# Best Practices for Climate Change and the Sustainable Design and Operation of Neighborhoods and Communities

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# BEST PRACTICES FOR CLIMATE CHANGE AND THE SUSTAINABLE DESIGN AND OPERATION OF NEIGHBORHOODS AND COMMUNITIES

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## EXECUTIVE SUMMARY

Climate change creates new challenges for the sustainable design and operation of neighborhoods and communities. The scientific community has clearly described and documented the role of anthropogenic greenhouse gases as drivers of climate change, as well as the increasingly pervasive consequences of climate change for people and the environment. Increasingly effective litigation and advocacy are making it clear that governments and companies will be held accountable for their action (or inaction) associated with climate change. Elected officials have responded to changes in public opinion, and they are moving to create policies to establish goals and the rules-of-the-road for a carbon-constrained economy. Taken together, scientific, legal, advocacy, and public policy developments create an imperative for action. The next step in the evolution of this issue will be moving from the emerging consensus surrounding the "big picture" to the hard work of achieving results on the ground. This change will place community planners and developers on the frontlines of both climate mitigation and adaptation. They will be asked to consider the role of neighborhoods and communities as contributors of greenhouse gas emissions, as well as to explicitly assess the consequences of changing climatic conditions. Fortunately, planners and developers can take action to address these new responsibilities while developing high-performance, sustainable neighborhoods and communities.

Current best practices include: (1) conducting an initial screening-level assessment of the consequences of climate change for a specific neighborhood or community, including contributions to the drivers of climate change (greenhouse gases) and exposure to the consequences (e.g., rising temperatures, changing precipitation patterns), (2) developing a quantitative greenhouse gas emissions inventory, (3) using information from the inventory to identify and prioritize emission reduction strategies, (4) use information from the climate change screening assessment to identify and prioritize opportunities to make the neighborhood or community more resilient to changing conditions.

Planners and developers who take these actions will be able to reduce the risk of regulatory surprises, minimize future liabilities, and potentially create new business opportunities.

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## INTRODUCTION

*Climate is changing.* Over the last century, global surface temperatures have climbed nearly 1°C accompanied by significant changes in important climatic metrics, such as extreme precipitation events, daily low temperatures, diurnal temperature range, and global sea level.[1] The scientific community has concluded that these changes are being driven by the emission of greenhouse gases associated with fossil fuel combustion.[2] Changing climatic conditions and society's continuing contribution to the drivers of change create new risks, responsibilities, and opportunities.

The implications of climate change reach across the economy as a whole. However, the focus here is limited to the implications for the design, construction, and operation of neighborhoods and communities ("communities"). Communities are long-term, capital-intensive investments that require years to build and are expected to perform for decades into the future. This paper considers two key issues:

(1) How can communities manage risks and opportunities associated with emission of greenhouse gases?

(2) How can communities adapt to limit adverse impacts to people and the environment associated with changing climatic conditions?

***Box 1.*** *Summary of key findings from the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report, Working Groups I and II.*[3]

- It is likely that *"…anthropogenic warming has had a discernable influence on many physical and biological systems."*

- Greenhouse gas emissions are contributing to climate change including:
  - Warmer temperatures, fewer cold days, more frequent hot days and nights
  - Increasing frequency of warm spells and heat waves
  - Increasing frequency of heavy precipitation events
  - Expansion of areas affected by drought
  - Intensification of tropical storms
  - Rising sea levels and increasing incidence of extreme high sea levels

- Climate change is associated with impacts on:
  - *Water resources:* changes in water availability; increased water stress
  - *Ecosystems:* increasing risks of species extinction, shifts in species ranges
  - *Food production:* changes in productivity and crop viability
  - *Coastal environments:* increased damage from floods and storms
  - *Human health:* increasing burden from cardio-respiratory, infectious disease; morbidity and mortality associated with heat waves, floods, and droughts.

## MOTIVATION FOR ACTION

This paper does not claim to review the science of climate change. Readers are referred to any number of excellent summaries, particularly the periodic reports from the Intergovernmental Panel on Climate Change (IPCC) (Box 1).[4] Most assessments over the last decade have reached similar conclusions: climate is changing as the result of human activities, with significant implications for people and the environment. Greenhouse gas emissions associated with the combustion of fossil fuels are the primary driver, and climatic conditions in the years ahead are likely to be substantially different from those observed over the last century.

The implications of climate change for planners and developers are mediated by an increasing dynamic web of policies, regulatory interpretations, and public processes. A comprehensive review is beyond the scope of this paper; however, the following sections describe five of the most relevant milestones for community planners and developers:

1. The United Nations Framework Convention on Climate Change
2. California's Global Warming Solutions Act (AB 32)
3. California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA)
4. Climate change-related information disclosure
5. U.S. Supreme Count: *Massachusetts v. U.S. EPA*

### *UN Framework Convention on Climate Change*

Much attention is given to the failure of the United States to ratify the Kyoto Protocol. However, the U.S. is a signatory to the United Nation's Framework Convention on Climate Change, and this provides key expression of national interests and goals with respect to climate change policy. In 1994, the U.S. Senate ratified the UNFCCC and, in so doing, aligned itself with the goal of avoiding "dangerous anthropogenic interference" with the climate system. This objective remains one of the most important and definitive expressions of global commitment to combating climate change; one that the U.S. fully supported.

