CLIMATE CHANGE AND THE CONSTRUCTION INDUSTRY – WHITE PAPER

City and County of Honolulu Climate Change Commission
DRAFT September 8, 2020

PURPOSE

Pursuant to the Revised Charter of Honolulu ("RCH") Section 6-107(h), the City and County of Honolulu ("City") Climate Change Commission is charged with gathering the latest science and information on climate change impacts to Hawai'i and providing advice and recommendations to the mayor, City Council, and executive departments as they look to draft policy and engage in planning for future climate scenarios and reducing Honolulu's contribution to global greenhouse gas emissions.

This white paper provides an overview of considerations of climate change and the construction industry for the City and County of Honolulu, with a focus on the implementation of sustainable design strategies for increased energy efficiency in the built environment.

INTRODUCTION

Buildings generate nearly 40% of annual global greenhouse gas (GHG) emissions.[1] Global building stock is expected to double by 2060. With current trends in urban growth, in 40 years over six billion people will live in cities. This will require a 2.48 trillion square foot addition to the current global building stock. This is equivalent to adding an entire New York City every month for 40 years.[2] This growth gives the industry, which has significant influence, the opportunity to change its adverse impact on the climate.

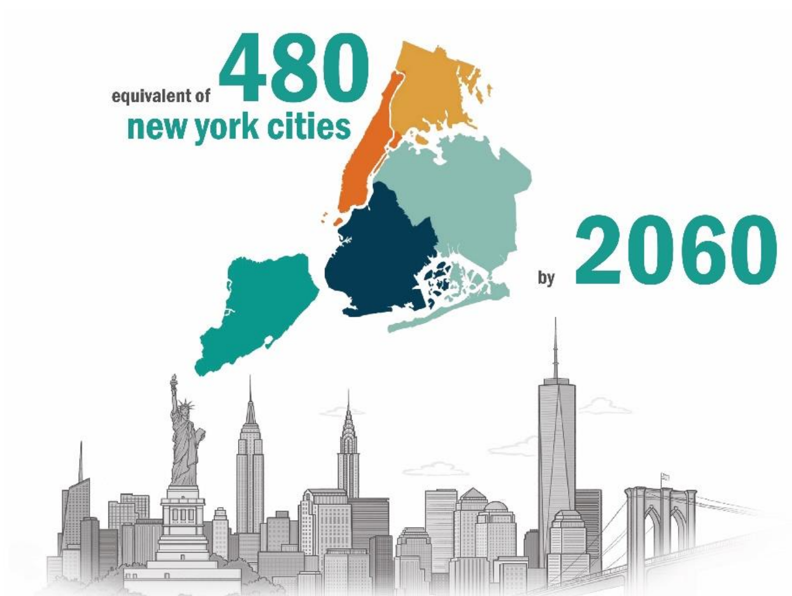

Figure 1: Expected Global Growth Rate

[1] Frequently Asked Questions (FAQs) - U.S. Energy Information Administration (EIA), 15 June 2020, www.eia.gov/tools/faqs/faq.php?id=86&t=1.

[2] "WHY THE BUILDING SECTOR?" Architecture 2030, architecture2030.org/buildings_problem_why/.

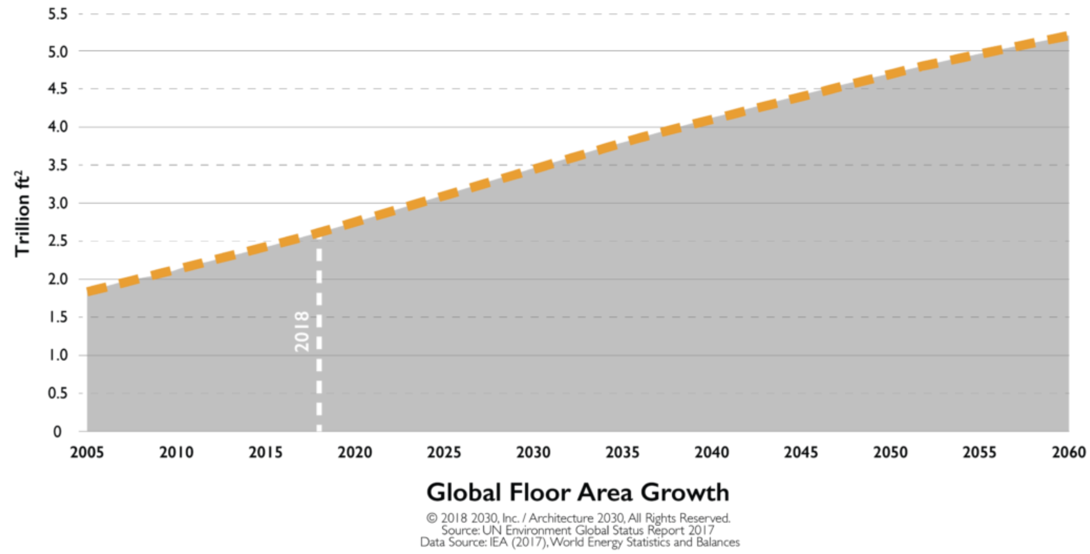

Figure 2: Global Floor Area Growth (Architecture 2030)

Planet Earth's current climate and energy crisis is altering the constants in our everyday lives through environmental destruction and weather destabilization. Increased consequences of industries driven by a search for resources and lack of regenerative design principles threatens our biodiversity, food systems, and global political stability.

Our business as usual sits within a negative feedback loop. As our planet is getting warmer and weather more irregular, there is a greater need for increased cooling and heating during respective seasons. This increased energy use, fueled in many communities by fossil fuels and natural gas, are adding to the amount of carbon emissions in the atmosphere.

It is important to recognize the role of the built environment within this circumstance. How we construct buildings, how we use them, and where we put them all contribute to climate change.[3]
The built environment not only situates itself among and between pockets of the natural environment, but also redefines the roles that materials play within various assemblies that create built space. Currently, the built environment is a contributor to a substantial amount of GHG emissions. Various stakeholders have identified an opportunity where the role of the built environment can be redirected to be a part of the climate and energy crisis solution.

O'ahu Specific Design

Specifically, to Oahu, our unique geographic location offers increased challenges in regard to resource availability and procurement, and slowed integration of innovative design techniques due to a smaller labor force. On the other hand, our environment allows us to inhabit a tropical climate, quickly see the positive outcomes of good design within a tighter ecosystem, and cultivate a community-oriented culture of ʻohana and mālama honua.

Need for Equitable Housing Systems

[3] Budds, Diana. "How Do Buildings Contribute to Climate Change?" *Curbed*, Curbed, 19 Sept. 2019, www.curbed.com/2019/9/19/20874234/buildings-carbon-emissions-climate-change.

More people in an increasingly unstable environment further exacerbates the divide between social classes and the spaces they inhabit. Ethnic minorities are more likely to live on less desirable property which is uncoincidentally hotter in temperature. Lack of adequate green space, elevation, prevailing winds, and proximity to large bodies of water increases the heat island effect. Heat absorbing surfaces like concrete used for roads and buildings soak up rather than reflect the sun's heat energy. Rising environmental temperatures and energy bills decreases the ability for people to live comfortably and the opportunity to create equity through homeownership. This creates a further call for equitable housing systems and its supportive infrastructure.

