Resilient Housing and Communities

Recovery & Resilience in Puerto Rico and the U.S. Virgin Islands

June 3, 2020

Materials will be available at: **www.eesi.org/060320prusvi**

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EESI

Environmental and Energy Study Institute

- Founded in **1984** by a **bipartisan** Congressional caucus.
- Now an **independent**, bipartisan **nonprofit** with no Congressional funding.
- We provide **fact-based information** on **energy** and **environmental** policy for Congress and other policymakers.
- We focus on **win-win solutions** to make our energy, buildings, and transportation sectors **sustainable** and **resilient**.

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Hurricane Season EERI Briefing 2020 Keep Safe

Enterprise®

Enterprise: Who We Are

Create opportunity for low- and moderate-income people through fit, affordable housing in diverse, thriving communities.

15 Years of Work in Housing Resilience, Recovery, Rebuilding
Disasters Impact Housing Security

Hurricane Katrina	Super Storm Sandy	Hurricane Harvey-Houston	Hurricane Maria-Puerto Rico/USVI	Fires, California
August 23, 2005 800K Homes	October 22, 2012 650K Homes	August 17, 2017 135K Homes	September 20, 2017 370K Homes	October 2017, 2018, 2019 60K Plus

We have an Affordable Housing Crisis in the United States

- For the majority of **states**, between 10% and 15% of households are **housing insecure**. California and New York have the most **housing insecurity**; 20% of households face **housing insecurity**. Island communities

COVID-19 SHELTERING IN PLACE

“The house is the place where both planning and community development impact upon the family and individual. Planning for housing must therefore take into account more than the physical structure and spatial requirements; it should consider the social, economic and psychological needs of the individuals and families who will occupy the housing. And housing must be considered within the community context.”

Lucilla Fuller Marvel

ATLANTIC HURRICANE FORECAST

2020

	AVERAGE	CSU FORECAST	2019
TOTAL NAME STORMS	12	16	18
HURRICANES	6	8	6
MAJOR HURRICANES	3	4	3

MAJOR HURRICANE IS CATEGORY 3 OR HIGHER

NATIONAL TROPICAL WEATHER CONFERENCE

THE SPREAD OF ILLNESS AND DISEASE IN THE WAKE OF NATURAL DISASTERS

Building Resilient Homes helps mitigate impacts to the health and well being of residents and communities facing extreme weather and natural hazard Risks. See Keep Safe for guidance.

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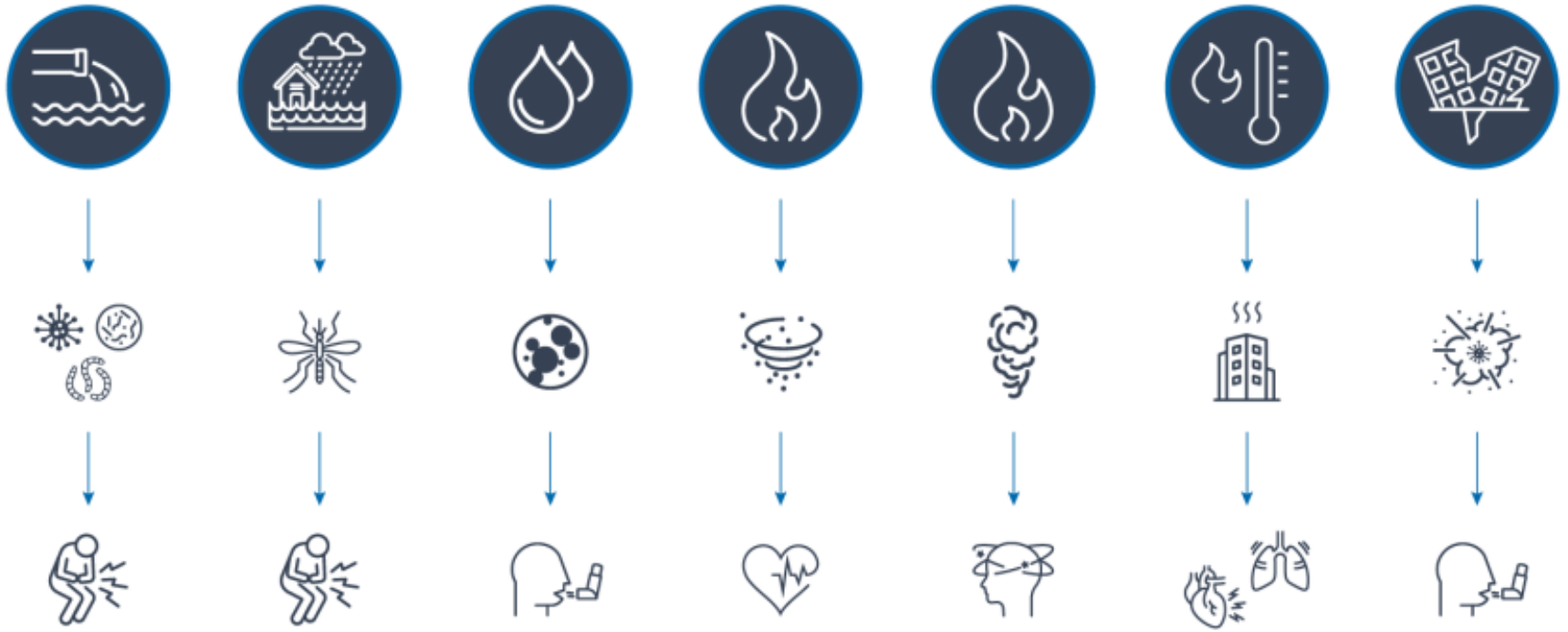

Untreated sewage after a flood can introduce bacteria, viruses and parasites

Heavy rain and flooding can create conditions for mosquitos and other vectors that cause malaria and dengue fever

Moisture after flooding leads to mold, which can cause asthma and other respiratory problems

Particle pollution from fires can trigger asthma attacks, heart attacks and strokes

Carbon monoxide from fires can lead to headaches, nausea, dizziness and, in high concentrations, premature death

Extreme heat can lead to cardiovascular and respiratory disorders

Earthquakes can create dust clouds that carry fungus spores, which can cause asthma


FEMA

Call upon Diversity of Community Members to inform and define what resilience and mitigation planning is. Build Prototypes for peer to peer learning and sharing.

Jurisdictions identify how to leverage the Weatherization model to ensure homes are fortified in advance of storms with focus on Structural Risk (Roofs, Anchorage), Energy and Health Related Conditions.

Consider regional planning not just locality-especially in consideration of flood plain management and resource management.

Consider importance of non-profit sector in implementation of work.

Call to Action-Promoting Climate Resilient Islands

Models: Rapido Temp to Perm Housing Houston, Texas

OPPORTUNITY

- FEMA-BRIC
- HUD- CDBG, CDBG-DR, CDBG-MIT
- DOT
- USDOE
- Community Reinvestment Act
- ESG

Mitigation-Investment in Community Development

Advance other community objectives

Capital improvements, infrastructure protection, open space preservation, and economic resiliency

A one-time cost for implementing a mitigation action often results in long-term savings to the community.

Faces of Resilience

People	The extent of personal discomfort, harm, injury, or loss of life.
Physical Assets	Loss or damage to structural and architectural building components, MEP and IT equipment, utilities, landscaping, contents.
Operations	Disruption to building operations and functionality, occupancy, egress/ingress, critical systems, or lab activities.
Revenue	Loss of revenue due to business interruption, specifically in relation to tenants.
Reputation	Negative media attention or impact on industry reputation in the aftermath of an impactful shock or stress.

MANTÉNGASE SEGURO

UNA GUÍA PARA EL DISEÑO DE VIVIENDAS RESILIENTES EN COMUNIDADES ISLEÑAS

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KEEP SAFE

A GUIDE FOR RESILIENT HOUSING DESIGN IN ISLAND COMMUNITIES

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UNIVERSIDAD DE PUERTO RICO 1903

