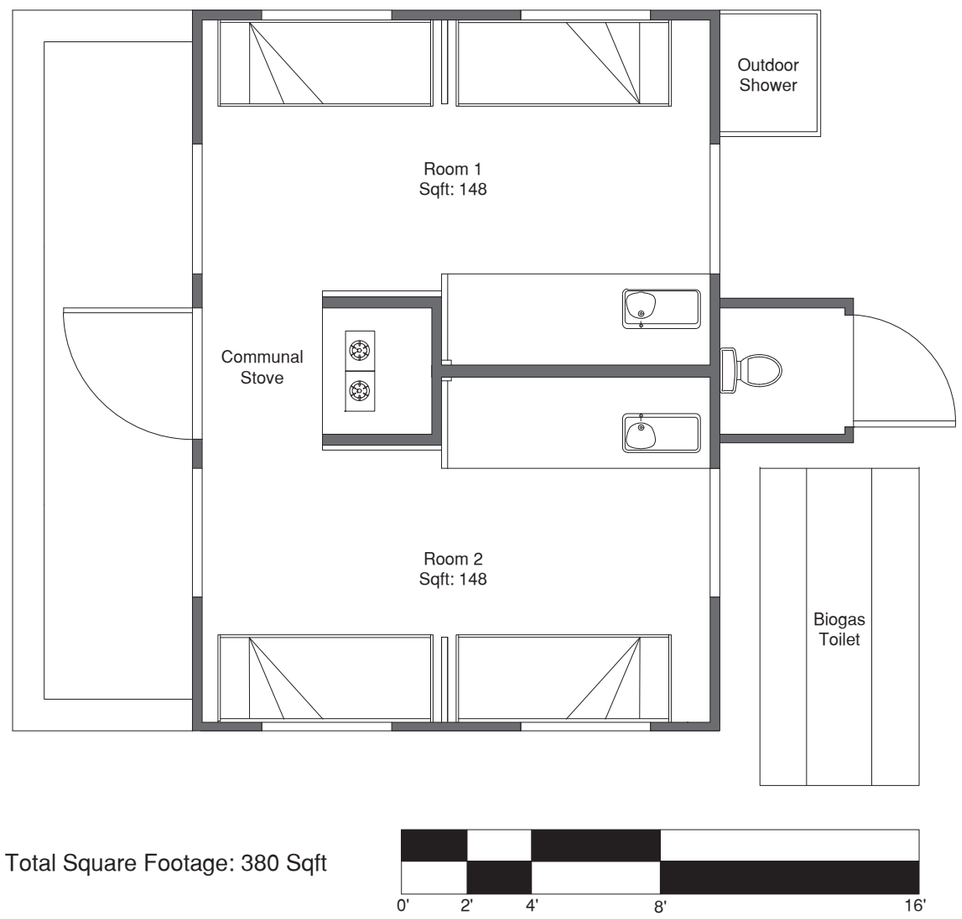
Sustainable Disaster Relief Housing

Ean Graff eanmg2@illinois.edu Team 31

At the moment there is a lack of development in affordable and sustainable disaster relief housing around the world. Alone in 2019 there were over 58.4 million people displaced from forms of disaster like armed conflict, flooding, and hurricanes. These disasters happen all over the world from Southeast Asia to Latin America. To provide these people homes, countries often bring in expensive, non-sustainable, and non-reusable housing that takes a massive toll on both the economies of nations as well as the environment. As populations rise and global warming continues, we will only see more displaced people requiring housing in disaster prone areas. The challenge moving forward is developing a affordable, sustainable, and disaster resistant home that provides shelter and comfort to the people who use it. The challenge addresses a various number of the UN's SDG's including Clean water and sanitation, Industry, innovation, and infrastructure, Sustainable cities and communities, and Responsible consumption and production. This type of housing will specifically need to target displaced peoples in hot or humid climates as well as third world nations.