THE COST OF ENERGY

Energy required for many basic conveniences and comforts has a high cost. The most immediate cost is financial, experienced by inhabitants of the built environment: renters, homeowners, employees and employers, and those who create it. Energy costs in Hawai'i are naturally higher (1.5 to 3 times) than other places in the United States because most of our energy comes from burning fossil fuels which must be imported. Other disadvantages of this petroleum-based energy include increasing our reliance and therefore vulnerability in the limited global fuel supply and its fluctuations, increased environmental pollution through GHG emissions,[4] and exposure to hazardous substances from the manufacturing process. Both embodied carbon and operational carbon contribute to the built environment's share of GHG emissions.

Embodied Carbon
Embodied carbon in the built environment comes from the manufacturing, transportation, and installation of construction materials.[5]

Operational Carbon
Operational carbon emissions come from a building's energy consumption like heating, cooling, and lighting needs.[6]

With the increase of operational energy efficiency, the impact of embodied carbon emissions in our buildings will become progressively more important.[7] Embodied carbon can be decreased through a variety of different design ~~and construction~~ decisions like material selection (type and sourcing), project delivery method, on-site construction and installation methods, and project end of life outcome.

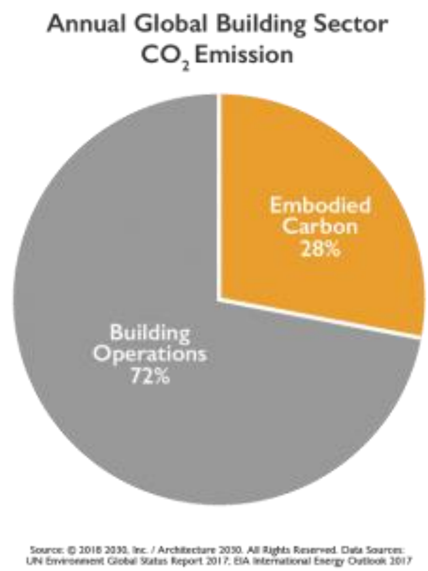

Figure 3: Annual Global Building Sector CO2 Emission (Architecture 2030)

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[4] United States, Congress, Department of Business, Economic Development & Tourism, et al. Field Guide for Energy Performance, Comfort, and Value in Hawaii Homes, State of Hawaii, Dept. of Business, Economic Development & Tourism, Energy, Resources & Technology Division, 2001.

[5] "WHY THE BUILDING SECTOR?" Architecture 2030, architecture2030.org/buildings_problem_why/.

[6] Ibid.

[7] Ibid.

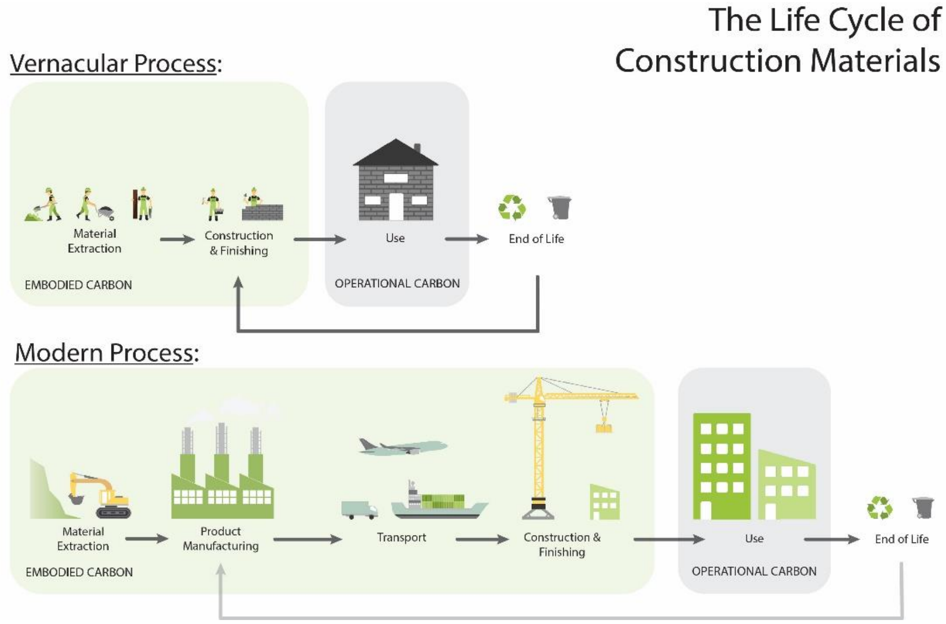

Figure 4: Embodied Carbon (Green) vs. Operational Carbon (Gray)

STAKEHOLDERS

Green buildings "are healthier, perform better, last longer, and are easier to maintain. In the long run, owners of green homes in Hawaii save energy, save money, preserve the environment, and help improve the state's economy, all at the same time."[8]

Many stakeholders who both influence and are influenced by building projects are shown in Figure 4. Incentives to make a shift towards green building design are growing as the pressure of the climate change crisis increases and as practiced sustainable methods are proven to be not only better for building's inhabitants, but also more cost-effective.

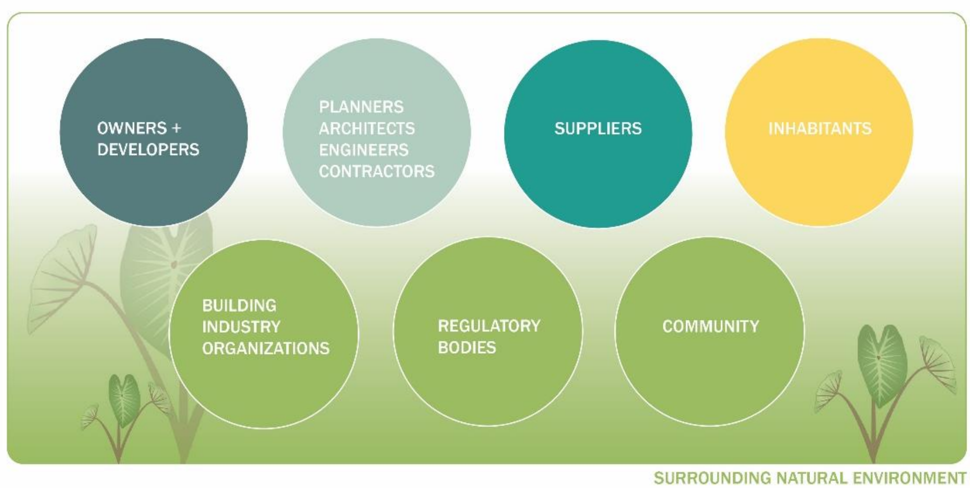

Figure 5: Stakeholders in the Built Environment

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8 United States, Congress, Department of Business, Economic Development & Tourism, et al. Field Guide for Energy Performance, Comfort, and Value in Hawaii Homes, State of Hawaii, Dept. of Business, Economic Development & Tourism, Energy, Resources & Technology Division, 2001.

Role of Policy
The role of government and policy as well as nonprofit and grassroot organizations can use action to effect change at various levels. Local jurisdiction amendments to the International Energy Conservation Code (IECC) form state law which dictates standards for local practices.

Plans, zoning ordinance revisions, locations of public institutions and services, and programs and strategies can provide top-down decision making that help shape the common practices of local industries.

Roles and Responsibilities of Professional AEC Businesses
A call to action for architects and the larger industry of construction to design for the greater good of their communities is not a new concept. As the climate crisis begins to take hold of our certainties and threatens future stability, it has already had devastating effects on those the furthest away from its causes. Climate change's relationship to social justice and the growing inequities of the built environment can be addressed in how we construct and use buildings.