DEPARTAMENTO DE LA VIVIENDA Gobierno de Puerto Rico

AD&V ALVAREZ-DIAZ & VILLALÓN ARCHITECTURE | INTERIOR DESIGN

Contributing Partners

MIT Urban RISK Lab

PERKINS + WILL

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

Thornton Tomasetti

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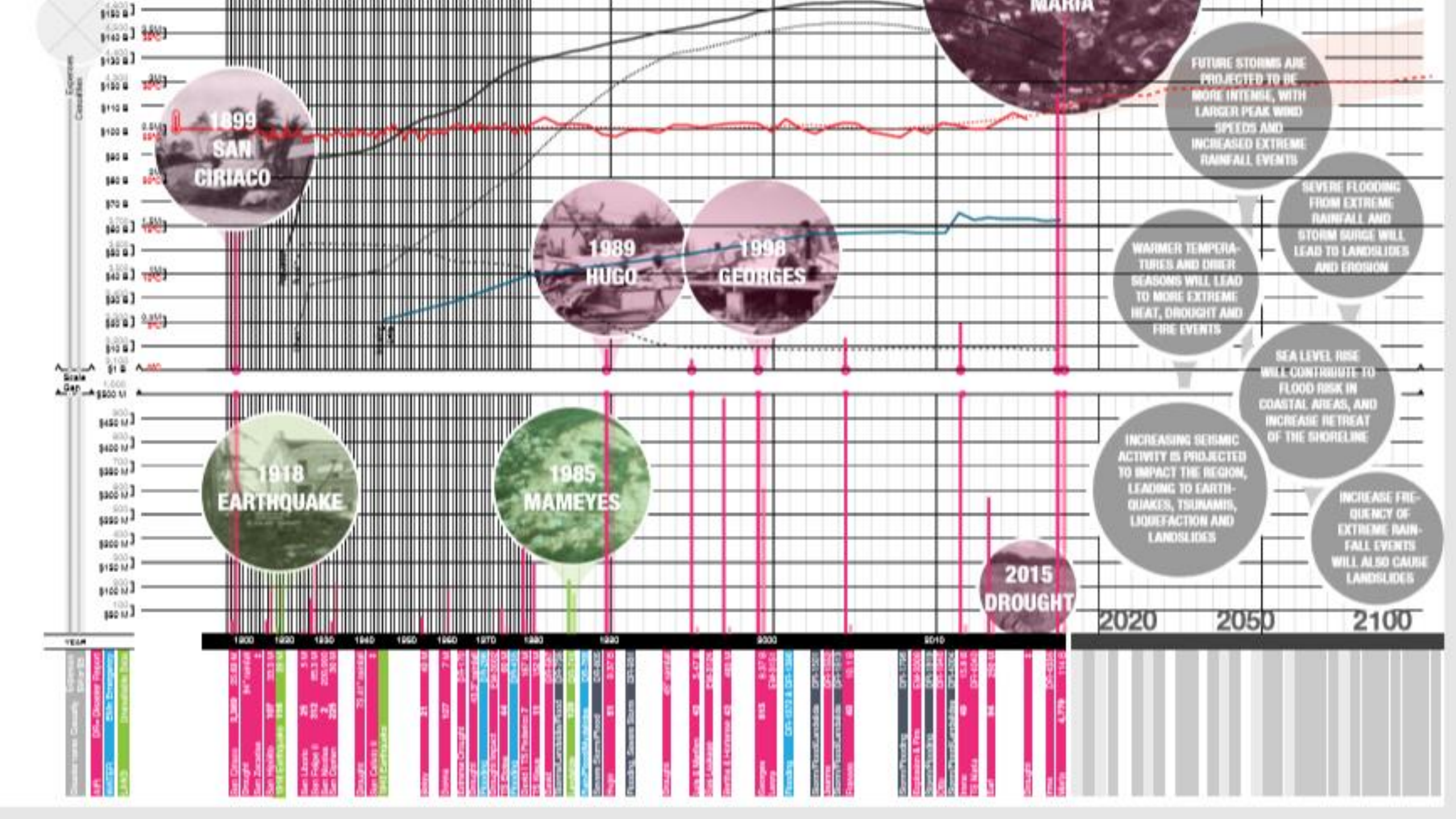
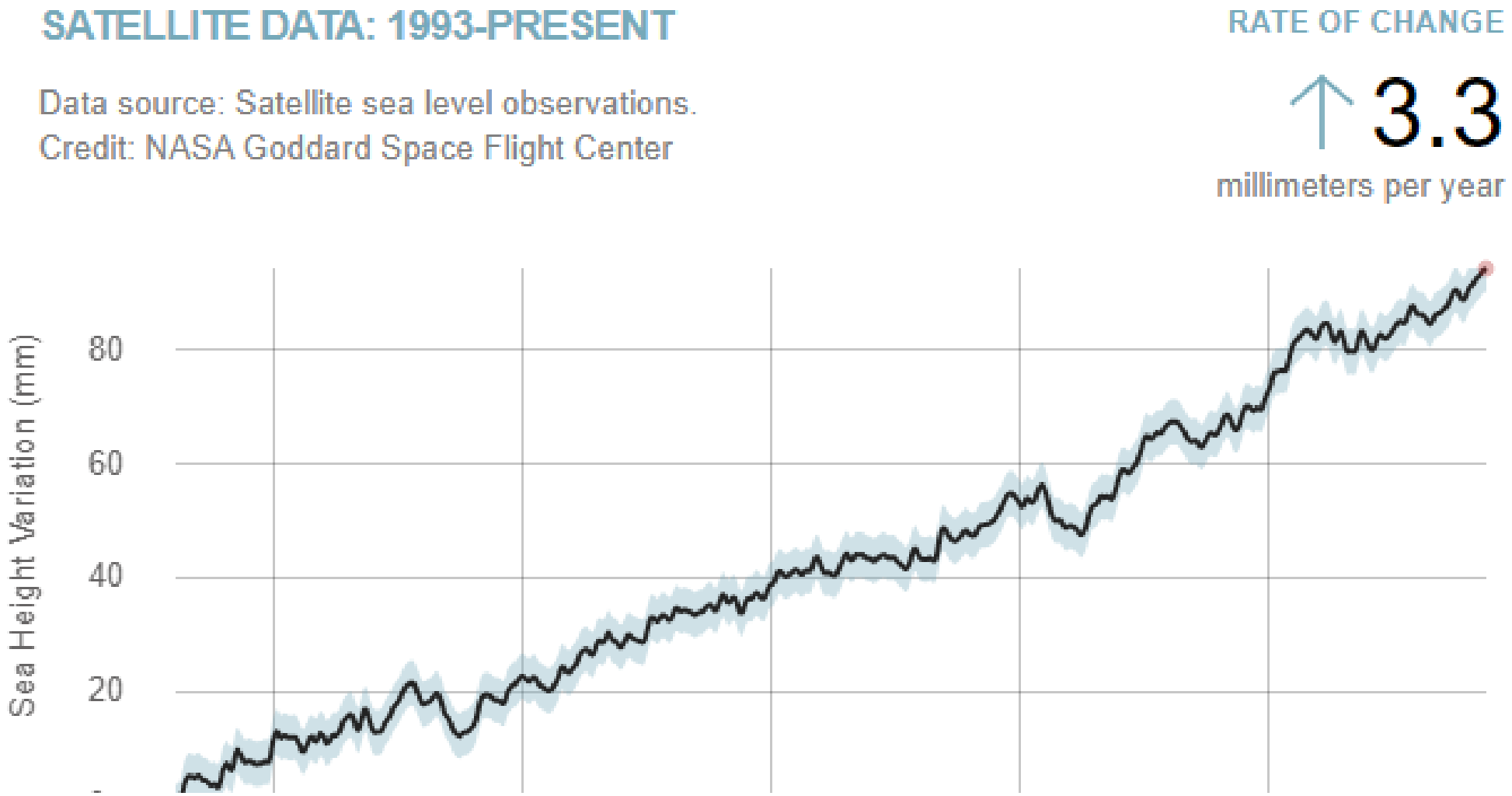
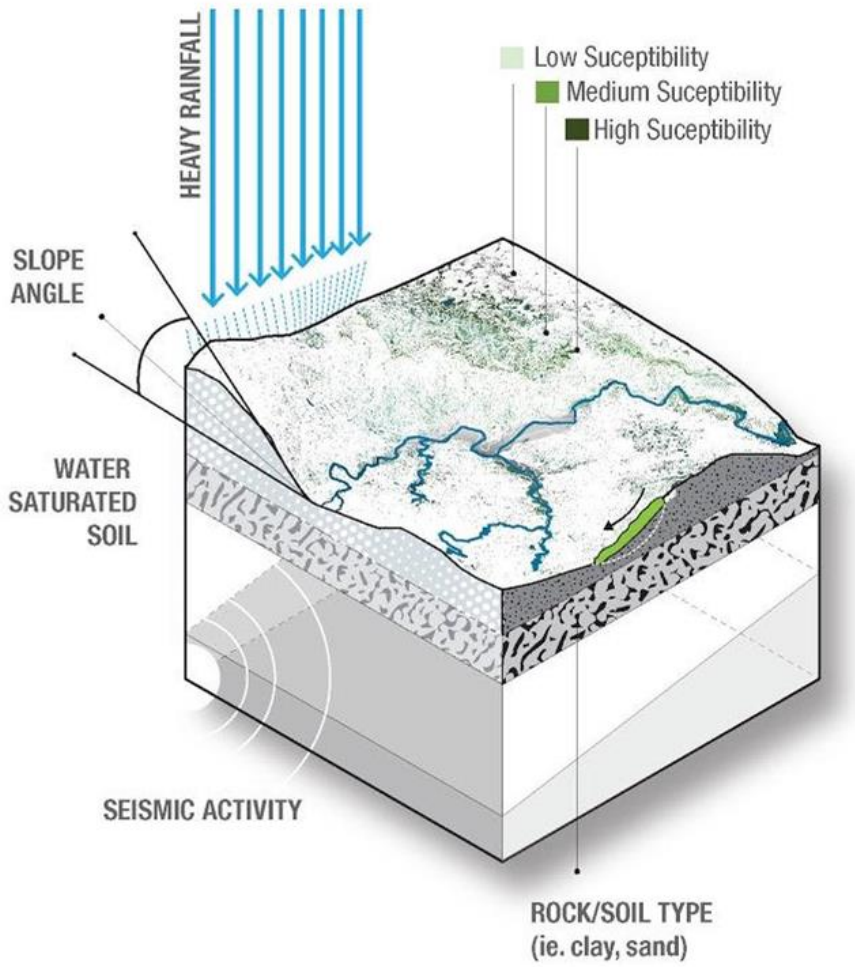