Project's SDG's:

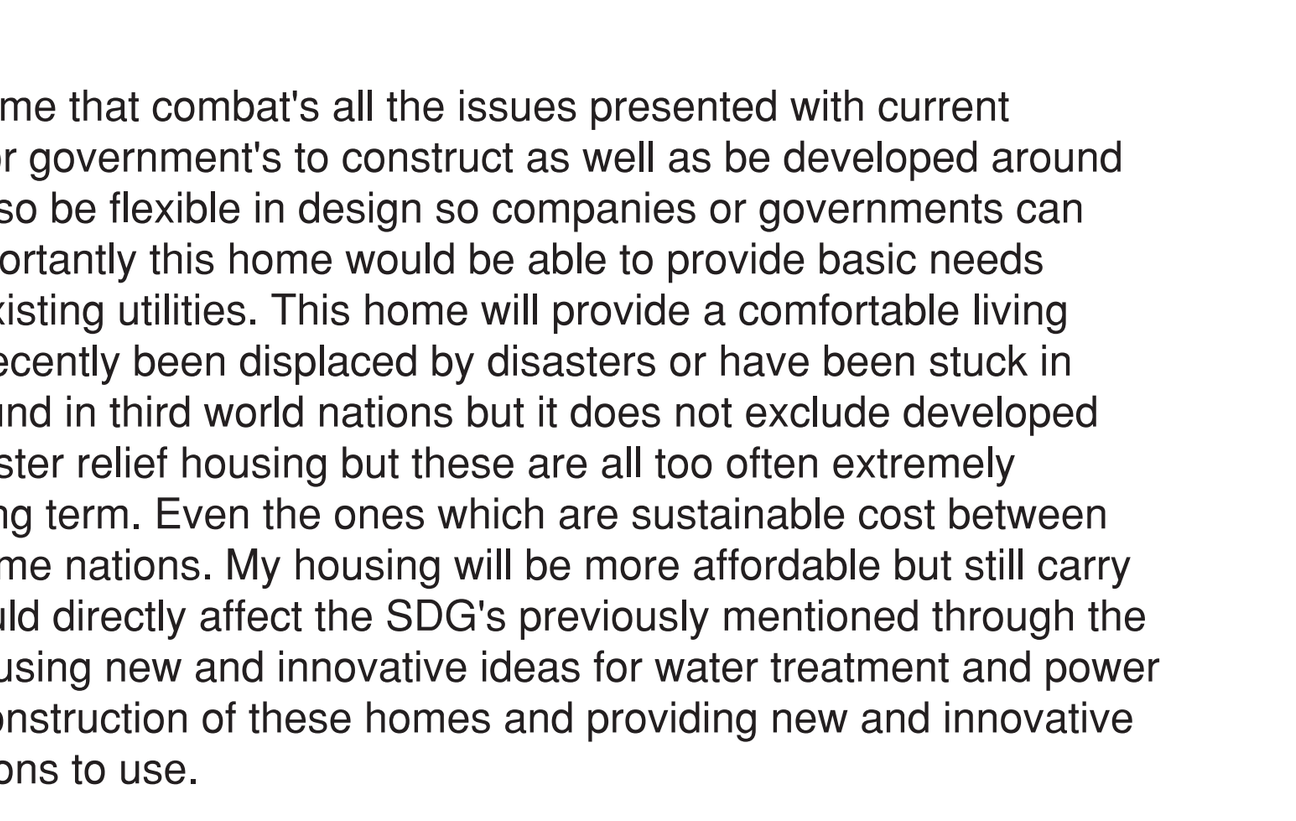


Plan Drawing of Propsed Structure

Relastic Rendering of Proposed Disaster Relief Housing in a Community Setting

My solution to this issue is to develop a disaster relief home that combat's all the issues presented with current housing. This disaster relief home would be affordable for government's to construct as well as be developed around the idea of sustainable construction. This home would also be flexible in design so companies or governments can change out pieces of it to best suit their needs. Most importantly this home would be able to provide basic needs of user's like gas and sanitation without the use of pre-existing utilities. This home will provide a comfortable living experience and safe environment for people who have recently been displaced by disasters or have been stuck in a cycle of having no housing. These are often people found in third world nations but it does not exclude developed countries. At the moment there is a large amount of disaster relief housing but these are all too often extremely expensive, non-sustainable, poorly designed, and not long term. Even the ones which are sustainable cost between $50,000 to $100,000 which is too expensive for low-income nations. My housing will be more affordable but still carry the idea of sustainability throughout it. This proposal would directly affect the SDG's previously mentioned through the use of ideas like sustainable concrete and CMU blocks, using new and innovative ideas for water treatment and power production, developing third world nations through the construction of these homes and providing new and innovative ideas to the construction of structures for future generations to use.