The *AIA 2030 Commitment Program* hosted by the American Institute of Architects (AIA) offers architecture firms a network of resources to prioritize a practice of energy performance design and the *2030 Challenge* by Architecture 2030. The organization states that zero net carbon (ZNC) building standards elevate the practice of architecture, saves clients money, and combats the effects of global climate change. Over 400 AEP firms have adopted this commitment and are helping to transform the practice of architecture to "respond to the climate crisis in a way that is holistic, firm-wide, project based, and data-driven."[9] (see "STANDARDS" section to learn more about the *2030 Challenge*)

Opportunity for Developers
Motivation and action from stakeholders in the process of creating built environments need to work to meet holistically at an intersection. Policy can help to provide guidance for developers looking to build projects within areas of increased exposure to environmental stressors. Developers can look to specific neighborhood needs, trends in our current climate and adapting markets, and tools that allow designers to effectively acknowledge quantifiable data and other related social vulnerabilities caused by environmental challenges.

> Example: Sea Level Rise
> See the *Pacific Islands Ocean Observing System (PacIOOS)'s sea level rise viewer* which "empowers ocean users and stakeholders in the Pacific Islands by providing accurate and reliable coastal and ocean information, tools, and services that are easy to access and use."[10]

[9] "The 2030 Commitment." The American Institute of Architects, www.aia.org/resources/202041-the-2030-commitment.
[10] "Hawai'i Sea Level Rise Viewer: PacIOOS." Pacific Islands Ocean Observing System (PacIOOS), www.pacioos.hawaii.edu/shoreline/slr-hawaii/.

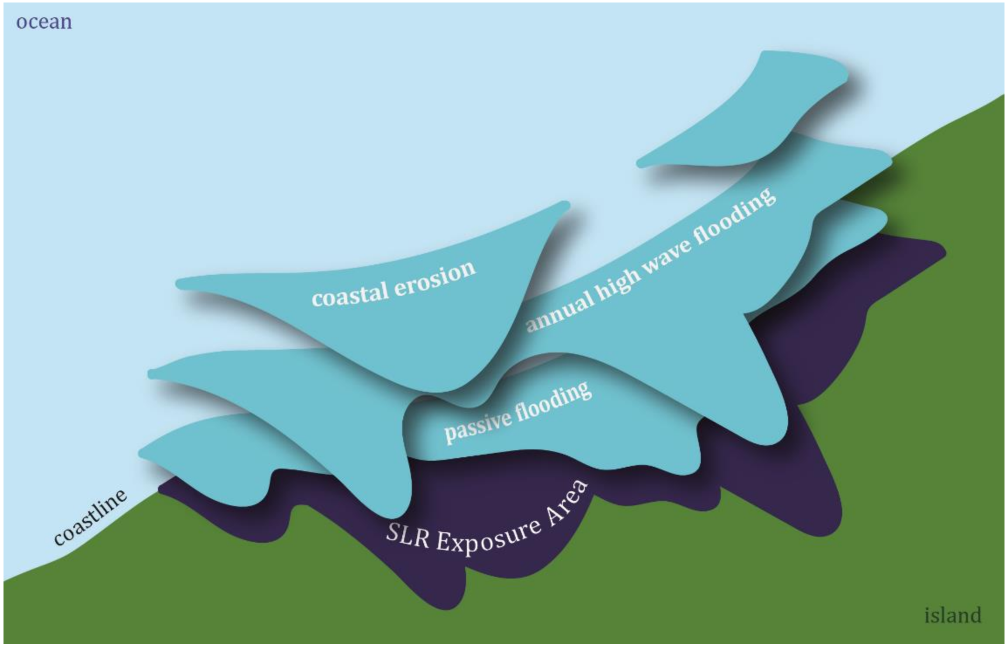

Figure 6: Coastal Exposure to Sea Level Rise (PacIOOS)

List of Actionable Steps:

Opportunity of the Department of Planning and Permitting

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The DPP is responsible for the City and County of Honolulu's "long-range planning, community planning efforts, administration and enforcement of ordinances and regulations governing the development and use of land, various codes pertaining to the construction of buildings, and City standards and regulations pertaining to infrastructure requirements."[11]

Recent legislation heavily tied to resilience planning and the causes and impacts of climate change is in discussion and affects their day to day responsibilities and decision making. Sea level rise, off-street parking, and tree canopy coverage are just a few.

The DPP's authority offers an influential role in policy making surrounding these related challenges. Their commitment to supporting the mission of the Office of Climate Change, Sustainability and Resiliency for a "more economically self-sufficient and safe O'ahu" is creditable.

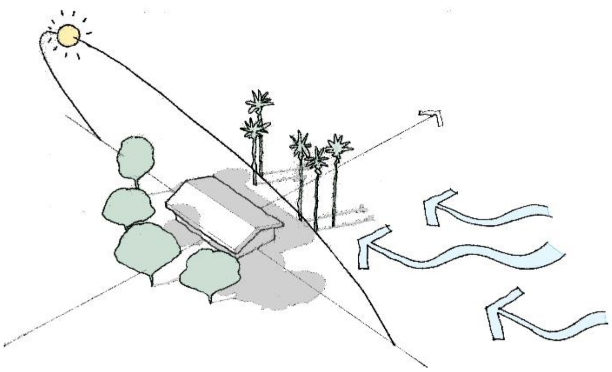
SOLUTION

[11] "CITY AND COUNTY OF HONOLULU." About DPP - Department of Planning & Permitting, City & County of Honolulu, www.honoluludpp.org/AboutDPP.aspx.

The prioritization of energy efficiency in the built environment works across many industries to decrease the impact we have on our environment and to slow the effects of climate change. Buildings with passive and integrated renewable energy systems will decrease operational costs, creating a more affordable and equitable society. Low-cost passive design allows inhabitants of the space to experience thermal delight as well as utilize ecosystem services. Design responsive to specific expected and unexpected environmental conditions increases resilience and provides a safer more sustainable cost-effective built environment.

Call to Implement Sustainable Design Strategies on O'ahu

Implementation of sustainable design strategies will increase energy efficiency through the utilization of no or low-cost passive strategies. Climatic specific design looks to the immediate environment of the site in order to utilize ecosystem services like natural lighting, ventilation, and elevation benefits. This decreases the space's reliance on the energy grid and the associated economy of energy. Vernacular architectural techniques, especially in a place like Hawaii, can also be used to inspire innovative passive strategies as well as acting as a form of cultural preservation. Open houses promote convective air flow which works to remove humidity from the skin through evaporative cooling with a decreased need for electrically powered cooling devices. Lighter weight materials and simplistic building design store less heat, allowing houses to cool quickly after the sun sets. Some common design elements with energy efficient drivers are single wall builds for maximum breathability, deep overhangs that wrap and shade homes, louvered windows that allow for views while promoting air movement, large surrounding shading trees, raised homes that can be situated on steep slopes and take advantage of trade winds, and large windows and lānais for increased daylighting and natural ventilation.[12]



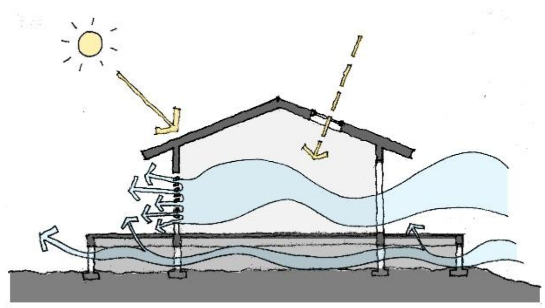
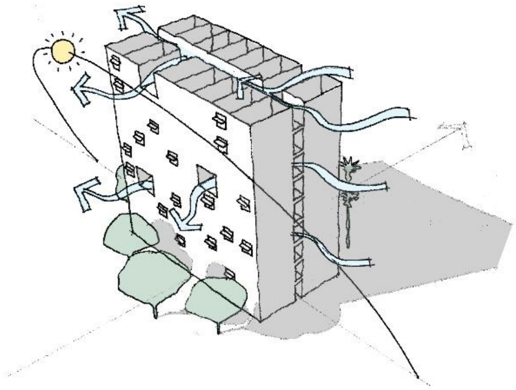


Figure 7.1: Tropical design strategies for low rise typology.