1899 SAN CIRIACO
1989 HUGO
1998 GEORGES
2017 MARIA
1918 EARTHQUAKE
1985 MAMEYES
2015 DROUGHT
FUTURE STORMS ARE PROJECTED TO BE MORE INTENSE, WITH LARGER PEAK WIND SPEEDS AND INCREASED EXTREME RAINFALL EVENTS
SEVERE FLOODING FROM EXTREME RAINFALL AND STORM SURGE WILL LEAD TO LANDSLIDES AND EROSION
WARMER TEMPERATURES AND DRIER SEASONS WILL LEAD TO MORE EXTREME HEAT, DROUGHT AND FIRE EVENTS
SEA LEVEL RISE WILL CONTRIBUTE TO FLOOD RISK IN COASTAL AREAS, AND INCREASE RETREAT OF THE SHORELINE
INCREASING SEISMIC ACTIVITY IS PROJECTED TO IMPACT THE REGION, LEADING TO EARTHQUAKES, TSUNAMIS, LIQUEFACTION AND LANDSLIDES
INCREASE FREQUENCY OF EXTREME RAINFALL EVENTS WILL ALSO CAUSE LANDSLIDES
2020
2050
2100
Expenses
Casualties
State GDP
YEAR

Designing for the Future





ATMOSPHERIC
AIR

- HIGH WINDS
- DROUGHT
- FIRE
- EXTREME TEMPERATURE

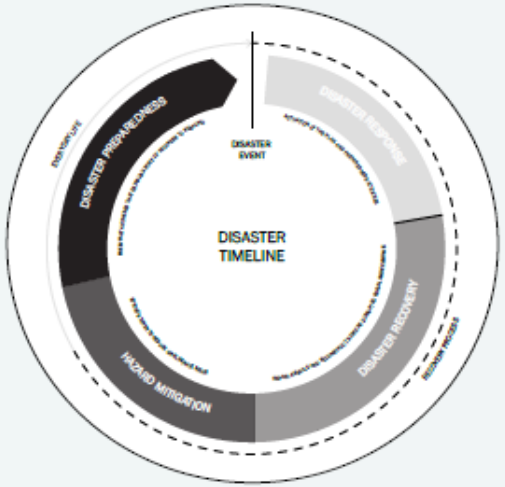
GEOLOGIC
LAND

- COASTAL EROSION
- LANDSLIDE
- EARTHQUAKE
- SUBSIDENCE
- LIQUEFACTION

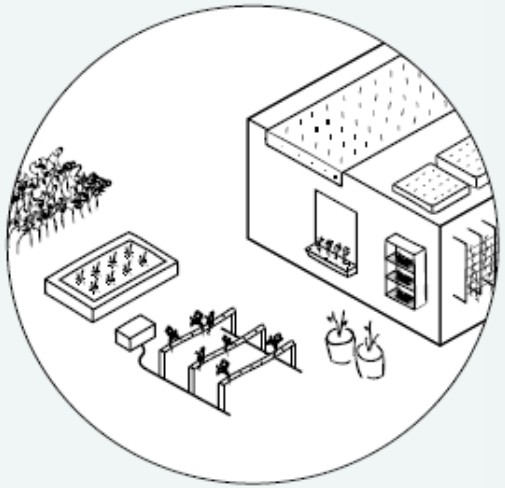
HYDROLOGIC
WATER

- HEAVY RAINFALL
- STORM SURGE
- TSUNAMI

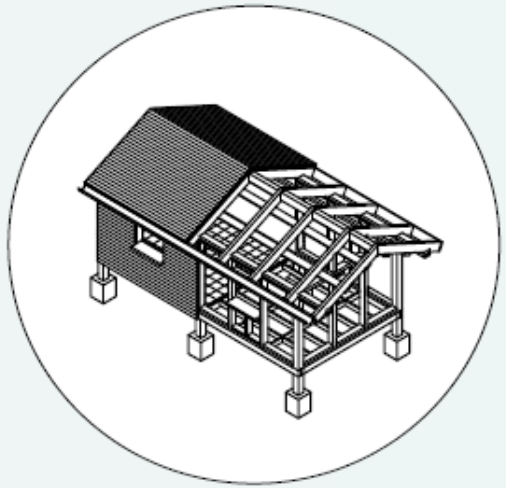
THE GUIDE IS COMPRISED OF THE FOLLOWING CHAPTERS:



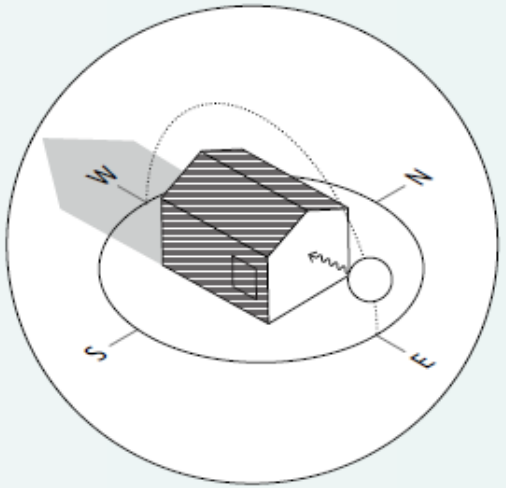
Introduction



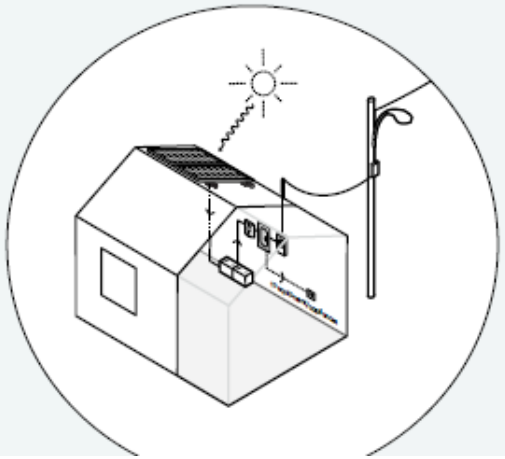
Chapter 1: A Safer Site

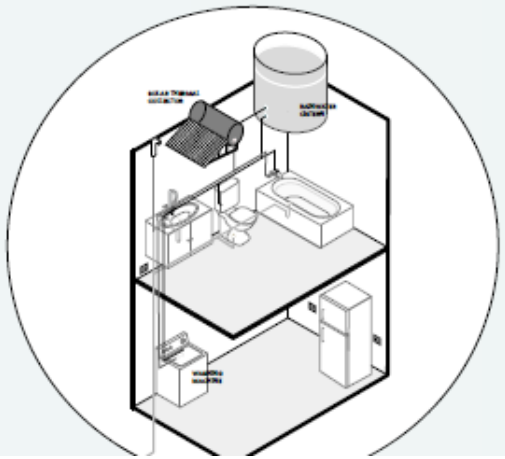


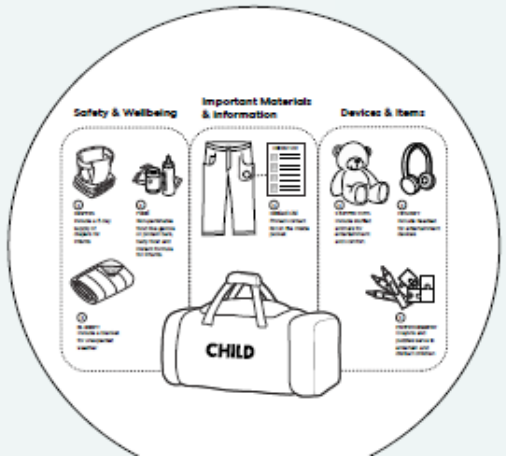
Chapter 2: Building Protection

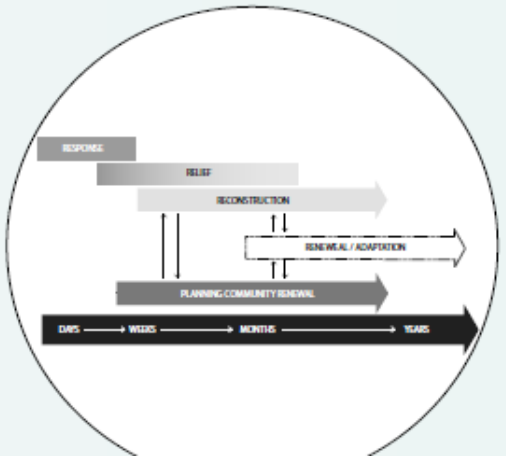


Chapter 3: Passive Habitability









PUTTING IT ALL TOGETHER

- Funding
- Contracting
- Building to Code
- Pulling Permits
- Insurance
- Design

Who is it for?

IS THIS GUIDE FOR ME?

Homeowner or Building Owner

As the owner of your home, be it a townhouse or a detached building, you wield the power to make decisions regarding your structure's resiliency. You can choose to make major, permanent changes to your site and home to ensure safety before, during, and after a natural disaster.

Community leader

The community regards you as their representative. Your communication and organizational skills enable you to serve as a liaison between governmental/external efforts during times of distress. By taking on a leadership role to bring your community together in the face of an emergency, you are catalyzing a collaborative effort towards resiliency that can persist long after the disaster hits.

Tenant

Renting at a multifamily building may limit the actions you can take in terms of fortifying your home against natural disasters because you have limited ability to determine how the building is prepared but you can still provide the authority with suggestions and key information found in this guide to improve your home.