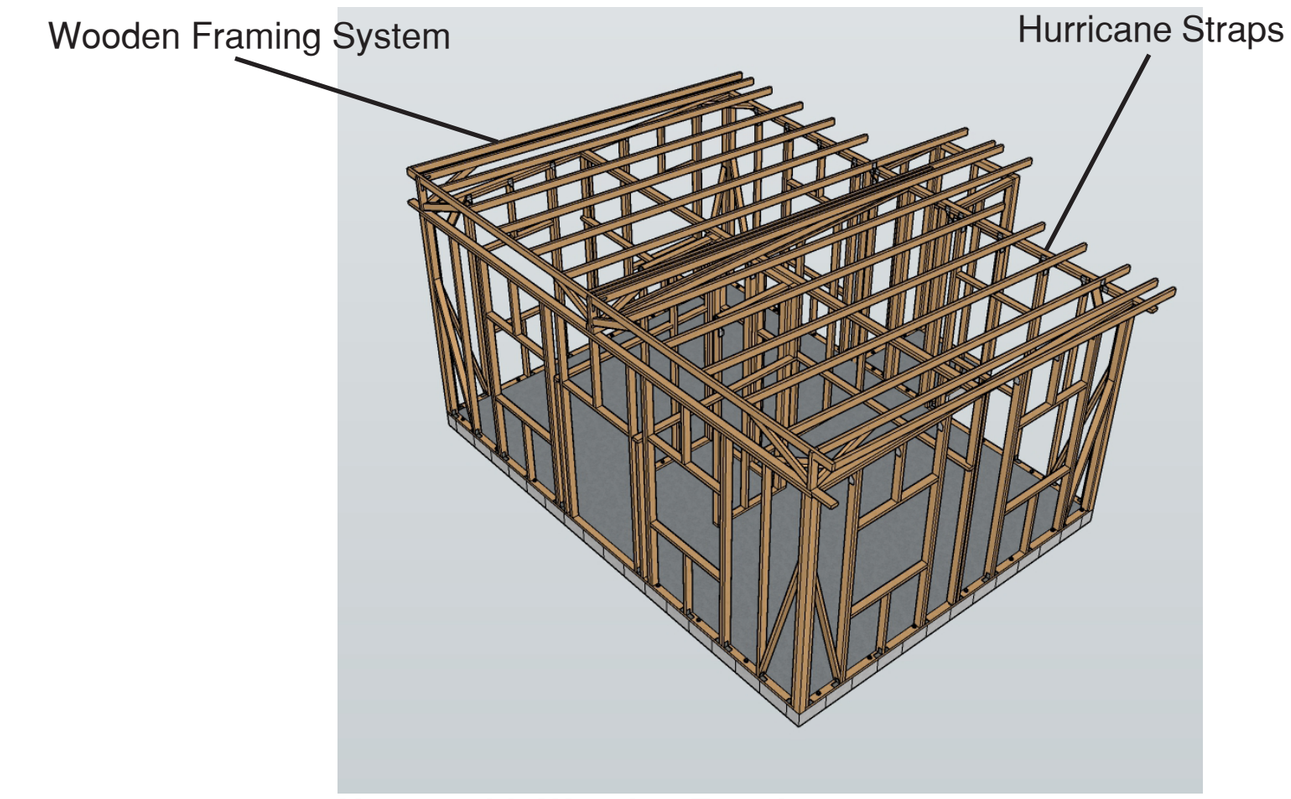
Foundation: The foundation of a typical house which has a lot of manufactured products like cement, rebar, and CMU blocks carries a lot of embodied energy and take massive amounts of carbon to produce. So changing some of these items will reduce the environmental impact of the structure by a large portion. The first thing to change is the CMU blocks. A single CMU block can off put 174 Kg of carbon during production, to combat this using a Watershed CMU block will help reduce the carbon off put to almost nothing because it is made from recycled materials as well as materials which require no carbon to compact. Another important part of the foundation is the green concrete. Normal concrete accounts for 3.8% of all global emission's switching this foundation type to green concrete will reduced the embodied energy by 50% because it uses the unused materials from manufacturing like fly ash and slag to create a recycled concrete. The foundation also uses a large amount of rammed earth in place of more concrete to reduce the carbon offput without effecting the structure of the building. It also has the added benefit of being a simple and well known foundation system and does not have any complex requriments. These characteristics stated and the others on the diagram create a cheap and sustainable foundation system that is flooding and hurricane resistant.