**Bottom-line: The U.S. has made a long-standing national commitment to address the causes and consequences of climate change.**

### *California's Global Warming Solutions Act*

It is a big jump from 1994 to 2006, with a myriad of important climate change-related landmarks (e.g., the Kyoto Protocol). However, from the point-of-view of a planner or developer this period of time was relatively quiet. In 2005, it became clear that change might be on the way in California, and in the closing hours of the 2006 legislative session, California passed Assembly Bill 32, the *Global Warming Solutions Act* (AB 32).

While not the first state-level action addressing climate change, AB 32 is the most far-reaching. It creates an economy-wide cap on greenhouse gas emissions and lays out enforceable emissions reduction goals starting with 25% by 2020. The California Air Resources Board has begun a rule-making process that will culminate in legally enforceable greenhouse gas reduction targets and a mechanism for trading greenhouse gas allowances between parties.

**Bottom-line: AB 32 articulates a substantial vision for addressing climate change. Subsequent rules and regulations required to achieve its goals may have profound implications across the economy.**

***Box 2.*** *The consequences of climate change for the standard-of-care expected of planners and developers.*

The concept of a "standard-of-care" is central to understanding expectations about the performance of the built environment. The concept dates from English Common Law which held that services should be provided in a careful and prudent manner that is consistent with the level of skill practiced by other members of the profession. The professional notion of standard-of-care is different from legal standards or compliance with regulatory codes. Standard-of-care evolves over time in response to changing market conditions, technology, and customer expectations. Practitioners monitor standard-of-care by reading articles in the professional press, reviewing product literature, attending training, examining work from professional peers, and participating in professional education and dialog through teaching and writing.

Planners and community developers need to watch carefully for changes in the standard-of-care associated with climate change. Increasing scientific consensus surrounding the drivers and impacts of climate change are building a substantial foundation of information. The breadth and depth of this information make it increasingly difficult to claim ignorance of these issues. Moreover, courts have found that it is feasible for organizations to explicitly consider the implications of these findings and seek practical mitigation measures. Increasing levels of public interest and awareness of this issue are causing customers to ask for accountability, and lead-edge planners and developers are already taking action. At some point, these factors may contribute to a shift in the accepted standard-of-care toward more explicit consideration of climate change-related issues. It is impossible to say exactly when this shift may occur, but prudent planners and developers will not wait to find out.

## *CEQA and NEPA*

AB 32 set the bar for California, but this action alone was not sufficient to create new mandates for planners or developers. The confluence of AB 32 and recent interpretations of the California Environmental Quality Act (CEQA) have tipped the balance from intangible goals to an imperative for action. CEQA is intended to protect California's environment by identifying significant environmental issues and identifying opportunities

to avoid or mitigate impacts. CEQA applies to activities with a potential physical impact on the environment, such as zoning ordinances or the approval of subdivision maps. A series of legal interpretations, based in part on concepts articulated in AB 32, have created a new requirement to address climate change within CEQA documentation.[5] This change has brought climate change to the doorsteps of planners and community developers.

One focal point for this discussion has been a series of actions by Office of the California Attorney General (AG). In a letter dated March 30, 2006, Deputy Attorney General Kathryn Egolf provided a series of comments on the Orange County Transportation Authority (OCTA)'s Draft Program Environmental Impact Report (DPEIR).[6] Egolf noted that the state government has *"acknowledged the true environmental impacts of greenhouse gas emissions on climate change."* This statement is based on Governor Schwarzenegger's Executive Order S-3-05 which includes a series of findings on the implications of climate change for California. The Executive Order concludes that *"…mitigation efforts will be necessary to reduce green house gas emissions and adaptation efforts will be necessary to prepare Californians for the consequences of global warming…"*

The AG's letter indicated that DPEIR's prepared in accordance with CEQA must identify and focus on the "significant environmental effects" of a proposed project. The letter continued that greenhouse gas emissions associated with the projected 45% increase in Vehicle Miles Traveled (VMT) may constitute such a significant impact and "should have been considered and analyzed" in the EIR. Moreover, the AG concluded that such an analysis was feasible because data are readily available and the proposed action could incorporate mitigation measures. The issue was resolved when the OCTA agreed to: (1) include a discussion of GHG-related impacts in its revised EIR, (2) inventory GHGs within the project area, and (3) work with the State's climate action team. *"Based on these actions, the Attorney General will not pursue legal action related to the environmental documentation…"* This AG has repeated this interpretation with subsequent county-level actions.[7]