Administrator

You may be an administrator of a housing program or are able to determine how to regulate a housing facility or home. This guide can help you determine ways to safeguard the building from hazards or set up a program to fund or support housing resilience.

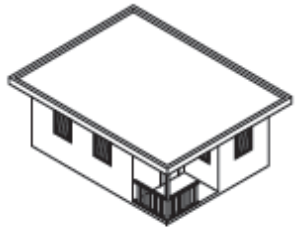
Property Operator

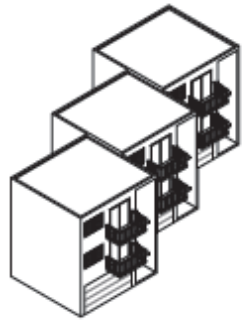
You are the legal owner of a property which you rent out and you are responsible for ensuring it is safe and has emergency plans in place. Your tenants can certainly engage in some of the preventive and prescriptive measures included in this guide.

Construction Professional

As an architect, engineer, contractor, master builder, inspector, or other professional in the construction industry, the information included in the main corpus of this guide may seem basic to you. However, it is becoming increasingly important to bear these principles in mind.

TYPE OF HOME





NAME

DESCRIPTION

WOODEN DETACHED

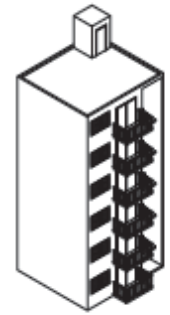
- Wooden Structure
- Can have Zinc roof

CONCRETE DETACHED

- Concrete/Block and rebar structure
- 1-2 stories

TOWN HOUSES

- "Medianera" or shared wall
- One owner per vertical unit



NAME

DESCRIPTION

WALK-UP

- Multiple owner
- Up to 3 floors from ground

HIGH RISE CONDOMINIUM

- Multiple Owner
- 3 floors and up
- Administrator oversees big decisions
- Requires elevators

TYPE OF COMMUNITY

NAME

DESCRIPTION

INFORMAL COMMUNITY

- Area of mixed use
- Uncertain property limits
- Organic growth
- Some units are only accessible via alleyways
- Limited outdoor space (private)

URBAN LOTIFICATION

- Defined lots
- Planned growth
- Formal roads
- Many units share walls
- Area of mixed use

URBANIZATION

- Defined lots with dedicated outdoor space
- Homogeneous building typologies
- Can be gated

NAME

DESCRIPTION

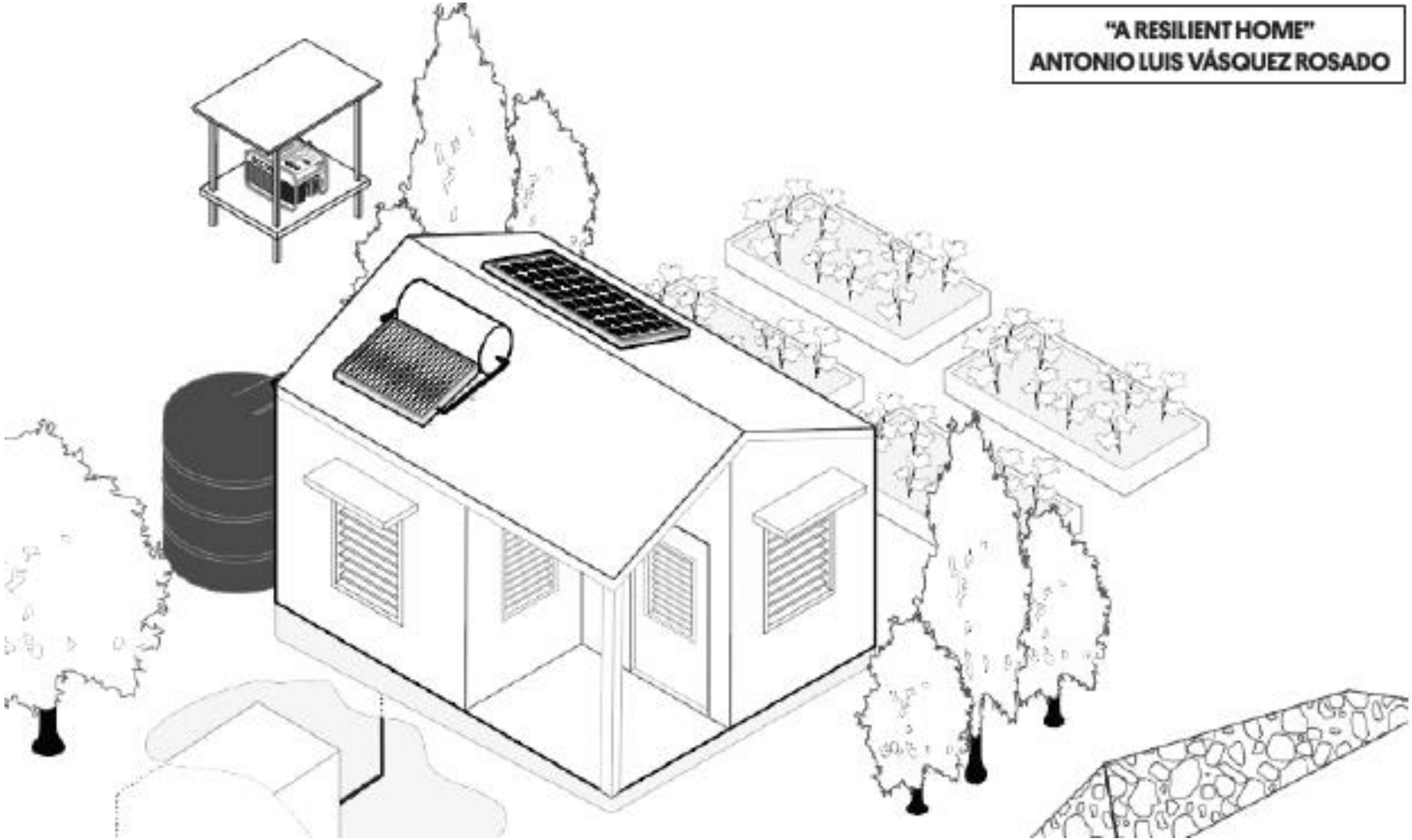
FINCA

- Irregular topography
- Lotification size and form varies
- Dispersed lotification

INDEPENDENT MEGA-LOT

- Strictly defined lot
- Defined areas for parking or outdoor spaces

"A RESILIENT HOME"
ANTONIO LUIS VÁSQUEZ ROSADO



8

- Continue to add nutrients to soil as needed.
- You can add a natural fertilizer, like homemade compost, up to once a month.
- Keep track of the rain so you do not saturate the plants with water.

9

- Till between crop cycles to oxygenate soil
- Keep track of the rain so you do not saturate the plants with water.

C. BEGIN THE PLANTING PROCESS

Hydroponic Gardening

- a. Hydroponics is a method of growing plants without soil by using mineral nutrient solutions in a water solvent.
- b. The nutrients used in hydroponic systems can come from an array of different sources; these can include, but are not limited to, byproduct from fish waste, duck manure, or purchased chemical fertilizers.
- d. For all techniques, hydroponic reservoirs are built of plastic, but other materials have been used, including concrete, glass, metal, vegetab solids, and wood. Containers should exclude li to prevent algae and fungal growth in the nutri solution.
- e. With hydroponic farming, there are two types of watering systems: continuous flow or static. continuous flow systems, water needs continuo

