the building path out of our climate crisis
MOTIVATION

Why we are doing this?
What’s the hurry?

CALIFORNIA CLIMATE GOALS,

How far do we need to go?
What is our goal for building buildings?

HOW TO BUILD TODAY:

To contribute to the Climate Solution
To respond to the climate’s changes and create resilient buildings.
How many of you are... architects or designers? contractors? homeowners? building officials?

How many of you think we have plenty of time to address climate change?

How many of you have made changes to your homes or lives to mitigate climate change?

James Bill, architect, certified passive house consultant, owner, ZIA Zero Impact Architecture, integrating beauty and deep sustainability
California has 129 million dead trees standing as match sticks.

The 2018 fires released 68 million tons of carbon, almost equal to the 76 million tons of carbon generated by electricity production.

Once forests start burning, they can release more carbon than we can reduce from other sources.

Creating

RUNAWAY CLIMATE CHANGE
The amount of carbon stored in permafrost soils is more than double the amount currently in the atmosphere. (wikipedia)

As the arctic regions start warming, as is happening now, thousands of years of carbon materials will start to decompose and release CO2 and methane gases. Creating

RUNAWAY CLIMATE CHANGE
Opinion

Time to Panic

The planet is getting warmer in catastrophic ways. And fear may be the only thing that saves us.
CALIFORNIA CLIMATE GOALS,
How far do we need to go?
What is our goal for building buildings?
Global CO2 emissions continued to rise in 2018 by 2.7%, accelerating 1% over the previous year.

The US emissions rose by 3.4% in 2018, having fallen since 2005.

Under the Paris climate agreement, the United States vowed to cut emissions 26 to 28% below 2005 levels by 2025.

Emissions are going **UP not DOWN**.
CALIFORNIA
Where Are We Going

100% Renewable Energy
Building Decarbonization
  New construction
  Deep Energy Renovations
  All Electric
  High Performance

Decarbonization is coming.
Start taking action
NOW
CA’s Greenhouse Gas Emission Reduction Targets:

- **2020**: Return to 1990 levels
- **2030**: 40% below 1990 levels
- **2045**: Carbon neutrality

Buildings, in 2016, created more than 26% of statewide GHG emissions (37 MMt of GHGs). 65% of building emissions were for space and water heating.

To meet the 2045 goal, all existing buildings need to be decarbonized. Any new building constructed before 2045 using fossil fuels will also need to be decarbonized.

Zero Emissions is coming. Start taking action **NOW**.

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1. Emission from buildings includes methane, electricity generation, fuel combustion and refrigerants.
CA’s Zero Emissions Building Code Targets:
- **2025** for residential new construction
- **2028** for commercial new construction

**3 BUILDING CODE GOALS:**
1. **Stop digging the hole**
   1/3rd of California’s 2045 building stock will be built NEW between now and 2045.

2. **Save money**
   New, de-carbonized, all-electric buildings cost less to build to code than those requiring additional gas infrastructure.

3. **Seed the market for retrofitting existing buildings.**
   2/3rds of California’s 2045 buildings will need to be RETROFIT by 2045.
   All new buildings which rely principally on fossil fuels for heat, hot water, cooking or drying clothes undermine carbon emissions goals, will also need to be RETROFIT.
HOW TO BUILD TODAY

STEP X STEP
Getting to High Performance, one-step-at-a-time
STEP X STEP
Getting to DER 1 step at a time

DESIGN
Design final project.
Create PHPP for final stage.
Break project down into affordable, coordinated steps.
Choose shell insulation and tightness for early steps.
Minimize forward-backward-forward steps.

San Anselmo Project Step X Steps
FIRST STEPS
Created PHPP performance model for final project.
Build the complete high performance shell.
Removed oak tree for PV system and ADU.
Install the high performance mechanicals.
Renovate the main living areas.

LATER STEPS
Finish out ADU.
Add PV system and inverter when affordable.
Add battery if and when affordable.
Renovate lower floor when ready.

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Sustainability Plan

**STEP X STEP**

**ADU’s roof creates SW orientation for new NZE solar needs in summer while allowing winter solar heating.**

**that wraps up walls and across roof creating thermal CO2 mitigation as the tree provides in CO2 capture.**

**the interior air is free of CO2, moisture, and cooking toxins while keeping the interior air temperature.**

**PV panels (or thin film) installation, further optimized by using a heat pump water heater that uses CO2 Heat Pump domestic hot water system.**

**HIGH PERFORMANCE SPACE CONDITIONING**

All electric house using Heat Pump technology for the mechanical systems.