These interpretations of CEQA have broad implications, but it is important to recognize that they are not new or ground-breaking. In fact, they reflect the culmination of a still incomplete process of executive review and judicial interpretation surrounding CEQA and, more broadly, the National Environmental Policy Act (NEPA). In 1997, then-chairman of the Council for Environmental Quality, Kathleen McGinty drafted an interpretation of NEPA for federal agency heads.[8] McGinty finds: *"(1) the potential for federal actions to influence global climatic change (e.g., increased emissions or sinks of greenhouse gases) and (2) the potential for global climatic change to affect federal actions (e.g., feasibility of coastal projects in light of projected climate change)."* McGinty concluded that NEPA provides an appropriate and feasible mechanism for considering climate change drivers and consequences. She recommended that NEPA should be interpreted to consider greenhouse gases associated with Federal *programs,* while climatic impacts should be evaluated for all *projects.*

The judiciary has already been confronted with a related set of issues.[9] Key pieces of case law include the *Border Power Plant Working Group v. Department of Energy (BPPWG v. DOE),*[10] *Mayo Foundation v. Surface Transportation Board (MF v. STB)*[11], and *Friends of the Earth v. Mosbacher (FOE v. Mosbacher).*[12] In *BPPWG v. DOE*, plaintiffs challenged environmental review processes used in the permitting of trans-boundary electrical transmission lines. The transmission lines provided the ability to generate and export electrical power from Mexico to the United States. The District Court found that the Department of Energy (DOE) should have considered CO2 emissions from the power plants when preparing its environmental review documents. They found that the pollution associated with increased generation was connected to the federal action. This was a victory for the *BPPWG*. However, the actual results were quite limited as the DOE conducted a cursory assessment of the emissions and summarily dismissed them as negligible.

*MF v. STB* built on the experience of *BPPWG v. DOE* when challenging the environmental impact assessment for new and upgraded rail lines. The action was anticipated to result in increased coal consumption. The Service Transportation Board claimed that all relevant pollutants were regulated by the Clean Air Act (CAA) under which rules the emissions were found to be not significant. However, the court disagreed, noting that CO2 is not regulated under the CAA, and the lack of analysis for these emissions was "irresponsible." Legal proceedings surrounding this case continue, in part based on the adequacy of treatment for climate change within environmental impact statement documents.

Both *BPPWG v. DOE* and *MF v. STB* have been limited by findings that emissions from any given project may be considered "negligible." *Friends of the Earth (FOE)* have addressed this issue through new legal action. In *FOE v. Mosbacher,* they argue that two federal agencies involved in financing international development projects have increased fossil fuel emissions without NEPA analysis. *FOE* asserts that projects supported by the Overseas Project Investment Corporation (OPIC) and the Export Import Bank (EIB) are associated with 8% of worldwide emissions. The hope is that the court will find that this large percentage of global emissions requires substantial assessment of climate change impacts – as opposed to simply labeling them as negligible.

The courts have also begun to examine legal issues associated with the consequences of climate change. This is particularly important for neighborhood or community planners and developers since developments are expected to perform for decades into the future and the traditional design process is littered with potentially problematic assumptions regarding future climatic conditions. For example, concepts such as the "100-year flood plain," the "design storm," or historic peak summer temperatures are key benchmarks for permitting and engineering. However, it is increasingly clear that these traditional metrics are likely to be unreliable guides to future conditions. The courts are beginning to consider whether circumstances warrant changes in the standard-of-care applied to these issues (Box 2).

NGOs have asked courts to consider the responsibility of planners, developers, and permitting authorities to consider the consequences of increasingly well-known trends, such as sea level rise. For example, the Natural Resources Defense Council (NRDC) filed suit against the California Reclamation Board for approving a development project in the Sacramento-San Joaquin Delta.[13] The issue centers on a plan to build 224 luxury homes on a levee on an island in the Delta. The lawsuit asserts the Reclamation Board violated CEQA when it failed to consider the implications of sea level rise for levee protection. The case rests on a Department of Water Resources study that found that 1 foot of sea level rise would flood the area and the IPCC notes that at least that much rise is anticipated over the next century. It is interesting to note that a former Reclamation Board member commented publicly on the lawsuit, saying *"The decision that the Reclamation Board is making today may not be durable in the face of climate change…People should be factoring that into their thinking when they're building these projects."*[14]

Taken together, we can draw two conclusions relevant to neighborhood and community planners and developers: (1) Climate change is now a potentially important issue in the preparation of environmental impact documentation.[15] (2) Challenges to the adequacy of climate change-related assessment and mitigation are likely to become more wide-spread and effective as the legal and advocacy community develops more comprehensive and sophisticated arguments.

