UC SANTA BARBARA
Bren School of Environmental Science & Management

Integrating Climate Mitigation and Adaptation Strategies into Low-Income Residential Developments in the City of Santa Barbara

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CLIENT

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OBJECTIVES

Buildings account for 42 percent of all GHG emissions globally, exceeded only by emissions from the transportation sector.[1] The United States, especially California, is facing a housing crisis. In fact, as of 2024, roughly half of all unsheltered people in the country are in California.[2] To address the problem, the Legislature has assigned new housing quotas to communities across the state. The City of Santa Barbara is required to add 8,000 new living units in the next decade, and the County of SB significantly more. This creates an opportunity to build housing that approaches a zero-carbon contribution. The City of Santa Barbara is working towards the creation of a slate of sustainable building guidelines more rigorous than what is required by current state codes.

The Housing Authority of the City of Santa Barbara (HACSB) proposes to use the results of this project on the Presidio Springs complex, a senior housing development, as they expand from 122 units to 300-350 units. Since the reconstruction of this complex is a long-term project, our proposed MESM Group Project will allow us to provide recommendations for sustainable building practices before design and construction begins.

This project will:

1. Perform an audit to determine the environmental impact of existing building methods and materials used in the original development of Presidio Springs.
2. Identify existing sustainable building materials and building strategies that will reduce the environmental impact of the housing complex, focusing on lowering the embodied carbon content of materials, wastewater recapture, and passive cooling design strategies.
3. Develop recommendations for future housing projects that go beyond the stringency of current regulations, incorporating equitable climate change mitigation and adaptation strategies.

IMPLICATIONS

Buildings and the construction sector account for 42% of global carbon emissions, making them one of the largest contributors to climate change.[1] These emissions are divided into two key categories: embodied carbon and operational carbon. Embodied carbon refers to the emissions associated with the harvesting, extraction, manufacturing, and transportation of building materials and accounts for 15% of global carbon emissions.[1] Operational carbon, on the other hand, includes the emissions generated during a building's use, primarily through energy consumption for heating, cooling, lighting, and appliances and is responsible for 27% of global carbon emissions.[1] Reducing both types of carbon creates buildings that are not only more sustainable but also more cost-effective in the long run, as they require less energy to operate and produce fewer emissions from the start. By focusing on both embodied and operational carbon, we can make substantial progress toward decarbonizing the built environment, a critical step in meeting global climate goals.

Santa Barbara is already experiencing significant climate change stresses, with extreme heat and persistent drought posing growing risks to the region's environment, economy, and public health. These challenges are particularly critical for vulnerable populations, such as senior low-income residents in outdated housing, who are less equipped to adapt to changing conditions. By integrating low-carbon construction, passive cooling strategies, and water-saving technologies into affordable housing projects, the Housing Authority of the City of Santa Barbara can strive for long-term resilience and livability.

Passive cooling strategies such as shading East and West facing windows, increasing operational windows across the residence, installing ceiling fans, installing a whole house fan and increasing thermal mass, and using exhaust fans in bathrooms and kitchens are all examples of fairly low-cost passive design strategies that have been proven to effectively cool residential buildings in Santa Barbara's warm marine climate zone (3C).[3] To reduce water stress, innovative solutions such as water capture and reuse systems are essential.[4] Strategies like condensate recovery from heat pumps and greywater reuse for landscaping can lower water consumption, reduce utility bills, and promote more sustainable water management for Santa Barbara residents.[5] By

integrating low carbon construction, passive cooling strategies, and water-saving technologies into affordable housing projects, the Housing Authority of the City of Santa Barbara can address these climate stresses while improving quality of life for residents. Proactive efforts to reduce both carbon emissions and resource consumption will not only mitigate local climate risks but also serve as a model for other regions facing similar challenges.