**HIGH PERFORMANCE INDOOR AIR HRV**

Heat Recovery Ventilator provides continuous fresh air that is filtered and where the heat is exchanged between the incoming and outgoing air to ensure the interior air is free of CO2, moisture, and cooking toxins while keeping the interior air temperature.

**HIGH PERFORMANCE WINDOWS**

Using air tight, triple pane windows and doors to complete the high performance shell system.

**NEW GREY WATER Plumbing and LANDSCAPING**

Capture greywater for inside uses and inside after filtration.

**NEW CAR CHARGERS AT PARKING AREA**

All electric house and cars means all can be powered by renewable energy.

**LOW EMBODIED CARBON RENOVATION**

Materials used for renovation are low embodied carbon materials to minimize Climate Change impacts of construction.

**LOW ENERGY HOUSE**

High performance walls and roofing; air tight walls and roof, exterior wood based insulation to reduce thermal bridging with negative carbon footprint, high performance, all light and triple pane windows and doors. High performance mechanical systems using CO2 Heat Pump domestic hot water system. Increased comfort and minimized operational CO2 emissions.

**ALL ELECTRIC HOUSE**

All electric house; all LED lighting, induction ranges, live, heat pump clothes dryer, CO2 type heat pump water heater (COP in 5) for domestic hot water and space heating, vacancy sensors for plug load reductions. The wood fireplace will be removed. No fossil or wood fuels burned.

**CARBON POSITIVE HOUSE**

(FUTURE) Install an approximately 10K PV system for NZE houses including 2-car electric car charging. Thus providing all of the residential and transportation energy needs for two families. An all electric house with 100% renewable energy is NZC (carbon). (FUTURE) Provides batteries for utility balancing of loads for future solar overproduction to ensure grid energy consumption is NZC.

**LOW CARBON FOOTPRINT MATERIALS**

Renovate existing house so structure can last 100 years, using existing and salvaged materials as much as possible. Exterior insulation is either cork or a splittable sheep wool to reduce thermal bridging, non-toxic, and compostable. Exterior finish is varnish plaster which is breathable, non-toxic and compostable.

**NON TOXIC, HEALTHY BUILDING MATERIALS**

Bamboo and linoleum flooring, paper resin composite panels which are breathable, non-toxic, and compostable. Exterior finish is varnish plaster which is breathable, non-toxic and compostable.

**ARCHITECTURAL**


**LOW WATER & GREYWATER REUSE HOUSE**

Bathroom use composting toilets to center NSF (National Sanitary Foundation) certified centralized composting system. Water safe roofing and downspout systems for rain water catchment collection. Indoor water supply and waste lines separated so grey water compatible devices (toilets and clothes washers) can use purified rainwater if wanted. (FUTURE) Rainwater storage tanks to capture rainwater for reuse, to minimize flooding, and for garden use.

**GREYWATER**

Greywater waste lines separated from black water lines so grey water can be distributed directly to non-edible landscaping plantings. Kitchen sink with both a black water connected sink basin and a grey water connected sink basin to maximize water reuse.

Greywater reuse plumbing using separate supply lines from the pristine water system for reuse when the future houses filters are installed.
HOW TO BUILD TODAY

OPTIMIZE

Modeling High Performance
Modeling Future Climate
MODEL THE BUILDINGS ENERGY DEMAND
Model the project using performance model, not compliance model.
Use current climate, IPPCC data or Meteonorm (PHPP ready)

BUILD A HIGH-PERFORMANCE SHELL
Right size insulation, thermal bridge free.
Triple pane windows, shaded as needed.
Air tight shell.
Essential for health, Forest fire smoke.

INSTALL HIGH-PERFORMANCE MECHANICALS
Use heat pump technology.
Ideally with low GWP potential, like CO2.
High performance ventilation.
Can be huge energy waste as running 24/7.
Turn off if wildfire or smoke in area.
Low energy appliances, lighting etc.
Hot water distribution system
Model Using Future Climate Data

SF is supposed to have similar climate as Palos Verdes Estates in 2080, near Ventura CA.

in 2080, SF winters will be, on average:
6.9 degrees F warmer
40% drier

Vancouver is about to change from Heating Dominated Climate to Cooling Dominated,
Large impact on design.
OPTIMIZE
Modeling - Future Climate

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HOW TO BUILD TODAY

DECARBONIZE

Operational decarbonization

Embodied decarbonization
DECARBONIZE
Operational Decarb - All Electric

**Electrification**
Removed all gas equipment:
- DHW, furnace, range, clothes dryer.
- Removed fireplace which increased air tightness and lowered combustion fuel use.
- Added Sanden CO2 heat pump combi space and domestic water heater.
- Signed up for 100% renewable electricity from SCE or MCE or personal PV
If not 100% elect, then it cannot be 100% renewable.