**Bottom-line: Climate change should be considered in the preparation of environmental impact assessments under CEQA and NEPA. Failure to explicitly consider climate change may create the opportunity for legal challenge by public or private entities.**

## *Corporate Disclosure*

Concern about the consequences of climate change and frustration with Federal inaction has contributed to an increasingly diverse and influential collection of private initiatives outside of the court room. NGOs are pursuing a variety of tactics to request, encourage, and sometimes demand that public companies consider the implications of their business activities with respect to climate change and take action to mitigate emissions and plan for changing conditions.

One prominent set of efforts involves the disclosure of climate-related liabilities, particularly greenhouse gas emissions. High-profile activities include the Carbon Disclosure Project (CDP) and the more broad-based Global Reporting Initiative (GRI).[16] Participation in these activities is increasing. Some companies are responding to executive leadership, others peer pressure, and in some cases shareholder resolutions demanding greater environmental transparency.

These voluntary disclosure activities may eventually turn into mandatory reporting requirements. For example, California's AB 32 legislation calls for greenhouse emitters to record their emissions with the California Climate Action Registry.[17] Publicly traded

companies may also face attention from the Securities and Exchange Commission (SEC). SEC has a variety of mandatory reporting requirements for public companies, and there is precedent for the SEC to ask companies to formally disclose their exposure to specific issues, most recently the Y2K computer bug.

**Bottom-line: Whether voluntary or mandatory, attention to corporate disclosure is designed to send a clear message: businesses will be held accountable for their greenhouse gas emissions and, potentially, the consequences of climate change.**

### *Massachusetts v. U.S. EPA*

On April 2, 2007, the U.S. Supreme Court made a landmark decision, ruling in favor of the state of Massachusetts and compelling U.S. EPA to reconsider its decision not to regulate CO2 emissions under the Clean Air Act.[18] The implications of the ruling are still unfolding; however, it is already clear that it is likely to increase the chances of success for future litigation and add to the political momentum for policy action. The Court found that, *"…the harms associated with climate change are serious and well recognized*." The court found that EPA's *"… refusal to regulate greenhouse gas emissions presents a risk of harm to Massachusetts that is both 'actual' and 'imminent…"* Moreover, the Court believes that action by EPA could reduce the risk of such damage, and the Court *"...attaches considerable significance to EPA's espoused belief that global climate change must be addressed."*

**Bottom-line: The U.S. Supreme Court found that climate change is an imminent threat, and it has compelled the EPA to reevaluate its decision not to regulate CO2 under the Clean Air Act.**

## Best Practices for Planners and Developers

Taken together these policies and legal activities create a foundation of public policy and legal interpretations that require consideration of greenhouse gas emissions and the implications of climate change for the performance of neighborhoods and communities. Current circumstances suggest four elements of due-diligence for planners and developers.

### *Assessment of risks and opportunities*

The first step is to assess climate change-related risks and opportunities associated with specific projects or programs. Such an assessment can range from a high-level, qualitative screening exercise (e.g., a climate sensitivity charrette) to a detailed, quantitative analysis based on mathematical modeling. One useful intermediate approach is called a "decision assessment."[19] A decision assessment entails considering each programmatic and project design "decision" and making a preliminary evaluation of its consequences for greenhouse gas emissions and its potential sensitivity to changing climatic conditions (see Box 3). By analogy, one might consider such an assessment a

climate audit. The goal of the process is to identify both risks and opportunities associated with specific decisions. In practice, the results of such an assessment can be presented as a narrative or series of tables that can be used to guide project design and can be incorporated into environmental documents (e.g., an Environmental Impact Report).

**Bottom-line: An initial screening assessment provides a "30,000 foot" view of climate change-related risks and opportunities associated with climate change.**

***Box 3.*** *An example of a decision assessment for decisions associated with the U.S. Green Building Council's Leadership in Energy and Environmental Design for Neighborhood Development (LEED-ND)™ Rating System.*[20]

The U.S. EPA's Global Change Research Program recently sponsored a study of the implications of climate change for design elements and Best Management Practices associated with the LEED-ND rating system. The study started with a qualitative "decision assessment" of the potential impacts of climate change on the performance of each prerequisite and credit in the draft LEED-ND rating system.

At part of the decision assessment, the project team considered the consequences of changes in peak summer temperatures, precipitation patterns, and surface water flows for features typically used to achieve each LEED-ND prerequisite of credit. The team used their understanding of climatic change and the performance characteristics of the individual feature or practice to make an initial, qualitative evaluation of the potential consequences of climate change. This screening analysis suggested the most sensitive prerequisites and credits were those associated with environmental protection, including wetland and water body protection, erosion and sediment control, success of off-site conservation measures, steep slope protection, stormwater, and non-point source runoff. Overall, the team found that climate change has direct consequences for the performance of approximately 35% of the draft prerequisites and credits.

This preliminary screening review was designed to highlight potential risks and opportunities for further study. The team conducted additional quantitative study of the stormwater and non-point source pollution control practices. They found it is possible to create a neighborhood that generated substantially lower levels of stormwater and non-point source pollution under present and future climatic conditions.