[12] United States, Congress, Department of Business, Economic Development & Tourism, et al. Field Guide for Energy Performance, Comfort, and Value in Hawaii Homes, State of Hawaii, Dept. of Business, Economic Development & Tourism, Energy, Resources & Technology Division, 2001.



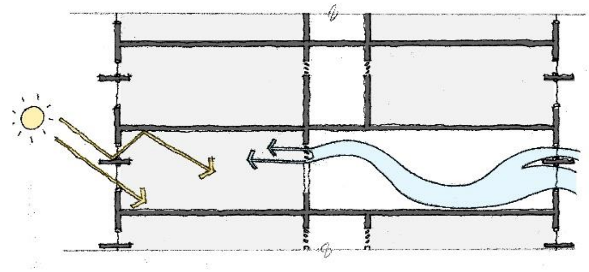


Figure 7.2: Tropical design strategies for mid to high-rise typology.

> ***Site orientation*** *maximizes environmental services of natural daylighting and trade winds. Minimizing east and west facing walls decrease sun exposure and consequent heat gain. Maximizing the south facing roof increases possible photovoltaic exposure. Skylights on the north facing roof creates an opportunity for increased daylighting. Canopy trees positioned on the south filter the low summer sun and tall, narrow trees in the north filter the high morning sun and help to buffer wind. Raised buildings allow for increased ventilation throughout and creates a separation between wet ground (depending on the microclimate).* ***Passing cooling*** *can be engaged through large roof overhangs that shade low rise buildings and awnings or sun shades on high rise buildings. Louvered windows and doors on at least two elevations create cross ventilation. Open corridors and lounges in larger scaled buildings also assist this.*

Material Selection and Project Delivery Method

These sustainable design strategies not only exist for the physical design of the building, but also in the material selection and project delivery method. Materials with inherently lower embodied carbon can be substituted for the traditional and, in many instances, can be of comparable price and availability. Utilizing local materials helps promote circular economies in addition to cutting down on its transportation time and distance to the site (intensified by our geographic location).

One-time use materials have an abrupt end of life that results in its disposal into waste streams. 569 million tons of construction and demolition (C&D) debris was generated in the United States in 2017. Redirection of this material decreases the amount of environmental impact associated with the extraction and consumption of natural resources. Sustainable materials management (SMM) can help to divert C&D materials out of waste streams by redefining them as new commodities. Additional benefits of SMM include decreased project expenses, decreased environmental impacts from waste disposal facilities and virgin material extraction, conservation of landfill space, and increased employment opportunities and economic activity. Sustainable material use can be exercised through source reduction, salvaging, or recycling and reusing existing material.[13]

> **Source reduction** prevents waste from being generated in the beginning of the life cycle of a building. Examples of this type of strategy that engages the design and construction phases include preserving existing buildings over new construction, designing adaptable buildings to extend the lifetime, utilizing construction methods that facilitate the reuse of materials, applying alternative framing techniques, and reducing interior finishes. Purchasing agreements with suppliers can also be adapted to prevent excess material and packaging transportation and arrival to site.[14]

[13] "Sustainable Management of Construction and Demolition Materials." EPA, Environmental Protection Agency, 26 May 2020, www.epa.gov/smm/sustainable-management-construction-and-demolition-materials#WYCD.

[14] "Sustainable Management of Construction and Demolition Materials." EPA, Environmental Protection Agency, 26 May 2020, www.epa.gov/smm/sustainable-management-construction-and-demolition-materials#WYCD.

Green Concrete

Concrete is the second most used material on the planet after water according to the Cement Association and the nonprofit Global Concrete. It is the second largest industrial source of carbon dioxide in the world.[15] In addition to its extractive manufacturing process, its transportation to site is another source of carbon emissions that is counted as a part of the material's embodied energy.[16] This distance is increased by the geography of our island state.

Carbon sequestering concrete is an opportunity to redefine the procurement of raw material extraction required for this commonly used building material. "CO2 mineralization takes waste carbon dioxide from an industrial emitter (usually a gas company or a power plant) and injects it into a concrete mix, creating a chemical reaction that turns the carbon dioxide into solid calcium carbonate. The resulting concrete mix gets incorporated with other ingredients to form the final product of carbon-infused concrete."[17] The injected mineral replaces some of the cement required for the concrete while maintaining strength requirements.[18] By utilizing the byproduct of a different local manufacturing process, this green concrete decreases the cost of cement, amount of materials to be transported from the mainland, embeds a polluter into a material, and allows a reduced carbon footprint. The carbon injected concrete is projected to reduce embodied carbon by 25lbs. per cubic yard. A 2019 HDOT demonstration of the concrete (150 cubic yards) by CarbonCure Technologies Inc. will save 1,500lbs. of carbon dioxide, offsetting the emissions from 1,600 miles of highway driving.[19] The concrete was produced by Island Ready-Mix Concrete.[20]

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[15] HDOT Tests Sustainable Concrete Mix Designed to Reduce Carbon Footprint of Road Construction, 16 May 2019, hidot.hawaii.gov/blog/2019/05/16/hdot-tests-sustainable-concrete-mix-designed-to-reduce-carbon-footprint-of-road-construction/.

[16] Matayoshi, Katarina P. "Greening the Concrete Jungle." Hawaii Business Magazine, 11 Sept. 2019, www.hawaiibusiness.com/greening-the-concrete-jungle/.

[17] Ibid.

[18] Matayoshi, Katarina P. "Greening the Concrete Jungle." Hawaii Business Magazine, 11 Sept. 2019, www.hawaiibusiness.com/greening-the-concrete-jungle/.

[19] HDOT Tests Sustainable Concrete Mix Designed to Reduce Carbon Footprint of Road Construction, 16 May 2019, hidot.hawaii.gov/blog/2019/05/16/hdot-tests-sustainable-concrete-mix-designed-to-reduce-carbon-footprint-of-road-construction/.

[20] "Hawaii Department of Transportation Demonstrates CarbonCure for Paving Infrastructure." CarbonCure Technologies Inc., 17 May 2020, www.carboncure.com/news/hawaii-department-of-transportation-demonstrates-carboncure-for-paving-infrastructure/.

Section 601: Structural Concrete of the DOT/State Projects Special Provisions 2005 Standard Specifications was updated on July 10th, 2020. Revisions to the section included the requirement of a carbon reduction strategy.

> "To reduce the embodied carbon footprint of concrete, concrete design on the island of Oahu shall include the use of carbon dioxide mineralization or equivalent technology" (601.01).
>
> "Concrete Design – Projects on Oahu will utilize CO2 Mineralization technology or equivalent. Supplementary cementitious materials (SCMs), CSH-SEA or equivalent or combination thereof the previously mentioned methods may also be used. Concrete design shall allow a reduction of portland cement content while maintaining the concrete design strength, durability and other requirements" (601.3).

