Management District's Sustainable Community Strategy (SCS) and incorporating it into the City's Climate Action Plan can harmonize efforts and garner more support.

Reduce greenhouse gases by reducing emissions from stationary sources that contribute to air and health problems in highly impacted neighborhoods. While the Bay Area Air Quality Management District is the state agency responsible for implementing control measures on stationary sources of air pollution in the Bay Area, the City can encourage and ensure these control measures are implemented by coordinating with the State to make sure all new sources are reviewed and existing sources are in compliance.

Develop a climate change adaptation plan with multiple-agency and community involvement. While many climate change actions reduce greenhouse gas emissions also make our communities more resilient to the impacts of climate change, additional actions will be required to ensure we are prepared for an increasingly changing climate. Efforts to protect San Francisco communities from sea level rise, heat waves, air pollution, economic stress and other impacts will require coordinated effort of multiple agencies, including the DPH, SF Department of Emergency Management (SFDEM), SF Department of Environment, and Office of Economic and Workforce Development.

Incorporate community involvement in the development of future climate change mitigation and adaptation actions. Many climate change actions ultimately require behavior change of San Francisco and Bay Area residents. Engaging these communities in climate change planning will strengthen the effectiveness of planning efforts. Further, including low income communities, communities of color and other vulnerable groups that will be hit hardest by climate change impacts in the decision making process surrounding how we prepare for and respond will result in more effective plans that supplement technical knowledge with community wisdom and an understanding of variation in the vulnerability of different neighborhoods.

Develop and support green jobs training and employment opportunities for low income communities. Low-income communities will be hit the hardest financially from the impacts of climate change, which if not addressed, will widen economic and health disparities. Supporting "green collar" job creation can help ensure these communities are not left behind in a transition to a green economy. Efforts to train and fill new jobs in the renewable energy sector and efforts to tap into pre-existing green job training pipelines to complete the energy and water efficiency retrofit and weatherization work supported by the city can help develop a local green collar job infrastructure.

Expand support and promote local food systems and access. Producing food locally reduces the distance food has to travel from produce to consumer, reducing greenhouse gas emissions associated with our food system. Promoting a local food system that readily connects producers with consumers, through farmer's markets, CSA programs, and farm to school/ community programs, and that supports resident gardening can create more equitable healthy food access. Improving poor nutrition can also improve the associate health programs, include obesity and type 2 diabetes. Low income residents are particularly affected by diet-related disease and would benefit from improved health food access. For instance, create a centralized kitchen in San Francisco to serve city schools.

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