This approach could be applied to any neighborhood or community to identify climatic risks and develop project design features that increase the likelihood of achieving performance goals under future conditions.

## *Greenhouse gas inventories*

After screening for risks and opportunities, the next step is to consider contributions toward the drivers of climate change in more detail with a quantitative greenhouse gas

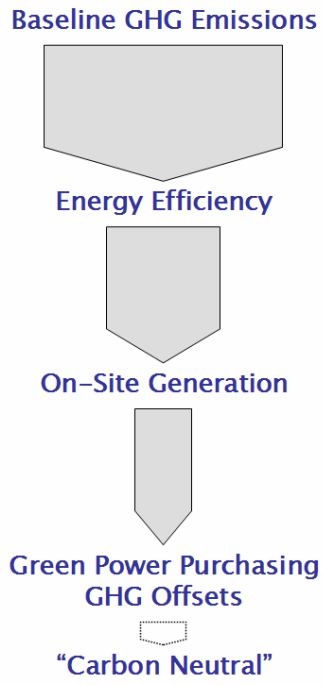
emissions inventory. An inventory involves estimating greenhouse gas emissions based on energy use and the characteristics of energy supply (e.g., carbon intensity). General approaches for such inventories have been outlined in documents such as the World Resources Institute and World Business Council for Sustainable Development's widely-used Greenhouse Gas Protocol. Such tools provide guidelines for bounding the scope of an inventory and reporting specifications.

Any effort to conduct emission inventories for new construction faces the obvious hurdle that the neighborhood or community in question does not exist yet. This means that the project team will need to rely on performance data for comparable communities and energy modeling to estimate future energy use. These estimates of future energy demand will need to be complemented by knowledge of current and future energy supply systems. Such assessments involve numerous important assumptions and require careful documentation. The result is an estimate of direct and indirect greenhouse emissions associated with a project at build out.

**Bottom-line: A greenhouse gas inventory is the foundation for any kind of GHG emissions reduction strategy.**

## *Emission reduction strategies*

An emissions inventory is not an end in itself. Rather, it is a starting point for efforts to reduce greenhouse gas emissions. The climate change community calls such action "mitigation." Achieving reductions requires planners and developers to consider a portfolio of strategies, including: (i) energy efficiency improvements, (ii) changes in energy supply (e.g., green power purchasing), and (iii) greenhouse gas offsets. These strategies are discussed individually in the following sections. In practice, they are often developed and deployed as part of coordinated process, such as an energy master plan (Box 4).




*(i) Energy efficiency*

Energy efficiency improvements provide the most direct and cost-effective mitigation opportunities. Reducing demand for energy prevents both direct and indirect greenhouse gas emissions. There are a variety of tools available to help planners and developers use a greenhouse gas inventory to identify and prioritize efficiency improvements based on their relative expense and energy use reduction benefits.

Improving the energy efficiency of built environments typically involves considering a set of interrelated factors, including: building location, site design and orientation, and specifications for the building envelope and systems. The performance of these

components is ultimately dictated by the behavior of facility managers and occupants. Addressing these issues early in the conceptual or schematic design phases can minimize potential increases in first-costs and accelerate pay-back schedules.[21]

For communities in California, the current benchmark for residential and commercial energy performance is the Title 24 California Building Standards Code.[22] In practice, it is possible to achieve at least a 25% improvement over code through cash-flow neutral measures (i.e., decreases in monthly energy costs offset payments required to service a larger mortgage incorporating energy efficiency improvements).[23] Some of the most important energy efficiency features include high-albedo roofing, high-performance windows, building insulation and efficient mechanical systems. These structural features can be complemented with specifications for Energy Star appliances. It is important to remember that buildings and communities are complex, and it important to consider them as integrated systems rather than simply collections of parts or features. An integrated "whole building" or better-yet "whole community" approach can reduce costs and maximize opportunities for efficiency.[24]

Efficiency measures do not end when the building or community is occupied. It is essential to educate facility managers and occupants in the operation of their buildings and its systems. While design and modeling are increasingly sophisticated, planners and developers should always maintain a "trust, but verify" approach to energy efficiency improvements. This means conducting post-construction and continuous commissioning to establish baseline energy usage and track improvements over time.[25] These monitoring and verification efforts take on even greater importance in a carbon-constrained world, where emissions are liabilities and real reductions may have market value.