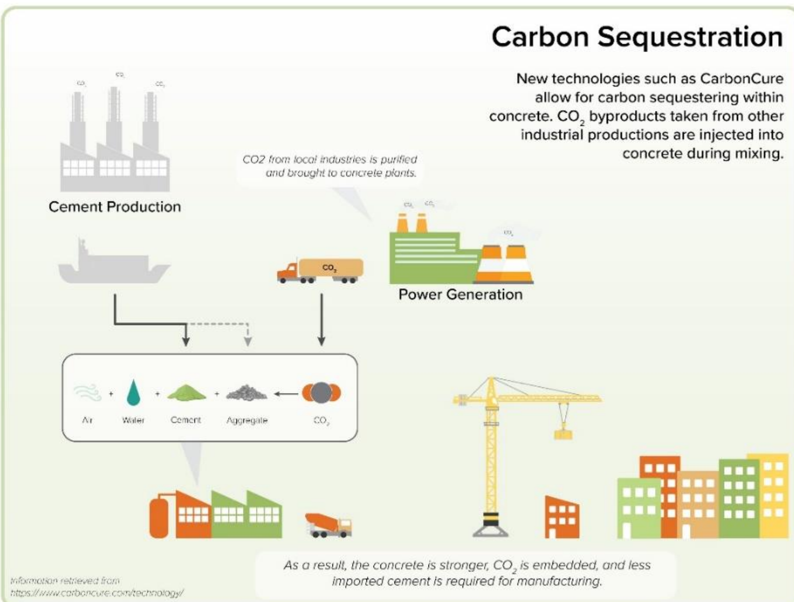

Figure 8: C02 Mineralized Concrete Process.

Iterative energy modeling tools are encouraged to be utilized to inform decision making throughout the entire design process. Building information modeling (BIM) techniques and lean construction methods can reduce material waste in projects. Better visualization increases accurate estimations of materials and costs on designs while reducing the number of errors made on site.

Call for generation of on-site (and off-site) renewable energy

In addition to sustainable design strategies, which can help to satisfy a low energy budget while preserving comfort, is the generation of on-site renewable energy. The creation of this resource furthers the impact of the building from energy efficient to zero-net-energy (ZNE). Some forms of renewable energy being generated on the Island of O'ahu include solar, wind, ocean, biofuel, and waste-to-energy.[21]

Resilient Design for Oahu's Buildings

Resilience is defined by the O'ahu Resilience Strategy as "the ability to survive, adapt, and thrive regardless of what shocks or stressors come our way." These shocks ("events which occur rapidly and unexpectedly") and stressors ("on-going strains on society that gradually sap community strength")[22] create vulnerabilities which detract from strong community culture, values, and experiences.

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[21] "Hawaii Clean Energy Leaders and Renewable Energy Projects." Hawaii Renewable Energy Projects, energy.ehawaii.gov/epd/public/energy-projects-map.html.

[22] United States, Congress, Climate Change, Sustainability and Resiliency. Ola O'ahu Resilience Strategy, 2019.

The top five identified **shocks** on Oahu in 2019 include:

1. Hurricanes
2. Tsunamis
3. Infrastructure Failure
4. Rainfall Flooding
5. External Economic Crisis[23]
6. Heat Waves

The top five identified **stressors** on Oahu in 2019 include:

1. Cost of Living
2. Aging Infrastructure
3. Climate Change Impacts
    a. Rising Heat
    b. Sea Level Rise
4. Lack of Affordable Housing
5. Over-reliance on Imports[24]

New build and existing retrofits can look at these challenges in order to help increase the resiliency of O'ahu. Design and selected materials can adapt to be better prepared for sea level rise around coastal areas, flooding during heavy rain showers, increased threat of hurricanes, and extreme heat especially in the summer months. A more equitable distribution of affordable housing in urban regions can help decrease the cost of living for many residents, while offering increased public transportation options and shorter commutes to work. Prioritizing the use of local building materials, local AEC businesses, and SMM cuts back on the industry's contribution to GHG emissions and reduces our reliance on imported goods.

Regenerative Buildings

Regenerative architecture is the "practice of engaging the natural world as the medium for and generator of the architecture focused on: conservation and performance through decreased environmental impacts of a building."[25] A refocus on the place and site of the specific built project allows designers and stakeholders to understand the natural and living systems in the design. A regenerative practice follows the approach that the production output is "greater than the net input of resources into the system."[26] In terms of architecture it means a surplus of food, clean water, and energy post consumption as well as a richer diversity than was there before.

Being prepared for adapting existing spaces as well as new builds post shocks and or stressors is especially important during our current climate crisis. Exploring questions like "What can be done differently?" and "How do we want to rebuild?" can be a great exercise in beginning the anticipation of both mitigation and resilient strategies. Regenerative buildings are inherently more self-sustaining and resilient because of its existence forming from mutually supportive relationships. A dependence on the specific landscape and biosphere of the site and a core belief of recycled resources always in flux helps to create a circular process loop. This type of process

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[23] Ibid.

[24] United States, Congress, Climate Change, Sustainability and Resiliency. Ola O'ahu Resilience Strategy, 2019.

[25] Littman, Jacob A., "Regenerative Architecture: A Pathway Beyond Sustainability" (2009). Masters Theses 1911 - February 2014. 303.

[26] Ibid.

contrasts strongly with the traditional degenerative process where energy and resources are taken from the site and utilized within the building. Waste is a large output.

Response to Water Shortage

"The average person in the United States uses 70 gallons of water every day for drinking, cooking, bathing, toilet flushing, and lawn watering." This valuable resource has been filtered through porous volcanic rock for up to 25 years and is held in the island's aquifers.[27] The limitations of the finite resource can be acknowledged and addressed through the design of the built environment. "One-water promotes the management of all water within a specific geography – drinking water, wastewater, stormwater, greywater – as a single resource."[28] This approach to community-based water management can be practiced through various types of action. One practice that can be applied to projects of various scales can be a greywaters systems approach. This method engages a system that separates greywater (or water that comes from washing machines, bathroom sinks, showers, and other kitchen appliances) from blackwater (wastewater from toilets). Greywater, which can be collected for reuse, can make up between 50% and 80% of water consumed in residential buildings. Redesigning the standard water management system in both residential and commercial scale projects to utilize the separate collection and reuse of greywater can make communities more resilient by decreasing sewer overflows and dependence an outside source of water.[29] Techniques for this strategy also exist for retrofit projects.

Potential Advantages:
- Potable water conversion
- Lower water bills
- Decreased load on local sewers
- Potential incentives to meet energy standard criteria
- Reduced energy use and greenhouse gas production from water treatment plants
- Enhanced drought resistance

Potential Uses of Greywater:
- Toilet flushing water
- Drip irrigation for various types non-edible gardens, landscaping, and or golf courses
- Ground water recharge
- Adjacent building needs
- Treatment systems for future water use
    - (sedimentation, membrane filtration, UV sterilization components)

Building Efficiency Standards:
- LEED Water Efficiency (WE) Category
    - WE Credit 1: Water Efficient Landscaping
    - WE Credit 2: Innovative Wastewater Technologies
    - WE Credit 3: Water Use Reduction
- Living Building Challenge's Water-related Imperatives
    - Imperative 5: Net-Zero Water
    - Imperative 6: Ecological Water Flow

[27] "Hawaii's Water Cycle." Hawaii's Water Cycle - Board of Water Supply, www.boardofwatersupply.com/water-resources/the-water-cycle.