EQUITY

This project addresses environmental justice by developing green building guidelines for sustainable, affordable housing in Santa Barbara. It aims to improve conditions for low-income families, many of whom live in outdated buildings with poor insulation and inefficient systems, resulting in high expenses, health risks, and vulnerability to extreme weather. Santa Barbara faces a severe housing crisis, with 17,037 low-income renter households lacking affordable options and 75% of extremely low-income households spending over half their income on rent. The average rent of $2,554 requires earnings of $49.11 per hour, far above the state minimum wage.[6] The sustainable reconstruction and expansion of Presidio Springs will add crucial housing supply to Santa Barbara, adding around 200 units of section 8 housing. The green building guidelines we will create through this project will focus on implementing energy-efficient design strategies to lower utility bills, replacing traditional materials with non-toxic alternatives and improving ventilation. This will improve indoor air quality, and climate-adaptive features to enhance resilience against heatwaves, wildfires, and other risks. Additionally, the guidelines can serve as a model for other cities seeking to expand affordable housing and meet carbon neutrality goals.

AVAILABLE DATA

The HACSB will provide information on all materials used in their recent housing projects, including Presidio Springs. Data shared with us will contain the source, type, amount, and cost of materials that were used in the construction of previous projects, as well as current utility usage and related costs. Other data will be retrieved from the following sources.

To establish embodied and operational carbon content of materials:

1. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Building Envelope Guidelines: Performance guidelines for all materials used in a building's envelope. The guidelines specify requirements for insulation, thermal properties, and air leakage rates.
2. Carbon Smart Materials Palette: A database that provides in depth information on both high embodied carbon materials and potential carbon-smart alternatives.
3. 2050 Materials Database: A database that provides embodied carbon counts of building materials, their sources and regional production availability.
4. The Inventory of Carbon and Energy (ICE) Database: A database of over 200 building materials including their embodied and operational carbon impacts.

To inform the selection and implementation of passive design strategies and provide insights into the broader impacts of these strategies on design decisions:

1. Pacific Northwest National Laboratory Building America Solution Center Database: A database of passive and low energy cooling systems for residential buildings based on local climate.
2. Heat Recovery Ventilation Guidelines for Houses: A comprehensive guide to implementing heat recovery ventilation systems in residential buildings.
3. Optimization of Building Energy Performance through Passive Design Strategies: Provides analysis of impacts and directions for adopting eight different passive design strategies.

To assess the feasibility of implementing a condensate recovery system at Presidio Springs and identify the most effective water reclamation strategies aimed at reducing reliance on water utilities:

1. Pacific Institute's Report on California's Urban Water Supply: Analyzes options for increased urban water efficiency, and water reuse and stormwater capture systems.
2. DOE Best Management Practices: Alternative Water Sources: Provides best management practices for rainwater harvesting, stormwater harvesting, reclaimed wastewater, and greywater.

3. Case Study of Economic Feasibility of Heat Pump Condensate Recovery across the United States: An economic feasibility study of using heat pump condensate recovery systems.
4. Alliance for Water Efficiency's Resource Library: Collection of scientific research, academic literature, and tools and models for cutting edge water conservation solutions.

POSSIBLE APPROACHES

- **Material Audit:** Use data provided by the HACSB to quantify the amount of materials used in the construction of Presidio Springs, along with their cost, embodied carbon content, and other important attributes to determine a baseline of environmental impact.
- **Data Collection and Research**: Conduct research on existing sustainable building materials to compile data for the creation of a material matrix. This matrix will inform our sustainable building guidelines, providing comparisons of traditional building materials to more sustainable alternatives (ex: cost, regional availability).
- **Modeling through use of Tools**: HACSB will connect the team with architects at Cearnal Architects, who will provide site plans and building mockups to run through energy usage tools. These tools include but are not limited to:
    - EnergyPlus: A whole building energy simulation modeling software. Will be used to model energy consumption based on different designs including fenestration, glazing, thermal mass, insulation, orientation, and more.
    - Advanced Ceiling Fan Design Tool: This tool will be used to calculate the size and strength of ceiling fans recommended to aid our passive design strategy.
    - NOAA Solar Geometry Calculator: This tool determines site specific solar geometry to create a sun chart diagram. This diagram will be overlaid onto the site and consider adjacent buildings to create an effective daylighting strategy for window placement, glazing, and overhangs to ensure spaces are well lit without exposure to excess solar radiation.
- **Urban Housing Design Research:** Conduct research on green design strategies, such as passive cooling, to better understand how changes to the structural design of the housing complex could reduce its environmental impact (i.e. energy consumption, GHG emissions). Applying passive design strategies to multi-story, multi-unit projects have few precedents but will be relevant and timely for the housing being required for Santa Barbara.