STATEGY
06

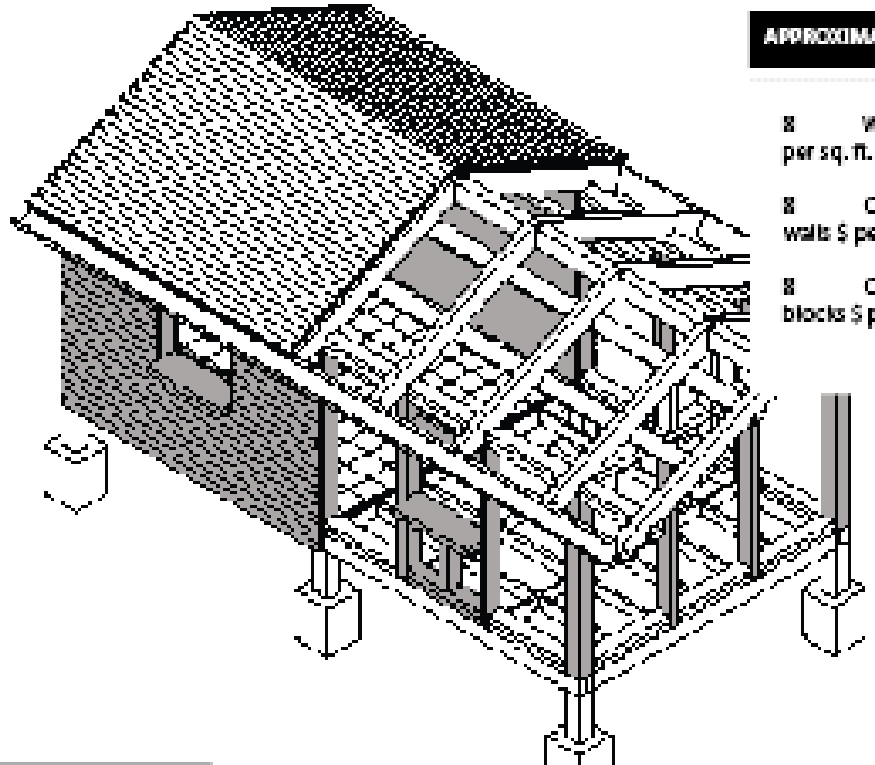
BUILD A STRONG FOUNDATION

STRATEGY IN ACTION

STEP 1 - WALL DESIGN PRINCIPLES

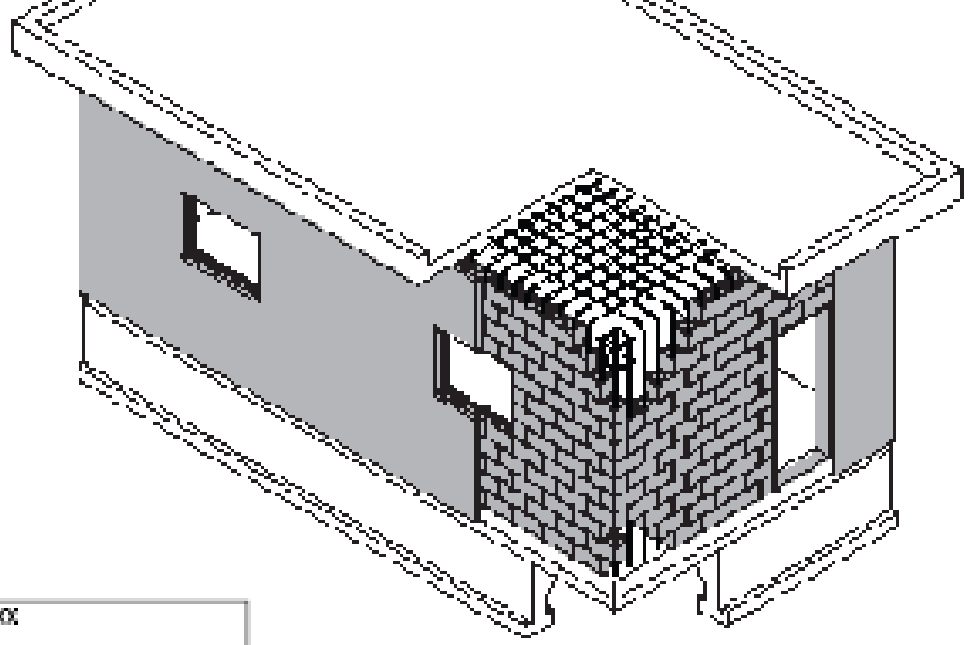
- Maintaining a continuous load path is like a chain that holds a home together from the roof to the foundation. A continuous load path is critical during an earthquake or hurricane because it holds a home together when ground forces or high winds try to pull it apart. Maintain a continuous load path by using vertical reinforcement, from the foundation to the roof, through the structural walls.

- Anchor interior partition walls into the structural frame for stability.



APPROXIMATE COST

- Wood frame with panels $ per sq. ft.
- Concrete columns with fill-in walls $ per sq. ft.
- Cast-in-place concrete with blocks $ per sq. ft.



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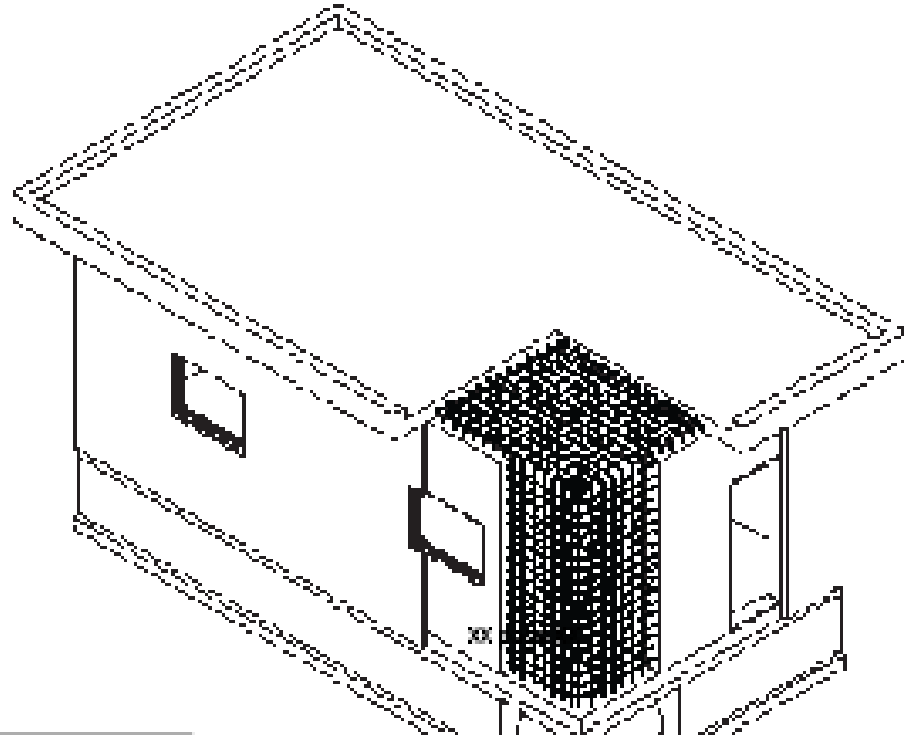
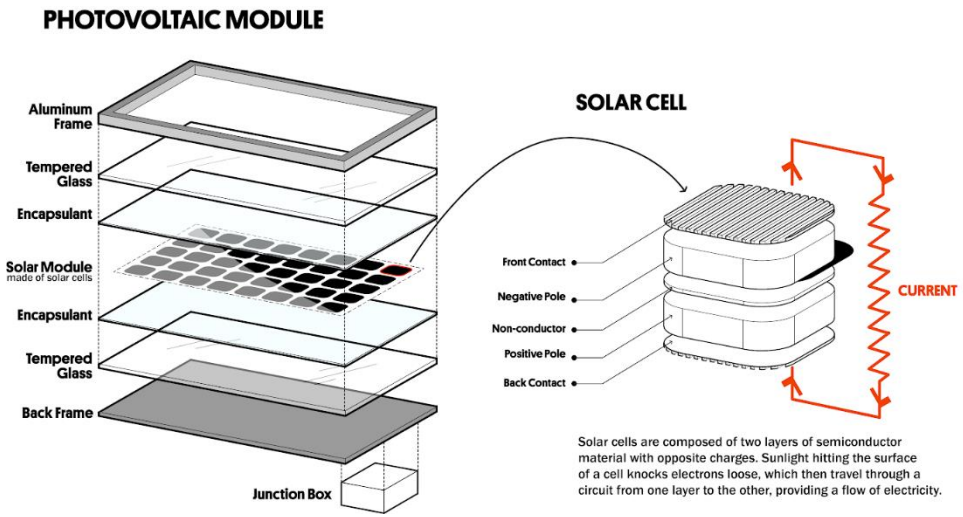


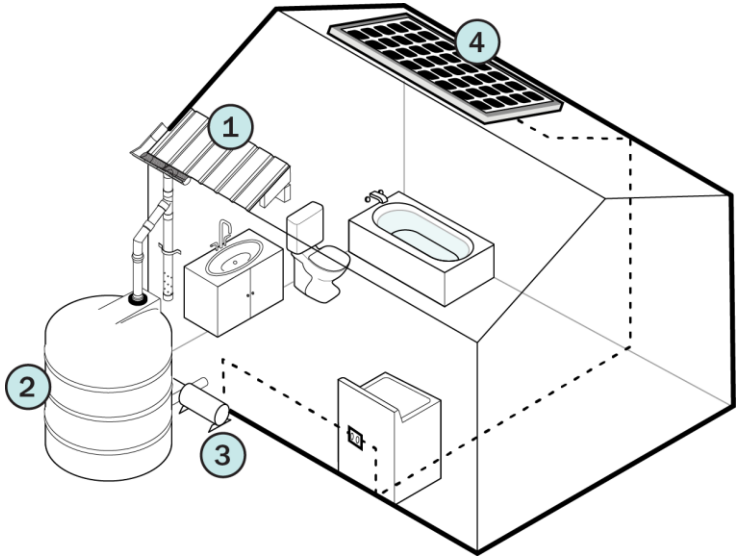
ENERGY GENERATION + BACKUP

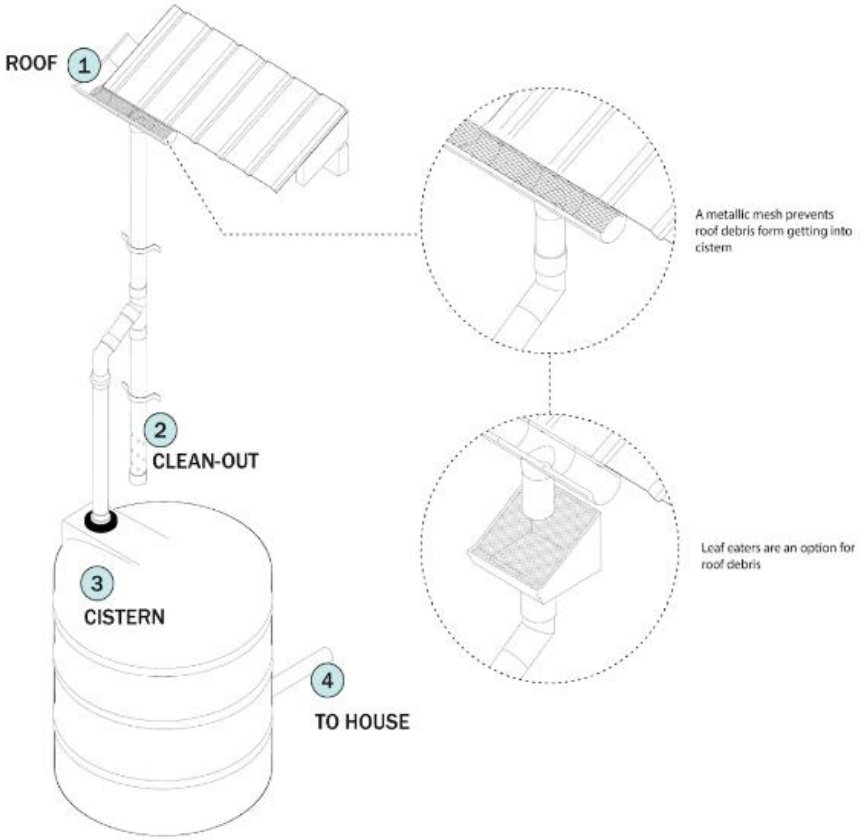
Strategies that provide critical needs for power when a facility loses power or other services