[28] Richards, Sarah. "Texas Swimming Holes Need One Water." Texas Living Waters Project, The Cynthia and George Mitchell Foundation, 28 Mar. 2018, texaslivingwaters.org/one-water-blog/.

[29] "Greywater Systems." Where All People Can Thrive, Green Building Alliance, www.go-gba.org/resources/green-building-methods/greywater-system/.

Community Resilience (section might be omitted)
When adverse situations hit, communities need to be equipped to use available resources to respond to and recover their economies and ecosystems. Communities both have social needs as well as dependencies on the built environment. Creating adaptable organizations and systems can allow communities to better prevent, protect, mitigate, respond, and recover from crisis.

Resources like energy production and distribution, communication systems, transportation networks, and food sources are put under stress during times of emergency, but also can be heavily relied upon if designed for the expected and unexpected circumstances. A community resilient plan provides a guideline to help governments and residents implement a distribution of volunteers and access to knowledge and resources for recovery.

Locally, The Office of Climate Change, Sustainability and Resiliency is tasked with "with tracking climate change science and potential impacts on City facilities, coordinating actions and policies of departments within the City to increase community preparedness, developing resilient infrastructure in response to the effects from climate change, and integrating sustainable and environmental values into City plans, programs, and policies." The top four priorities they have identified with insight from engaged community members are:

1. Remaining Rooted: Ensuring an Affordable Future for Our Island
2. Bouncing Forward: Fostering Resilience in the Face of Natural Disasters
3. Climate Security: Tackling Climate by Reducing Emissions and Adapting to Impacts
4. Community Cohesion: Leveraging the Strength of Local Communities

A call to improve community resilience can be answered from the construction industry through the prioritization of resilience hubs in new build and retrofit projects. This type of "joint-use" space is an example of designing adaptability into the program spaces of projects. Community serving facilities or centers can have dual functions during day to day business and serve as emergency centers during times of crisis.[30] Future projects including this in their design scope could help to increase the capacity of community resources and therefore its resilience.

[30] "What Are Hubs?" Resilience Hubs, 2 Oct. 2019, resilience-hub.org/what-are-hubs/.

Figure 9: Resilience Hub Characteristics (Mercy Corps)

Contribution to Livable Neighborhoods
Increased challenges are faced as growth-related problems rise. One challenge is the loss of community identity. The experience of a complete street is detracted by poor environmental quality, a congested transportation network, lack of access to green space, deficiencies in affordable housing, lack of locally-oriented businesses, and a loss of sense of place.[31]

The built environment has great influence on creating and maintaining *livable neighborhoods* that are "pleasant, safe, affordable, and supportive of human community."[32] "Livable communities above all feature 'people places' – places where people like to congregate, hang out, meet friends, or savor the public environment."[33] Designing at the level of the neighborhood in comparison to the specific project and its immediate site, can allow for increased quality of life for a larger number of residents while targeting issues that contribute to climate change.

Some priorities of livable neighborhoods include:

- A pedestrian oriented public realm
- Low-traffic speed
- Decent, affordable, and well-located housing
- Convenient schools, shops, and services
- Accessible parks and open space
- A clean natural environment
- Safe and accepting places to a diverse range of users
- Presence of meaningful cultural, historical, and ecological features

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[31] Wheeler, Stephen. "Livable Communities: Creating Safe and Livable Neighborhoods, Towns, and Regions in California." EScholarship, University of California, 27 May 2004, escholarship.org/uc/item/8xf2d6jg.

[32] Ibid.

[33] Ibid.

(can lend to the preservation and cultivation of the unique features of a neighborhood) Friendly, community-oriented social environments."[34]

Complete Streets

How people move to, within, and through a space heavily influences the experience of everyday urbanism. According to the City and County of Honolulu, complete streets are the designed solutions "to accommodate people traveling by foot, bicycle, transit, or automobile, and of all ages and abilities."[35] Principles "move away from streets designed with a singular focus on automobiles toward a design approach that is context-sensitive, multimodal, and integrated with the community's vision and sense of place."[36] Increased accessibility, safety, encouraged physical activity, and design responsive to needs of specific communities can be achieved through complete street design solutions.

Multimodal Access

Multimodal access to and from public transportation is one of the priorities of complete streets and works to provide a smaller network of support services to the larger public transportation system. Accommodation of multimodal demand starts from understanding the needs of transit users, especially those of kupuna with limited access. Some methods of multimodal transportation include walking, bicycling, riding feeder public transportation, and driving. "When effectively integrated, bicycling and walking to public transportation help to advance various environmental, health, and congestion-mitigation benefits for communities."[37] Considerations to include in the decision making and design of this type of strategy include: benches and shading structures at public transportation stops, sidewalks, multi-use paths, crosswalks, pedestrian signals, sufficient crossing times, parking and storage of bicycles at public transportation hubs, availability of shared bike services, parking for vehicles, informational and navigational support, and transit-oriented development.

Transit-oriented Development

Transit-oriented development (TOD) "is a pattern of different uses – housing, jobs, and services – surrounding a transit station that takes advantage of the convenience and affordability of transit." Generally occurring within a one-quarter to one-half mile radius (about a five to ten-minute walk) to the transit route, TODs are situated within an accessible distance for pedestrians who live, visit, or work there. City and County planned TODs around future rail transit stations attempt to reduce household transportation costs and dependence on automobiles by creating neighborhoods made up of a "mix of housing choices, employment and commercial opportunities, and new recreational spaces."[38] The creation of these hubs strives to improve the efficiency of government services and infrastructure. They seek to increase the quality of life for residents while combating climate change by creating more outdoor "green space and public gathering places, safer streets, and less pollution and noise."[39]

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[34] Wheeler, Stephen. "Livable Communities: Creating Safe and Livable Neighborhoods, Towns, and Regions in California." EScholarship, University of California, 27 May 2004, escholarship.org/uc/item/8xf2d6jg.

[35] Complete Streets, 2020, www.honolulu.gov/completestreets.

[36] Ibid.

[37] "Multimodal Access to Public Transportation." U.S. Department of Transportation, 2015, www.transportation.gov/mission/health/Multimodal-Access-to-Public-Transportation.

[38] "DPP TOD Home." Transit-Oriented Development Home, 2019, www.honolulu.gov/tod.

[39] Ibid.