Foundation of Proposed Housing

Affected SDG's:

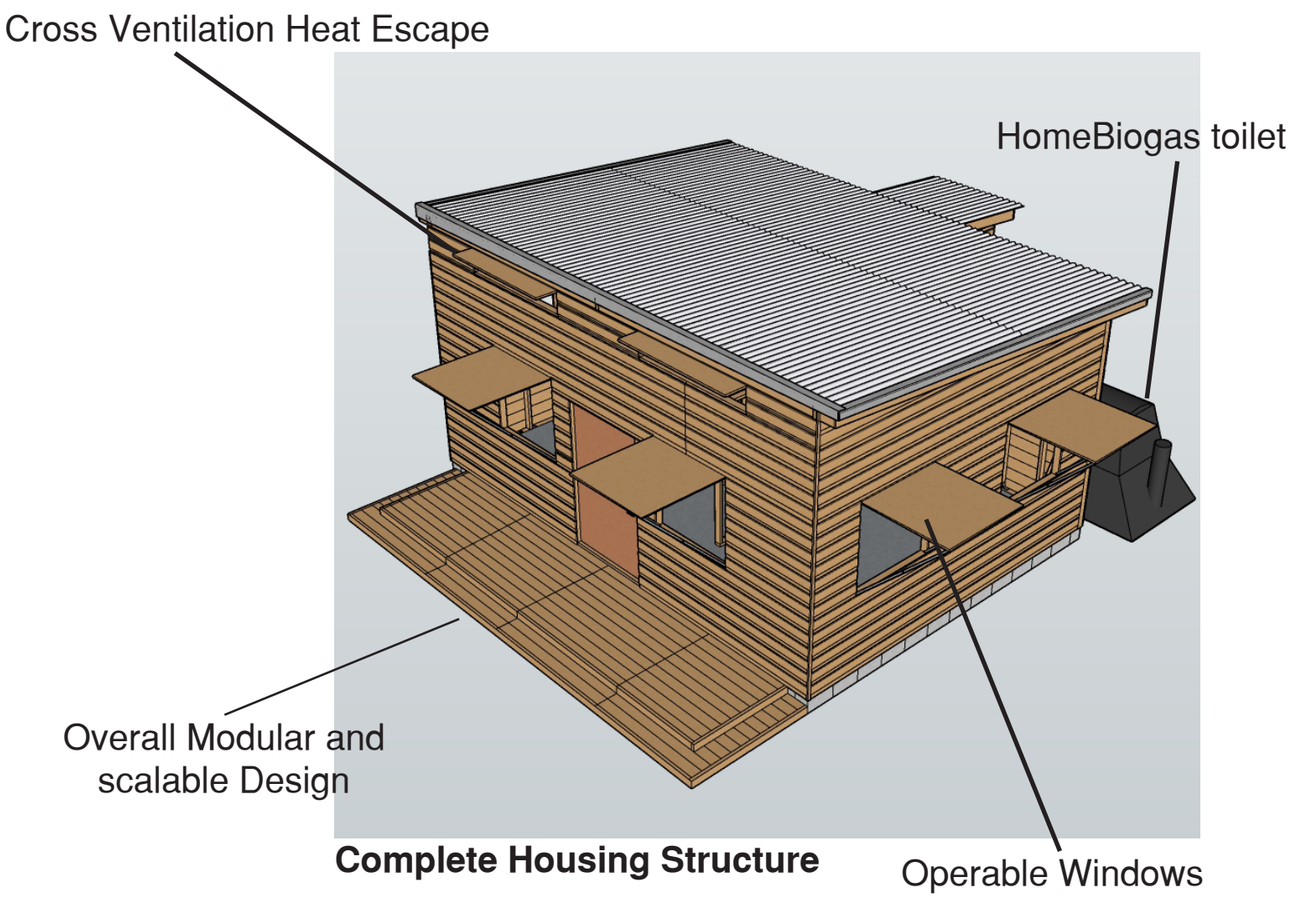
Wall framing system: The wall system in the structure uses a typical 2x4 wooden stud system. This wooden system has a decreased amount of carbon offput compared to other framing system and materials like Concrete walls or metal stud walls. This also allows flexibility in finding the exterior framing system since wood is a readily available material. This allows for low-income governments to afford the house because wood can be found cheap. This wooden framing structure with the combination of hurricane straps also allows for the structure to be kept hurricane resistant while adding only a small amount of embodied carbon energy to the whole structure. Another benefit of having this wall system is that it is very simple to construct because of the wide spread use of wood framing construction as well as making it easy for builders to follow the specifications in which the home is designed.