Opportunities for energy efficiency extend beyond the performance of buildings and building systems. The most important are the implication of site location and design for transportation-related emissions. Mobile-sources typically account for at least 50% of community greenhouse emissions. To some degree, these emissions sources are outside of the "direct operational control" of planners and developers – a concept associated with greenhouse gas inventory protocols.[26] However, these are real and important greenhouse gas emissions associated with a community, and planners and developers can play a role in reducing them. The key is to recognize that on-balance community design is only a part of the solution. The Caltrans Climate Action Program suggests that local features can influence 10-30% of transportation-related greenhouse gas emissions with the balance associated with larger scale issues (e.g., transportation infrastructure, regional congestion, technology availability).[27] Key factors in minimizing emissions within the control of the planner or developer are very familiar: compact, connected, safe, walkable places that provide a mix of housing, jobs, recreational, and cultural opportunities.[28] When deployed effectively, community features can substantially reduce regional vehicle miles traveled.[29]

*(ii) Energy supply*

Built environments consume natural gas, purchased electricity, and possibly other fuels such as diesel, gasoline, and propane. Each of these is associated with a different level of greenhouse gas emissions, and, in many cases, it is possible to identify opportunities to switch to fuels with lower emissions or, potentially, no emissions. The U.S. Department of Energy has promoted the development of so-called zero-energy homes. These are buildings that use aggressive energy efficiency improvements to reduce energy demand to the level at which it can be cost-effectively met through on-site energy production.[30] Such zero-energy homes are typically designed to be connected to the electrical grid so that surplus power can be sold to the utility and periods of low on-site generation can be addressed through grid purchases (e.g., nighttime energy demand).

On-site generation offers a variety of benefits; however, it is often a costly way to achieve large-scale greenhouse reductions.[31] Electricity-producing solar photovoltaics (PV) are the most common form of on-site energy generation. They reduce greenhouse gas emissions by displacing purchased electricity. Current PV systems supply 1.2-2.4 kW at a cost of approximately $10,000 per installed kW. These installations are encouraged through government incentives such as the California Solar Initiative as well as incentives from local utilities and the federal government. Other on-site energy generation strategies include solar thermal (for water heating), wind power and geothermal or geo-exchange (using the constant temperature of the earth for heating/cooling). High efficiency generation systems, such as fuel cells and microturbines combined with co-generation to utilize the waste heat can also reduce greenhouse gas emissions, particularly when effectively incorporated into the design of high density mixed use communities. Some developers are finding it cost effective to either partner with a third party financing organization who will provide, own and maintain the energy generation technologies and sell power back to the community at competitive rates, or to form their own utilities based on on-site generation strategies.

An alternative approach is to change the mix of energy supplied from the electrical grid. While it is not typical for a community to directly change the source of the electrons, it can ensure that the utility purchases renewable power to offset the community's use. This is accomplished through renewable energy certificates or so-called green power purchasing. Where available, green power purchasing is very simple, and it typically involves relatively modest marginal costs. The additional cost of green power creates some marginal incentive for energy efficiency and accelerates pay-back schedules. However, it is an indirect and somewhat passive approach to reducing greenhouse gas emissions; one that offers relatively few opportunities to engage community members or motivate wide-spread behavioral change.

***Box 4.*** *Energy master plans as a tool for greenhouse gas mitigation.*

A community's energy master plan is a living document that can provide an effective vehicle for designing and implementing greenhouse gas reduction strategies.

Planning for community energy supply requires evaluating the costs and benefits of both on-site and utility-provided energy sources. With respect to greenhouse gas emissions,

the energy master plan should describe the carbon intensities of different energy sources and identify cost-effective opportunities to switch or substitute lower emission fuels or technologies. In other words, the energy master plan describes a supply curve for greenhouse gas reductions available to the community.

Estimating energy demand and effective demand-side energy management requires understanding the implications of myriad project design features, such as site lighting, building design, potential tenant activities (e.g., data centers) and even the extent of future owner-installed amenities (e.g., hot tubs). These factors can be combined through models to anticipate annual average, seasonal peak, and time-of-day demand profiles. This information can be used to identify and prioritize opportunities for energy efficiency, such as shifting demand to periods when low-emission energy sources are available (e.g., daytime PV, nighttime wind power).

The success of the energy management plan is evaluated based on long-term, quantitative data collected from a carefully designed metering system. A comprehensive energy plan lays out a specific program for monitoring and verification, including details regarding the carbon content of specific energy sources over time.

Finally, an energy master plan provides guidance for education and outreach. It can provide residents and tenants with information to guide their energy and greenhouse gas-related decisions and feedback on the performance of the neighborhood as a whole.

*(iii) Greenhouse gas offsets*

The third greenhouse gas mitigation option is to pay a third-party to provide greenhouse gas reductions. Surplus emissions reductions are called "offsets." This term reflects their use in compensating for unavoidable greenhouse emissions. In other words, a community continues to emit greenhouse gases, but they pay to create equivalent, offsetting reductions elsewhere.

The concept of third-party offsets is based on a solid foundation of economic theory. Offsets recognize that the cost of achieving greenhouse reductions varies across the economy. Consequently, offsets can help maximize emissions reductions per dollar. For many California communities, the first 30-40% of energy use can be cost-effectively mitigated through energy efficiency improvement. However, higher levels of reduction often incur substantial higher costs per unit reduction. Third-party offsets may be a credible and cost-effective mechanism for achieving aggressive greenhouse gas reduction goals, such as carbon neutrality.