WATER MANAGEMENT + STORAGE

Strategies that provide critical needs for water when a facility loses power or other services.





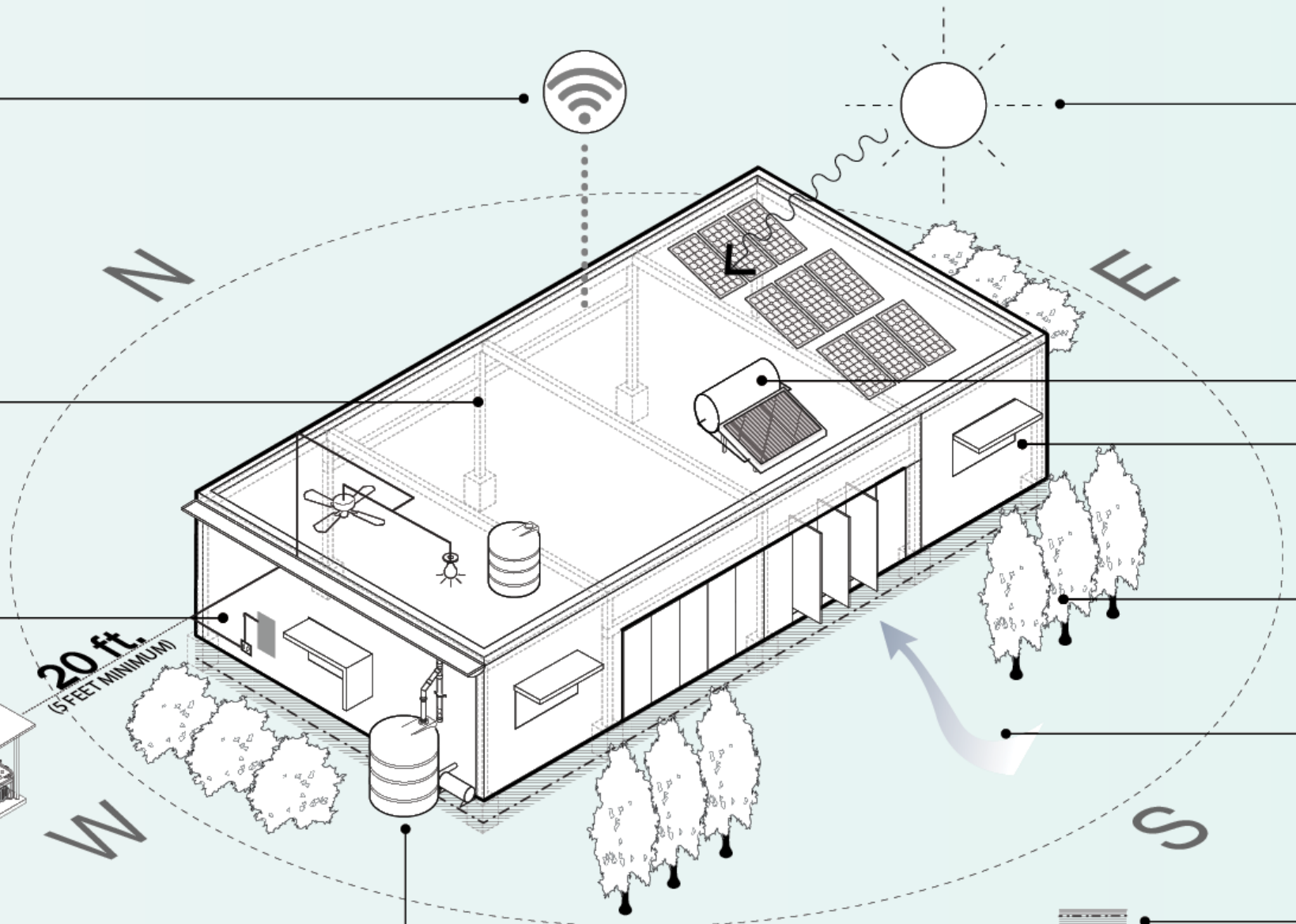
Keep Safe USVI

Creamos este recurso para ayudar a las comunidades a diseñar centros comunitarios resilientes para fortalecer la capacidad organizativa, promover la educación durante todo el año y poder enfrentar cambios climáticos, sociales y económicos. Ofrece sugerencias prácticas, incluido el desarrollo organización comunitaria, capacidad operativa y activos físicos relevantes para lograr resiliencia.

COMUNIDADES UNIDAS

GUÍA PARA EL DISEÑO DE CENTROS COMUNITARIOS RESILIENTES EN COMUNIDADES ISLEÑAS

Systems of a Community Resilience Center



COMMUNICATIONS

- KP4.
- Satellite phone.
- Loudspeaker.
- Wifi/Data access for social media/ community bandwidth access for communication.
- Community-based radio station.
- Analogue telephone life.
- GoTenna mesh system- allows texting and GPS without internet.

STRUCTURAL

A professional structural engineer should be consulted to verify the building meets code requirements for seismic movement. Depending on location, ensure the structure can withstand forces caused by storm surge produced by hurricane or tsunami events.

ENERGY STORAGE

Design a holistic system that includes batteries for storing energy. Ensure that basic needs—like ventilation, emergency lighting, and electricity for essential equipment—is connected.

ENERGY GENERATOR

Have a backup energy generator for emergencies. Ensure that the generator is placed outdoors, at least 20ft from the structure, and is protected from debris.

RAINWATER COLLECTION

Install a rainwater collection system for non-potable water use, such as irrigation, flushing toilets and cleaning. If purified, water can be used for drinking.

Rainwater storage tank could be located on the roof or ground.

SOLAR POWER

Install solar panels with batteries (some centers might also have a connection to the grid for selling power during low use or consuming power during high use), and/ or other forms of renewable energy. Other recommendations for the community center or individual houses: portable solar charger for mobile phones, solar lamps, portable solar power generators, dedicated solar panels for critically ill patients (for example, requiring dialysis or respirators), solar refrigerators, or back-up diesel generator.

SOLAR THERMAL HEATER

Use solar energy to heat up water.

OPENINGS

Design using operable windows and doors, that allow cross breezes and ventilation. Maximize space by allowing the exterior areas to be used. Shade openings to reduce amount of sunlight and heat gain entering the building.

VEGETATION

Use native vegetation to increase shade, mitigate excessive sunlight, reduce heat gain, and generate breeze, thereby reducing energy costs.

VENTILATION

Design a ventilation system in which air is always circulating through the inhabited space. This ventilation system could be passive with natural breezes or mechanical with active systems, such as air conditioning.

DFE (Design Flood Elevation)

If new construction, place the building above the Design Flood Elevation (DFE). If it is already built, ensure equipment that might get damaged with water is stored above the DFE.