House with Wooden Framing

Affected SDG's:

Overall: Outside the structure itself the building is able to use innovative ideas and technologies to improve user comfort and make the building more sustainable. One idea throughout the design is natural ventilation of the building. This natural ventilation takes cross winds coming from windows and uses it to push hot air upward and out through the upper windows. This removes the need for energy intensive cooling while still providing a cool living space. In addition to this, windows have operable flaps that shade the inside of the building reducing heat and allowing for the windows to close. Another innovative technology present is the HomeBiogas 4+ toilet system. This system takes human waste and stores it in a biogas container converting it into usable gas for a communal stove. This creates 2 hours a day of usable cooking gas, save's up to 72,000 gallons of water a year, and reduces carbon by 6 tons. The final design factor is the modularity and scalability. The home can be built by itself or constructed to make a community of homes of the same design. It can be placed in Urban, Rural, or natural environments without effecting it's hurricane resistance or size. This allows it to be an all encompassing structure with the capability of providing all with a home.



Complete Housing Structure

Affected SDG's:

Overall, the building is able to create a safe and comfortable living environment for up to 8 users in two different rooms creating a multi-family living space. Another major improvement from other forms of housing is that this has long lasting durability meaning it can be used for multiple years. Once reaching its end life all the materials throughout the building are either completely recyclable or can be reused for other projects. After calculating all the used material for the project, in it's current configuration, the structure costs approximately $10,000. This is almost 3 times less than some of the typical disaster relief housing. To refrence a real life situation, in 2017 after Hurricane Maria over 50,000 people were displaced in Puerto Rico. Currently FEMA has multiple options for short term housing, costing from $17,000 to above $100,000. At the lowest cost, this is almost 40 percent cost increase to house 50,000 people than what this project is proposing. While my project directly combats the need for sustainable disaster housing, it would also have the added effect of implementing new and innovative sustainable strategies into the design allowing for builders and architects to become more knowledgeable with them, more specifically in developing nations.

Interior Perspective of Home

Table of Prospective Prices for Materials

Item	Quantity	Unit Cost*	Total Cost
Wood Studs 2”x 4”x12’	150	$7.56	$1,134.0
Watershed CMU Block	164	$4.39	$720
Rafters 2”x4”x16’	24	$10.98	$263.52
Siding 8”x 1/4”x16’	166	$12.45	$2,066.70
Green Concrete	240.14 cuft	$5.95 cuft	$1,428.83
Plywood 6’x2’x1/4”	13	$25.00	$325.00
Metal Sheet 16’x12’	5	$30.00	$150.00
Hurricane Straps	75	$8.00	$600.00
Cabinets	8	$150.00	$1,200.00
BioGas Toilet 4+	1	$1,335.00	$1,335.00
Battery Shower Kit	1	$269.99	$269.99
Bunk Beds	4	$200.00	$800.00
Doors	8	$50.00	$400.00
Total Costs*			$10,693.04

*All Prices were found using basic industrial prices through industrial suppliers websites or google and therefore are subject to market fluctuation.
*Total Costs do not include hired labor.

Refrences:
"Biodigester Toilet." HomeBiogas, 18 Nov. 2021, www.homebiogas.com/product/bio-toilet-kit/#tab-hbg4-biotoilet.
"2020 Global Report on Internal Displacement." IDMC | GRID 2020, www.internal-displacement.org/global-report/grid2020/.
Hurricanes: How to Build a Safer Wooden House - Youtube. www.youtube.com/watch?v=vp7FxW0Ze6Y.
Michael Windle. Disaster Housing Construction Challenges in America. humanitarian.mit.edu/wp-content/uploads/2019/12/MIT_HSCL_Housing_Report_final_102819_HigherRes.pdf.
"Hurricane Maria." Wikipedia, Wikimedia Foundation, 3 Nov. 2021, en.wikipedia.org/wiki/Hurricane_Maria.
"Eco-Friendly Alternatives to Traditional Concrete." Specify Concrete, www.specifyconcrete.org/blog/eco-friendly-alternatives-to-traditional-concrete.
"Watershed Block - Product Overview - Watershed Materials." Watershed Materials - Technology for New Concrete Blocks, watershedmaterials.com/watershed-block.
Dr. Rick Strand UIUC School of Architecture rkstrand@illinois.edu
Professor Grant Mosey UIUC School of Architecture gmosey2@illinois.edu
Instructor Eric Green UIUC Institute for Sustainability, Energy, and Environment ewgreen@illinois.edu

ILLINOIS