The utility of greenhouse gas offsets is entirely dependent on the availability of reliable third-party offsets with low transaction costs. California's AB 32 legislation allows for emissions trading of offsets, stipulating that they be permanent, additional, and verifiable. Each of these terms is subject to ongoing discussion. Greenhouse gas offsets are a relatively new commodity, and markets are still establishing trading procedures and

standards. Key issues include a lack of standardizing accounting protocols, inconsistent monitoring and verification, short-term contractual relationships, and relatively low prices. In today's voluntary markets within the U.S., offsets are as much about buying a story as buying a commodity. In other words, many buyers are as interested in the story associated with the reduction as much the emissions themselves.

While many planners and developers are interested in using offsets to address community emissions, it is also possible that communities could be sources of greenhouse gas offsets. Community developments create demand for energy, but they are not huge direct emitters themselves. This means that the design and operation of communities may ultimately create significant opportunities for the creation of high-quality greenhouse gas offsets, i.e., permanent, verifiable, beyond business-as-usual reductions in greenhouse gas emissions.

An offset typically represents value created by reducing emissions. Therefore, it requires some way of assessing emissions before and after an intervention. For existing facilities, this is fairly straightforward. One determines the composition of energy inputs, measures energy use, and calculates net emissions. The situation is more complex for a neighborhood or community that does not yet exist. In this case, the value of an offset is the difference between what is built and what would have been built if not for some efficiency or process change improvement. There simply is not a brick-and-mortar point of comparison. The international community has invested substantial time and effort considering these issues for a variety of projects. However, these projects are typically quite different than domestic community developments. In California, it may be that Title 24 building energy performance standards provide a practical benchmark. This makes sense today, but how does one track the value of offsets as energy codes improve over time, even before construction stops on a large community project. The key is to develop clear, widely-accepted standards. These may evolve organically as a product of practice, or through the explicit action of a government agency or non-government organizational. Until such a consensus emerges, individual projects will be left to make and defend their own choices – potentially in court.

**Bottom-line: Fundamentally, reducing greenhouse gases is a three step process: (1) deploy cost-effective efficiency measures, (2) consider on-site energy production, and (3) carefully consider the risks and benefits associated with greenhouse gas offsets.**

## *Adaptation strategies*

Mitigating the magnitude and rate of climate change through reductions in greenhouse gases is currently the center of attention for policymakers and the public. However, past and present emissions have committed the Earth's system to substantial environmental change regardless of near-term policy interventions. This means that future conditions are likely to be significantly different from those experienced over the past century.

This finding has substantial consequences for the design, construction, and operation of built environments. New or redeveloped communities represent long-term, capital-intensive investments that are expected to perform for decades into the future. We have ample reason to suspect that conditions at that time will be warmer and subject to greater climatic extremes, such as storm events and droughts. These changes are likely to undermine key assumptions used in the design, operation, financing, and insurance of individual buildings and whole communities. Some of these changes may jeopardize occupant comfort and productivity; others may pose threats to health and property. Regardless, these changes create new risks.

These risks are not just academic theory. The experience of the Gulf Coast during the 2005 hurricane season shows that many communities are ill-prepared for even the most predictable environmental extremes. Moreover, the consequences of this vulnerability are measured in billions of dollars and thousands of lives. Climate change is likely to bring such issues even closer to home, and we must consider what constitutes a reasonable standard of care in the design, construction, and operation of a community. For example, global sea levels have risen steadily over the past 50 years and future increases are very likely. These changes are driven by two processes: (1) thermal expansion of the oceans, and (2) inputs of freshwater, primarily from melting glaciers.[32] Thermal expansion is a long-term process that occurs in response to global heat balance. Increases in global mean temperature observed over the last century are predicted to result in up to one foot of rise by the end of this century. Inputs of freshwater will add to this increase, but the amount of increase remains a wildcard. The IPCC has concluded it is not possible to define an upper bound for sea level rise. Extrapolation from past trends suggests that melting ice could add another 0.7 feet by 2100; however, scientists have identified a number of processes that could accelerate – perhaps dramatically – glacial melting and, by extension, sea level increases. Recent work puts the overall increase by 2100 in range of 1.6 to 4.5 feet.[33] These lines of evidence support an increasingly clear conclusion: continued anthropogenic warming will lead to substantial increases in sea level that will continue for decades, probably centuries, into the future.[34]

Given this information, what is the proper standard of care for planning coastal communities? It seems that developers have been given fair warning about imminent implications of climate change with respect to sea level rise. When future "disasters" occur, it will be hard to claim lack of knowledge and it will be hard to avoid the perception of negligence.