DELIVERABLES

In addition to the deliverables required by Bren, our final deliverable will be a tool that assesses green building strategies and materials to be used in construction of new buildings in Santa Barbara. The HACSB has requested a physical document that can be provided to architects, developers, and the City of Santa Barbara that provides a recommendation of green building strategies and materials for future developments. This document will include the following:

- A matrix of building materials that includes their embodied carbon content and regional availability, and a cost-benefit analysis of traditional building materials compared to alternatives.
- Recommendations for implementing passive cooling, greywater recycling and other design strategies in all new housing projects, supported by our cost-benefit analysis and literature reviews. Links, diagrams and videos will also be included for ease of implementation.
- A supplementary interactive database to allow users to calculate impact of material choice or implementation of a design strategy.

INTERNSHIP DESCRIPTION

The Housing Authority of the City of Santa Barbara, along with the generosity of Dennis and Jenny Allen, can sponsor one full-time summer internship with payment up to $8,500 for the duration of the internship. $3,500 will be paid by the HACSB and Dennis and Jenny Allen will contribute an additional $5,000 to the role. The internship length and weekly time commitment will be determined with the clients closer to the summer.

SUPPORTING MATERIALS

BUDGET AND JUSTIFICATION

We do not believe that the proposed project would require additional funding beyond the $1,000 from the Bren School for the group's basic operations.

ACKNOWLEDGEMENTS

We would like to thank Dennis Allen for bringing this project concept to our attention and connecting us to Rob Fredericks and Dale Fathe-Aazam at The Housing Authority of the City of Santa Barbara. His preliminary guidance helped shape the goals and potential outcomes of the project, and we are grateful to have his expertise on our team. We would also like to thank Satie Airamé and Dr. Roland Geyer for reviewing our proposal with thoughtful consideration and providing content and structural guidance.

CLIENT LETTER OF SUPPORT

Please see attached document. Note that client used prior title "Sustainable Building Guidelines for New Santa Barbara Housing to Reduce Impacts and Increase Resilience" when referring to this project.

CITATIONS

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HOUSING AUTHORITY OF THE CITY OF SANTA BARBARA

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January 8, 2025

Bren Group Project Review Committee
Bren School of Environmental Science and Management
2400 Bren Hall
University of California, Santa Barbara
Santa Barbara, CA 93117

RE: SUPPORT FOR GROUP PROJECT PROPOSAL

Dear Members of the Bren School Group Project Committee:

The Housing Authority of the City of Santa Barbara provides enthusiastic support for the group project proposal, "*Sustainable Building Guidelines for New Santa Barbara Housing to Reduce Climate Impacts and Increase Resilience*".

The Housing Authority provides decent and affordable housing to approximately 1,500 low- to moderate-income households in Santa Barbara and also administers Housing Choice Vouchers for approximately 3,000 low-income households in the greater south coast area. In order to fulfill our mission, the Housing Authority is an active developer of new affordable housing projects and are proud that many of them have been recognized for their attractive and functional design and their improvement to the surrounding neighborhood. In addition, we have as one of our primary objectives that our developments are built with sustainability in mind. For example, all of our recent apartment developments have incorporated photovoltaic systems into their design.

If this project is accepted by the review committee, it would help take the sustainability of our projects to the next level. Not only would we be concerned with meeting energy parameters and generating passive solar energy, but many other design considerations (e.g. selecting the best low carbon materials, use of passive energy design, etc.) that impact sustainability could be factored into the design and selection of materials. By tying the data-driven approach of the project to an actual long term redevelopment property that the Housing Authority has in its development pipeline will provide tangible guidance and have an immediate real-world impact.

If the project is accepted by the review committee, we are committed to supporting the group of students throughout the process by providing mentorship and guidance, access to our records/data, and commit to contributing $3,500 towards funding an internship supporting the project in the summer.

We heartily endorse this project and would be happy to make ourselves available to answer any questions you might have.

Sincerely,

Dale Fathe-Aazam
Deputy Executive Director
Real Estate and Technology

Rob Fredericks
Executive Director/CEO

cc: Dennis Allen