RESILIENT POWER PUERTO RICO

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PORTFOLIO PROTECT

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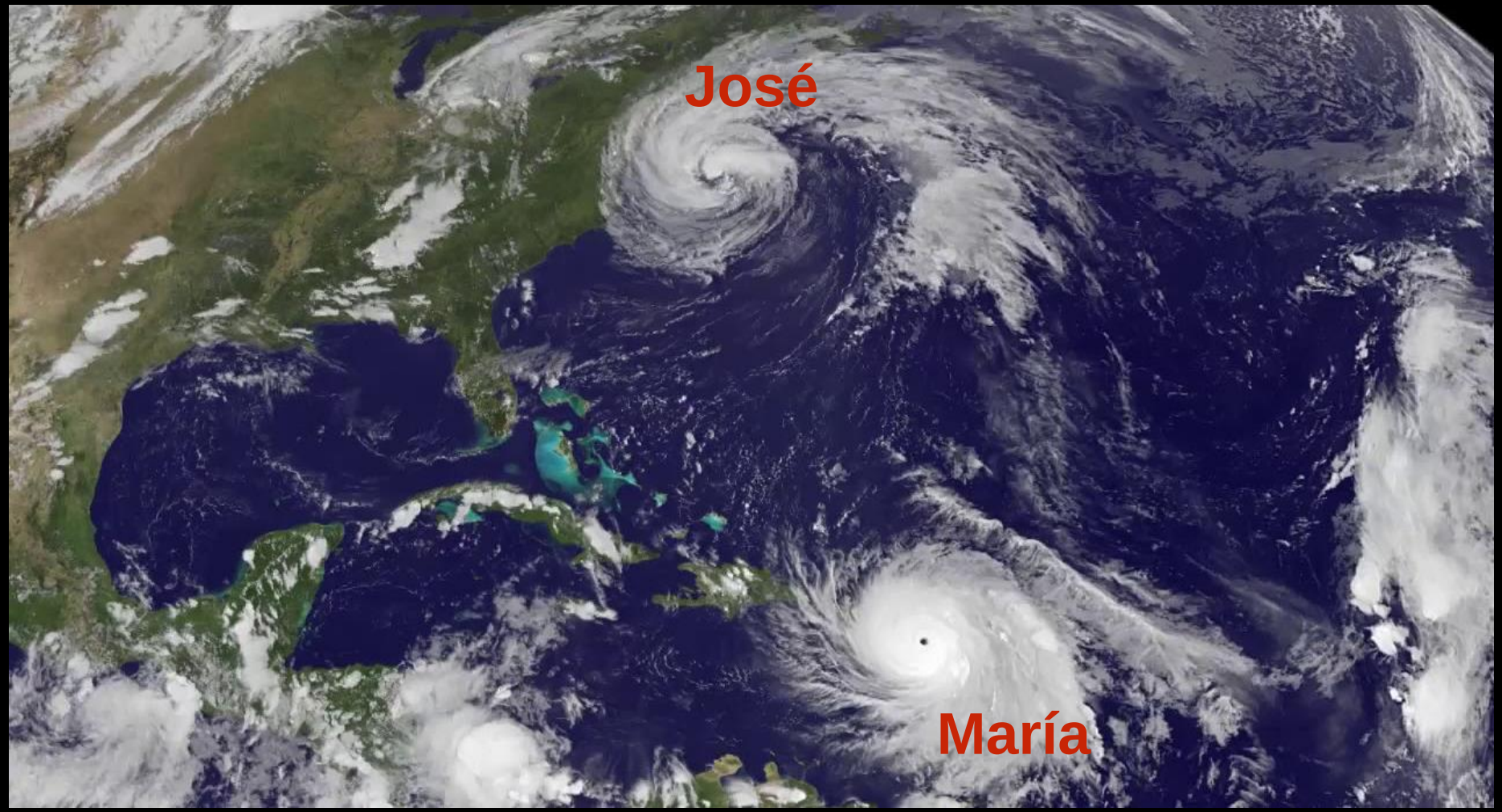
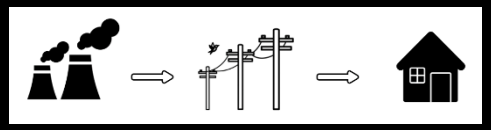
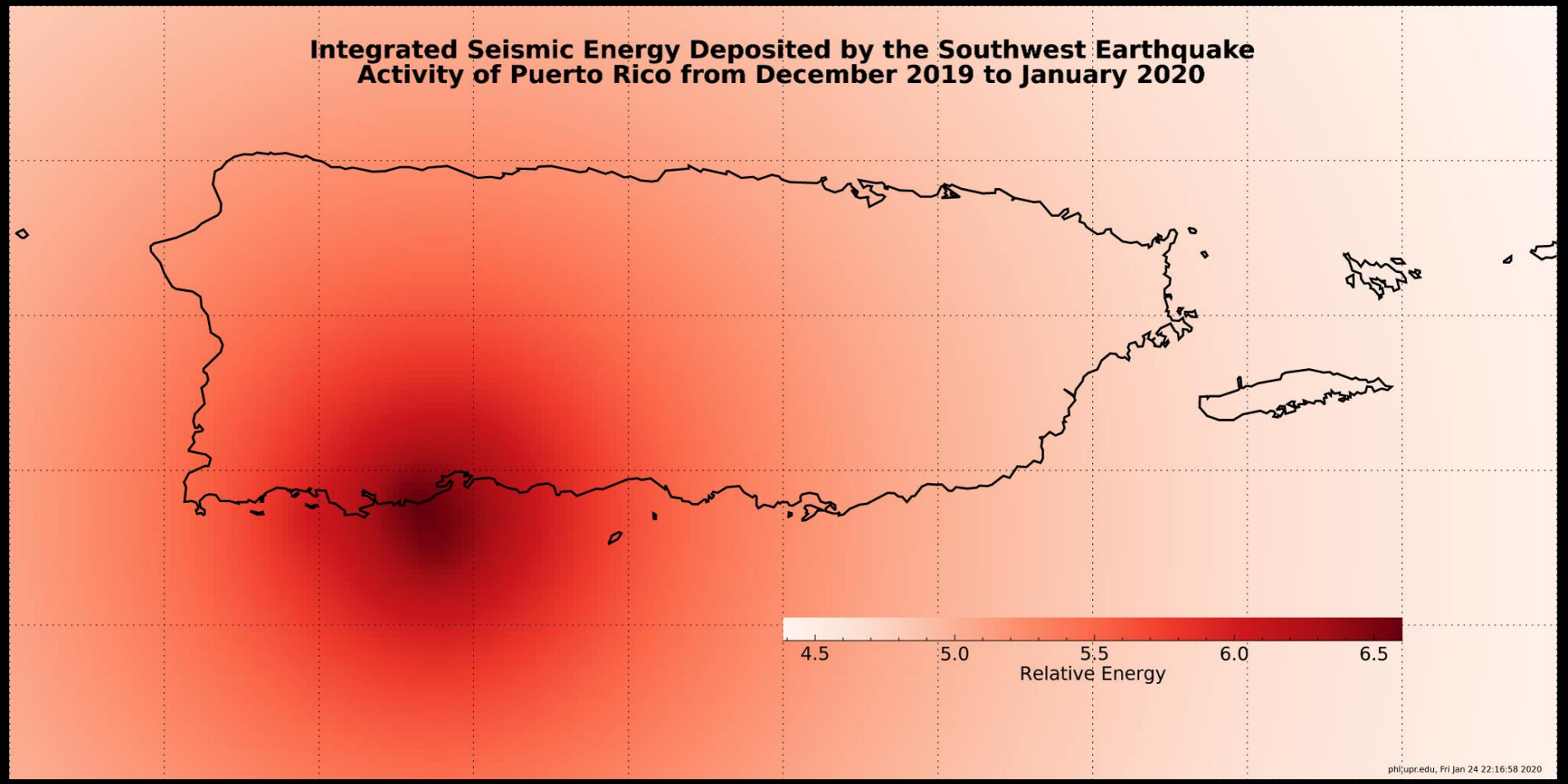
lschoeman@enterprisecommunity.org


José
María

PREPA

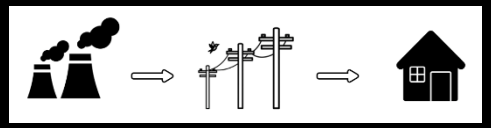
[Puerto Rico Electric Power Authority




Integrated Seismic Energy Deposited by the Southwest Earthquake Activity of Puerto Rico from December 2019 to January 2020
4.5
5.0
5.5
6.0
6.5
Relative Energy
phl.upr.edu, Fri Jan 24 22:16:58 2020

PREPA

[Puerto Rico Electric Power Authority



COVID-19

PANDEMIC


1999
Today


RESTAURANT AL RIO


HOGAR LA MISERICORDIA INC

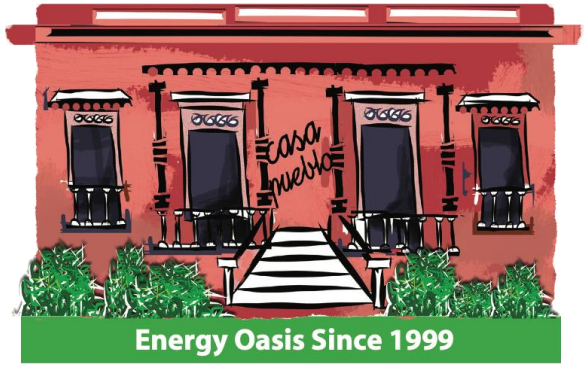

Don Pepe
HIELO
JUEGA AQUÍ

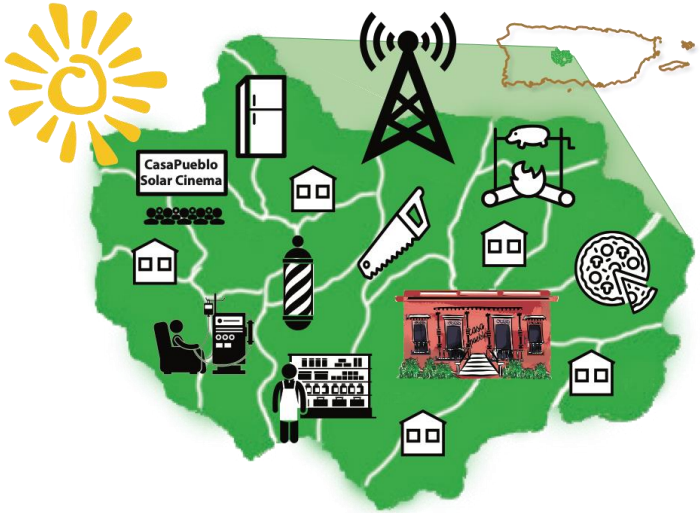
Changing the Energy Landscape in Adjuntas and Puerto Rico