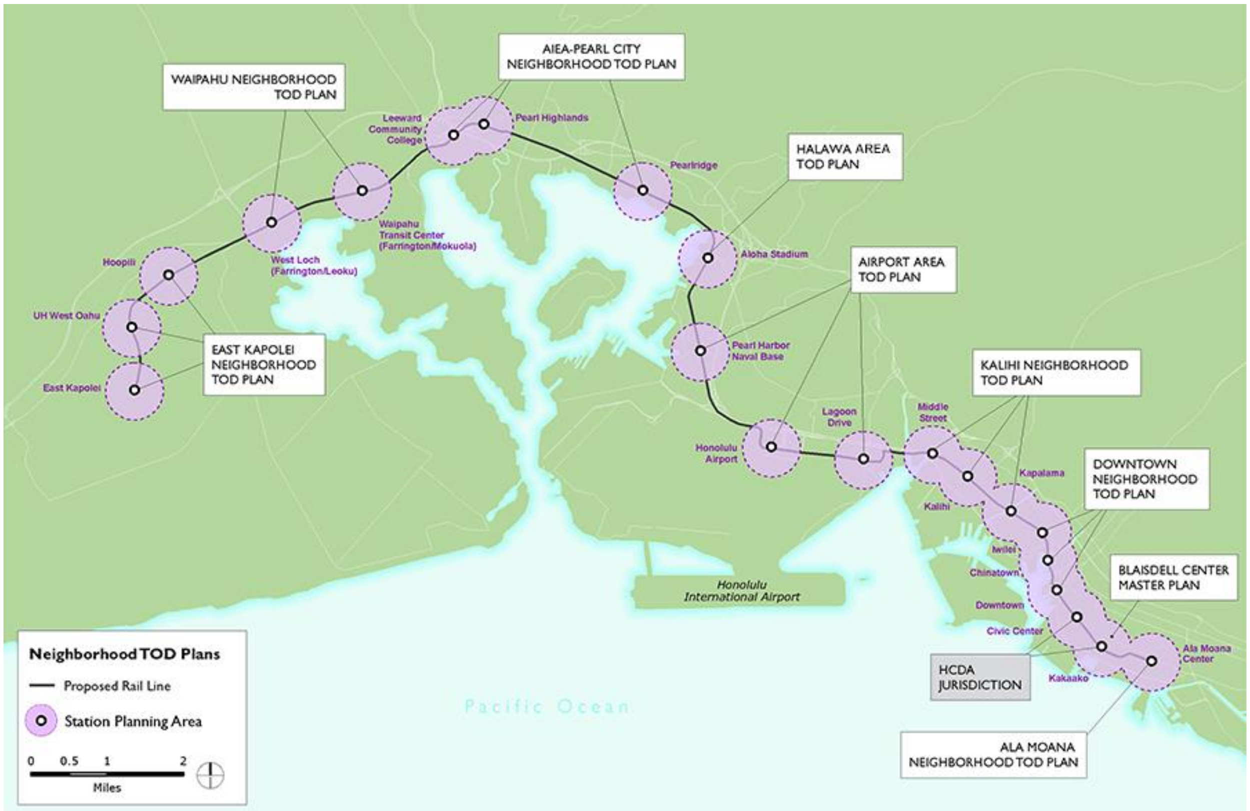

Figure 10: Neighborhood TOD Plans (DPP). Last updated September 30th 2019.

Potential complete street solutions, when combined into a larger strategy can help to create stronger livable neighborhoods. Some of these priorities include:

1. Designing spaces that prioritize walkability and gatherability amid streetscapes. One technique could be through increased preservation and usage of large trees and shade structures to provide inhabitants relief from the sun. *(See Prioritizing Shading for Community Gathering Spaces)*
2. Creating design guidelines that promote the use of vernacular architectural styles and building materials.
3. Placing an emphasis on unique architectural, ecological, cultural, and historic qualities of places[40] (more specifically related to Native Hawaiian Culture). One technique could be through relevant eye level signage and wayfinding.
4. Promoting the retrofitting of existing buildings to improve energy efficiency and decrease energy demand.
5. Encouraging a fine-grained mix of buildings and land uses[41] that lend to healthy neighborhoods.

Prioritizing Shading for Community Gathering Spaces

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[40] Wheeler, Stephen. “Livable Communities: Creating Safe and Livable Neighborhoods, Towns, and Regions in California.” EScholarship, University of California, 27 May 2004, escholarship.org/uc/item/8xf2d6jg.

[41] Ibid.

The built environment has a responsibility to its occupants to provide inhabitable areas that offer thermal comfort, clean air, and physical space conducive for community engagement. The natural environment offers a valuable resource that when incorporated holistically into design, can have little operational cost and carbon contribution. Embodied carbon created during the assembly of these places can be partially offset with increased habitation of flora. Reactivating spaces in existing structures can be done through adaptive reuse focused on providing shade and open covered gathering spaces for building occupants. Creative shaded areas can be designed on various scales and levels of permanency.

Two strategies for increasing shading on both existing and newly developed sites include plants & vegetation and tensile shading structures. Proper location and selection of flora surrounding the built environment can reduce up to 25% of the cooling costs of the building's operational loads. Branches and leaves provide shade, leaves help filter polluted air, and evapotranspiration from leaves cools surrounding air.[42] The installation of fluid tensile structures also can help create shading in outdoor areas. Their flexibility is enabled by the type of material used, various anchor points, as well as their level of permanence throughout the space during different times of the year. These types of shading structures can be installed on existing projects, but also fully integrated as a potential design feature of the site with upfront planning during the design process of projects.

Looking at various types of spaces and their current uses with a fresh perspective allows decision makers, at all levels, to leverage existing resources to better accomplish goals within our new normal. Outdoor shading strategies, especially in our tropical climate, can allow for more adaptable flex space within buildings, campuses, neighborhoods, and city centers. Shaded areas not only decrease heat island effect, but also encourage outdoor activities that lend to community participation, engagement, and stewardship.

These various solutions that prioritize livable neighborhoods can be achieved through community-based problem solving, access to neighborhood-oriented services, and public/private cooperation. Potential policy response could be in the form of revised zoning ordinances, requirements, and incentive programs. Rejuvenation of a sense of place and local identity will help promote community relationships and support of local businesses and economies. Proposed strategies at different scales help to iterate that collaboration is needed from various groups of stakeholders including and beyond those in the construction industry.

STANDARDS

Green Building Standards

Green building standards encourage more sustainable design and development. Various programs and standards exist to help guide, incentivize, and provide accountability through moral codes and rating systems for communities.[43] These standards are hosted by code councils, professional American societies,

[42] LECHNER, NORBERT M. HEATING, COOLING, LIGHTING: Sustainable Design Methods for Architects. JOHN WILEY, 2020.

[43] "Green Building Standards." EPA, Environmental Protection Agency, 23 Jan. 2018, www.epa.gov/smartgrowth/green-building-standards#:~:text=Buildings%20(ASHRAE%20189.1)-,A%20model%20code%20that%20contains%20minimum%20requirements%20for%20increasing%20the,and%20modular%20and%20mobile%20homes.

NGOs, and nonprofits. The following are some mandatory and voluntary standards popular in the United States.

International Code Council's 2012 *International Green Construction Code* (**IgCC**), 2012 edition
Mandatory "model code that contains minimum requirements for increasing the environmental and health performance of buildings' sites and structures. Generally, it applies to the design and construction of all types of buildings except single- and two-family residential structures, multifamily structures with three or fewer stories, and temporary structures."

American Society of Heating, Refrigeration, and Air-Conditioning Engineers' ANSI/ASHRAE/USGBC/IES Standard 189.1-2011, *Standard for the Design of High-Performance Green Buildings Except Low*-Rise Residential Buildings (**ASHRAE 189.1**), 2011 edition
Mandatory "model code that contains minimum requirements for increasing the environmental and health performance of buildings' sites and structures. Generally, it applies to the design and construction of all types of buildings except single-family homes, multifamily homes with three or fewer stories, and modular and mobile homes."

National Association of Home Builders' ICC 700 *National Green Building Standard* (**NGBS**), 2012 edition
Voluntary "rating and certification system that aims to encourage increased environmental and health performance in residences and residential portions of buildings. Its criteria apply to the design and construction of homes and subdivisions."

Green Building Initiative's ANSI/GBI 01-2010: *Green Building Assessment Protocol for Commercial Buildings* (Green Globes), 2010 edition
Voluntary "series of rating and certification systems that encourage improved environmental and health performance for all types of buildings except residential structures. Green Globes is administered in the United States by the Green Building Initiative."