Private groups have already recognized the implications and brought suit against developers for not considering sea level rise in the design of levees surrounding new communities on the Sacramento delta. These suits have yet to be successful, but they are clearly only the tip of the iceberg. The implications go far beyond sea level rise. The size of stormwater management systems is often based on the concept of a 100 year flood. Yet, we know that the statistics underlying such calculations rely on a station set of climate observations. Observations of the past become increasingly meaningless as we better understand that conditions are changing. As a result the assumptions upon which systems are designed are becoming invalid. When lives are lost and property is damaged,

will it be acceptable to have relied on patently inaccurate statistics? Similarly, rising temperatures are one of the most consistent findings associated with climate change. Are buildings being designed to maintain occupant comfort under more extreme peak summer temperatures? In France, we saw that heat waves cost the lives of thousands of citizens. By 2050, such "extreme" temperatures may happen every other year.

Fortunately, we can identify such vulnerability and take action to create sustainable buildings and communities that are robust and resilient to changing conditions. We can take sea level rise into account with adequate coastal set backs and well designed shoreline defenses. We can map floodplains under future precipitation regimes and develop more robust stormwater management systems. We can design more efficient buildings capable of adapting to future conditions through future upgrades, such as higher capacity cooling systems. Climatically-informed, sustainable designs can reduce many of the negative impacts of climate change. This kind of long-term planning is not simply benevolence to future generations. It avoids liability and is a necessary prerequisite for achieving the kind of long-term sustainability so often discussed.

**Bottom-line: Climate change may undermine widespread assumptions associated with the design and operation of neighborhoods and communities. Planners and developers can take action to assess the consequences of changing conditions and create robust and resilient built environments.**

***Box 5.*** *Carbon neutrality for neighborhoods and communities*

The term of "carbon neutrality" has caught the public's attention. This phrase was The New Oxford American Dictionary's 2006 "word of the year."[35] Despite this high-profile attention, the concept can have multiple meanings in practice. The question here is what does this mean for neighborhood and community planners and developers?[36]

There is a variety of definitions for "neutrality" and the related concept of "zero energy" buildings and communities. Carbon neutral refers to the notion of balancing greenhouse gas emissions through on- and off-site actions with the goal of achieving a balance of zero emissions (a.k.a., net zero). The term "zero energy" has received more rigorous attention. Torcellini and colleagues (2006) suggest that, *"At the heart of the ZEB [Zero Energy Building] concept is the idea that buildings can meet all their energy requirements from low-cost, locally available, nonpolluting, renewable sources."*[37] They go on to describe five different pathways for achieving ZEB's in practice through combinations of energy efficiency improvements, on-site energy production, and off-site energy supply.

Currently, it is possible to achieve carbon neutrality or near-zero energy use for some individual buildings[38] or prototype communities[39] using combinations of high-performance energy efficiency measures and on-site generation. A recent survey of advanced green buildings found approximately 100 buildings across the United States that reduce energy use 50% below the ASHRAE 90.1-2001 levels with only a handful achieving 70-80% reductions. These industry-leading buildings demonstrate that these

levels are within reach; however, experience also suggests that there are significant barriers to the widespread design and construction of low energy buildings.[40] For most neighborhoods and communities, carbon neutrality can only be achieved through the purchase of third-party greenhouse gas offsets. It is unclear whether existing mechanisms are capable of providing the large amounts of high-quality, verifiable offsets that would be required for widespread use in offsetting new construction. Even if suitable offsets become available, public policies to guide their fair and efficient use have yet to be developed. These circumstances mean that carbon neutrality for neighborhoods and communities is as much a marketing decision as a design goal.

## CONCLUSIONS

Climate change is a daunting challenge for community planners and developers. It is a global problem tied to the foundation of our fossil fuel-based economy. Addressing it requires recognizing that our emissions of greenhouse gases have consequences for the Earth's climate. While the processes are global, the impacts will also be felt locally.

Society is beginning to understand the general scope of these issues and demand action. This will inevitably be associated with a degree of posturing and hand waving. However, once the smoke clears, it will become apparent that planners and developers are on the front lines of dealing with these challenges.[41] Fortunately, they have in-hand tools to mitigate greenhouse gas emissions and create communities that are resilient to changing conditions. Moreover, many of these benefits can be achieved through cost-effective mechanisms that contribute positively to a community's overall quality-of-life.

Practical steps for addressing climate change include:

1. Consider the contributions of a community to the drivers of climate change and the consequences of changing conditions for the sustainability of the community.

2. Conduct a quantitative greenhouse gas inventory to provide the foundation of information needed to reduce emissions.

3. Use the inventory to identify greenhouse gas reduction opportunities, take action to implement project design features, and monitor and verify the results.

4. Examine assumptions involving climatic conditions and consider the implications of climate change for a community. Use this information to take action to develop and implement project design features that reduce threats to people or the environment.

These four actions provide due diligence, reduce emissions and performance risk, and contribute meaningfully to society's response to the global challenge.

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