#Autosuficiencia #InsurrecciónEnergética #50conSol

- Casa Pueblo Radio's Solar Transmitter
- Solar Minimarkets: Strategically Located in 6 of Adjuntas' Barrios
- Solar Barber Shop
- Solar Classroom in our Forest School
- 100% Solar Homes: 25 Fireflies
- Solar Cinema
- Casa Pueblo Radio: 100% Solar Powered
- Solar Refrigerators: 54 Units Throughout all of Adjuntas' Barrios
- Restaurants: Vista del Río and El Campo es Leña
- Two Solar Hardware Stores and Other Small Businesses
- Comunidad El Hoyo: 10 Homes with Solar Energy Backup Systems
- 14,000 Solar Lamps: IluminandoPRconSOL
- Workshops and Lectures on Renewable Energy
- Hybrid Biomass Energy Generation Systems
- 5 Permanent Systems for Dialysis Machines
- Cerro Mágico Ecoturism Project

Icons / The Noun Project

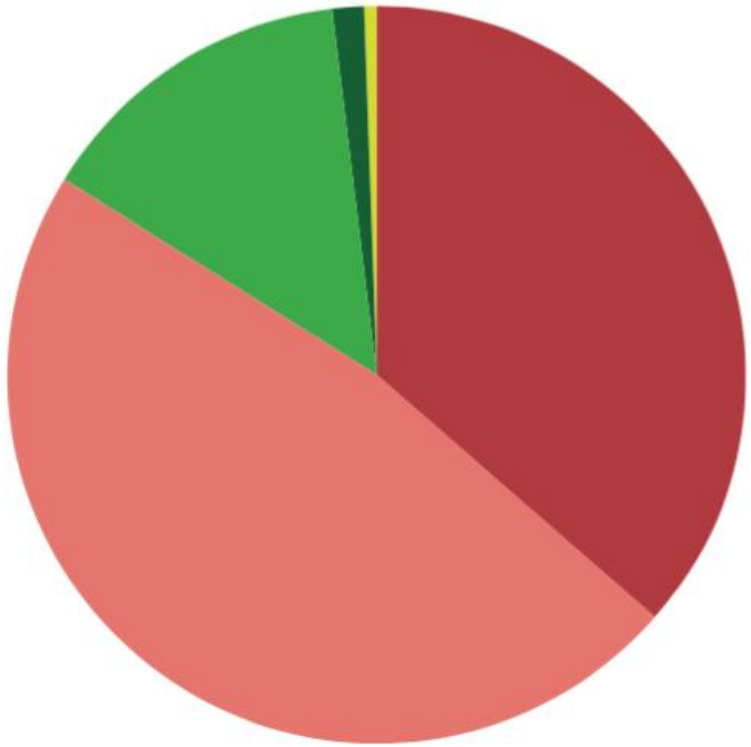




Communications
Innovation
Economic Activation
Food Security & Nutrition
Education
Right to Power
Health
Entertainment

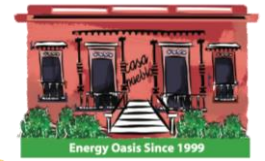
PUERTO RICO 2018

Residential Consumption	36.50%
Commercial Consumption	47.40%
Industrial Consumption	14.10%
Public Lighting	1.47%
Agriculture	0.15%
Others	0.31%



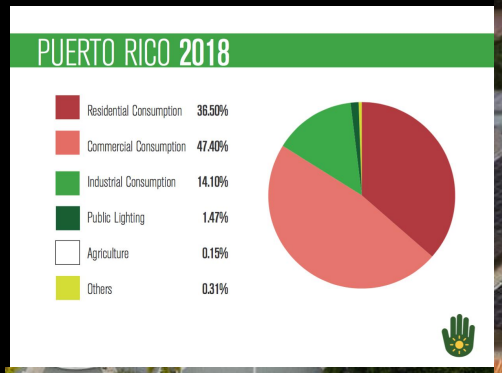
Los Cucubanos - Fireflies

50% con SOL IN THE RESIDENTIAL SECTOR **EQUALS**:



- Average energy **consumption per home is 1.68 kWh**.
- **Six 330 Wp solar panels per home** can meet this consumption level.
- This system, including batteries and installation, costs **$8,000 per home**.
- Wherever electrical service is "stable", the system can be installed without energy storage, thereby reducing the cost to **$5,000 or less**.
- 50%conSOL Residential equals **$481 million in fossil fuel costs saved annually**.
- 50%conSOL Residential equals **NOT needing the Costa Sur power plant's output, or one and a half times that of the San Juan power plant**.
- The use of **solar water heaters** should be maximized in order to minimize electrical consumption for this need.
- It's necessary to invest in **energy efficiency** in order to reduce household consumption and waste. This includes replacing light bulbs, air conditioning, and refrigeration systems with more efficient models, for example LED lights and "inverter" equipment/appliances.

Adjuntas Pueblo Solar



"Resilience is Community Strength”

Science AAAS

PHOTO: GENNIE M. IRIZARRY/CHARDON/ASSOCIATED PRESS

EDITORIAL

Renewable energy for Puerto Rico

Puerto Rico is not prepared for another hurricane. A year ago, Hurricane María obliterated the island's electric grid, leading to the longest power outage in U.S. history. This disrupted medical care for thousands and contributed to an estimated 2975 deaths. The hurricane caused over $90 billion in damage for an island already in economic crisis. Although authorities claim that power was restored completely, some residents still lack electricity. Despite recovery efforts, the continued vulnerability of the energy infrastructure threatens Puerto Rico's future. But disruptions create possibilities for change. Hurricane María brought an opportunity to move away from a fossil fuel–dominant system and establish instead a decentralized system that generates energy with clean and renewable sources. This is the path that will bring resilience to Puerto Rico.

Puerto Rico is representative of the Caribbean islands that rely heavily on fossil fuels for electric power; 98% of its electricity comes from imported fossil fuels (oil, natural gas, and coal), whereas only 2% comes from renewable sources (solar, wind, or hydroelectric). The distribution of 6023 MW is challenging, requiring thousands of miles of transmission and distribution lines over the island's steep topography. This makes the island's centralized electrical grid vulnerable to hurricanes that are predicted to increase in severity because of climate change.

In Puerto Rico and the rest of the Caribbean, where sun, wind, water, and biomass are abundant sources of renewable energy, there is no need to rely on fossil fuel technology. Unfortunately, the government of Puerto Rico and the U.S. Federal Emergency Management Agency have been making decisions about the local power authority that are restoring the energy system to what it was before Hurricane María hit, perpetuating fossil fuel reliance.

Despite these decisions, a transformation has begun in communities across Puerto Rico. For example, in the mountain municipality of Adjuntas, local initiatives headed by Casa Pueblo, a self-reliant nonprofit community organization, has increased the installation of solar energy systems. Fortunately, the solar power–based infrastructure of Casa Pueblo was not affected by the hurricane, allowing Adjuntas to serve as the organization's center of operations for immediate local and regional response after the hurricane. Adjuntas became an oasis of power, where people got immediate assistance. Analog solar-based energy systems were designed and installed by Casa Pueblo to supply the needs of numerous entities in the community: medical equipment, such as peritoneal dialysis for homes with patients; a radio transmitter for a community radio station; and equipment for hardware stores, minimarkets, restaurants, and other businesses. Around the island, other examples of off-the-grid local energy production reflect community resilience grounded in projects that foster renewable energy. They include a solar microgrid in Orocovis, multiple community aqueducts, and sustainable farms. These new energy systems are changing the energy landscape of the municipality. But the majority of rural communities is still in need of sustained help.

"...moving away from dependency on imported fossil fuels should be the guiding vision."

At this juncture, when the opportunity to build a sustainable and resilient electrical system presents itself, moving away from dependency on imported fossil fuels should be the guiding vision. Puerto Rico must embrace the renewable endogenous sources that abound on the island and build robust microgrids powered by solar and wind, install hybrid systems (such as biomass biodigesters), and create intelligent networks that can increase the resilience of the island. The Puerto Rican government and U.S. Congress should use Hurricane María as a turning point for pushing Puerto Rico toward using 100% renewable energy rather than a platform to plant generators across the island. The Fiscal Plans approved and certified by the Financial Oversight and Management Board for Puerto Rico, created by Congress in 2016, should be amended to pursue this vision of sustainable development based on renewable energy.

–Arturo Massol-Deyá, Jennie C. Stephens, Jorge L. Colón

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SCENARIO JOURNAL

Arturo A. Massol-Deyá, "**Our Energy for Our Country**,"
Scenario Journal 07: Power, January 2020
https://scenariojournal.com/article/energy-for-our-country/

"Decolonization and building spaces for self-determination is an urgent need. We were raised on a political narrative that told us that we were weak because we are small, that we lack the natural resources to fuel a modern economy, that we are incapable of self-determination. Who needs oil, gas, or coal when we can embrace the renewable natural resources of the future? We have within our reach enough sun, wind, and water to power the Island and much more."

4 AÑOS CASA PUEBLO

autogestión comunitaria por
Puerto Rico y el Planeta Tierra

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Resilient Housing and Communities

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