U.S. Green Building Council's *Leadership in Energy and Environmental Design* (**LEED®**)
Voluntary "series of rating systems aimed at increasing the environmental and health performance of buildings' sites and structures and of neighborhoods. LEED® covers the design, construction, and operations of all types of buildings."

The International Living Future Institute's ***Living Building*** *Challenge*, version 2.1 (May 2012)
Voluntary "certification system that advocates for transformation in the design, construction, and operation of buildings. In addition to encouraging improved environmental and health performance, it supports the building of structures that are restorative, regenerative, and an integral component of the local ecology and culture."[44]

BREEAM Global "sustainability assessment method for masterplanning projects, infrastructure, and buildings." Published by the Building Research Establishment (BRE) in 1990.[45]

EDGE, E+C-, Futurebuilt, Green Star, ILFI, Zero Carbon?
Need to have a conversation about relevancy

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[44] "Comparison of Green Building Standards." EPA, Environmental Protection Agency, 15 Aug. 2017, www.epa.gov/smartgrowth/comparison-green-building-standards.

[45] "The World's Leading Sustainability Assessment Method for Masterplanning Projects, Infrastructure and Buildings." BREEAM, 7 Oct. 2019, www.breeam.com/.

The 2030 Challenge as a Potential Vehicle for Change

Architecture 2030 is a nonprofit organization established in 2002. Their primary objectives are to "achieve a dramatic reduction in the energy consumption and greenhouse gas (GHG) emissions of the built environment; and advance the development of sustainable, resilient, equitable, and carbon-neutral buildings and communities."[46]

To achieve this, Architecture 2030 issued *The 2030 Challenge* in 2006. It challenges the building community to adapt the following targets:

1. All new building projects (new builds and renovations) shall meet "a fossil fuel, GHG-emitting, energy consumption performance standard of 70% below the regional (or country) average/median for that building type."
2. "At a minimum, an equal amount of existing building area shall be renovated annually to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 70% of the regional (or country) average/median for that building type."
3. The fossil fuel reduction standard for all projects shall be increased to:

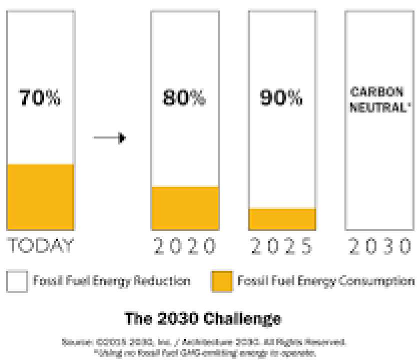

Figure 11: The 2030 Challenge Energy Goals (Architecture 2030)

4. "These targets may be met by implementing innovative sustainable design strategies, generating on-site renewable energy, and/or purchasing (20% maximum) off-site renewable energy."[47]

This challenge is supported by the AIA's 2030 Commitment Program.

Zero Code

Zero Code is an initiative of Architecture 2030 that integrates "cost-effective energy efficiency measures with on-site and/or off-site renewable energy resulting in zero-net-carbon (ZNC) buildings."[48] This energy standard produces buildings that not only create the energy that they need to operate, but also a surplus which can be fed back into the energy grid. This national and international energy standard is supported by Architecture 2030, a non-profit committed to facilitating the creation of a world with carbon neutral buildings by 2030.

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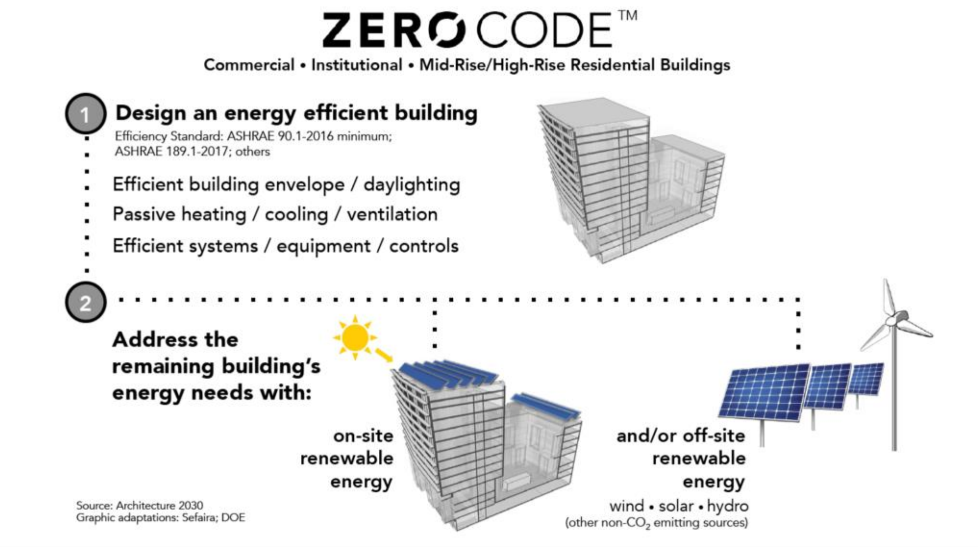
[46] "ABOUT US." Architecture 2030, architecture2030.org/about/.

[47] "Meeting the 2030 Challenge." Architecture 2030, architecture2030.org/2030_challenges/2030-challenge/.

[48] "Introducing the ZERO Code." ZERO Code, zero-code.org/.

Figure 12: Zero Code Standards (Zero Code)



RECOMMENDATIONS AND CONSIDERATIONS *(still in progress)*

Based on current trends and studies of Honolulu and other U.S. cities, the Climate Change Commission suggests that the C&C:

1. Incorporate the goals of Architecture 2030 to support climate change adaptation and risk management on O'ahu.
2. Reduce potential risk by updating building and energy code and implement both new build and retrofit programs that prioritize energy efficiency.
3. Calls upon the DPP to …

CONCLUSION

The adoption of a collective value of the design and construction of the built environment driven by energy efficient design strategies will help to be a part of the climate and energy crisis solution. As architects, engineers, contractors, municipalities, nonprofits, community members, and neighbors, we all have a responsibility and role in creating a new norm of efficient energy usage. Its impact is directly related to the consequences of climate change that affects the natural and built environment we inhabit.

RELEVANT DOCUMENTS

State of Hawaii Department of Business, Economic Development & Tourism Energy, Resources & Technology Division (DBEDT) + The Honolulu Chapter American Institute of Architect's
Field Guide for Energy Performance, Comfort, and Value in Hawaii Homes
https://energy.hawaii.gov/wp-content/uploads/2011/10/Field-Guide-2.pdf

City and County of Honolulu Office of Climate Change, Sustainability and Resiliency's
Ola O'ahu Resilience Strategy
https://www.honolulu.gov/rep/site/ccsr/Ola_Oahu_Resilience_Strategy.pdf

Urban Sustainability Directors Network's
Resilience Hubs White Paper
https://www.usdn.org/uploads/cms/documents/usdn_resiliencehubs_2018.pdf

Hawai'i Climate Change Mitigation and Adaptation Commission's
Hawaii Sea Level Rise Vulnerability and Adaptation Report
https://climateadaptation.hawaii.gov/wp-content/uploads/2017/12/SLR-Report_Dec2017.pdf

City and County of Honolulu's
Complete Streets Policy (Ordinance 12-15) and **Honolulu Complete Streets Design Manual**
https://www.honolulu.gov/completestreets/912-site-dts-cat/site-dts-te-cat/28682-complete-streets-policy.html

Department of Planning & Permitting
TOD 101 Brochure
http://www.honolulu.gov/rep/site/dpptod/dpptod_docs/TOD_Brochure_web.pdf