**Future**
- Designed PV sized for energy demand of 2 EVs plus energy for house plus ADU.
- Designed space for wall battery.
**DECARBONIZE**

Operational Decarb - Renewables

**Removed Oak Tree Shading PV Roof**
Oak tree sequestered 1.1 lbs of CO2 per year. PV panels offset 16,254 lbs of CO2 per year. Tested PV exposure with modeling. Plan maximizes CO2 reduction.

**New Roof**
Old roofs were sloped either NW or SE. SE direction had trees all along. New roofs are sloped in SW direction. Maximizing solar gain. Roof will be built Phase 1. PV will be installed at later phase.

**PV Output**
PV designed to supply enough KW for high-performance house for 3-4 people plus high-performance ADU for 2-3 people plus 2 EV cars driven average mileage.

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Batteries
Store energy for use when renewable energy is not available in the needed quantity.
We need to put energy into storage when it is not needed for use later on.

House as battery
If a house can hold heat or cooling efficiently over time, then the house can act as a battery, and collect electricity for heating when it is available and store it in the structure.

Hot Water Tank as Battery
An efficient hot water system can use energy when electricity is abundant to add heat to a water tank for use when the hot water is needed.
Materials

Reused 100% of existing concrete foundation by keeping building footprint the same, thus reusing high carbon footprint concrete.

Reused 80% of existing wall and floor framing, minimizing wood manufacture and transportation, minimizing disruption of carbon sequestering forest soils.

Salvaged sheathing boards to reuse as interior finish.

Salvaged interior finishes for reuse in ADU.

Recycled waste as possible.

Used FSC for new framing and sheathing.

Used negative carbon footprint cork as exterior thermal insulation break.

Installed thin layer of low carbon footprint lime plaster as cork finish.

Installed recycled content cellulose as framing cavity insulation.

Used earth blocks for retaining walls.

Use locally sourced materials to minimize travel footprint.
Forests Sequester CO2
In the tree wood
And in the soil

FSC vs Non-FSC Lumber
The logging operations of non-FSC lumber disturbs the soil, and releases large quantities of stored carbon, increasing the carbon footprint of the lumber.

Wood vs Concrete, Steel, etc
Steel requires 24x the energy needed to produce steel.
Concrete requires 0.14 tons of CO2 per 1 m3.
Whereas 1 m3 of wood stores 0.9 tons of CO2.

http://benefitsforbusiness.fsc.org/why-use-fsc-wood.2.htm
**Increased Occupancy**

Original house has 3-berooms for 3-4 people.
Added 2-bedroom ADU for 2-3 people.
Total new occupancy is 5-7 people.
Added 722 sf ADU to existing 2100 sf main house.
ADU reduces embodied and operational per-capita carbon footprint.
Concrete Foundation
Reusing existing 100%
Adding 40 lin ft

Exterior walls
Reusing 80% exterior wall and floor framing
Adding 100% new FSC lumber for ADU and new walls
Reusing 10% exterior wall sheathing as interior finish
Using dense pack cellulose framing insulation
Adding 2” cork insulation for thermal bridge free walls
Adding 1/8” lime plaster exterior wall fire finish

Roofs
Salvaging roof framing for infill framing
Salvaging sheathing boards for reuse as interior finish
Adding new FSC roof framing and sheathing
Adding 2” cork insulation for thermal break at roof
Using dense pack cellulose framing bay insulation
Adding new recycled metal roofing for rain catchment
HOW TO BUILD TODAY

RESILIENCY

water
fire resistance
land
RESILIENCY

Water

**Rainwater**
Rainwater safe metal roofing
2 Rainwater capture storage tanks (all allowed)
Reuse of rainwater in house when filtered

**Greywater**
Install greywater waste and supply plumbing lines.
Install centralized and accessible cold-water supply line manifold going to dedicated fixtures so can use rain or greywater in future as needed.

**Filtration System**
In future, as needed, install water reuse filter system. Preinstall electrical and reuse supply plumbing at location.

**Minimize water use**
Hot water recirc pump to minimize waste water.
Optional composting toilet to minimize potable water use.
Low flow faucets and shower heads.
RESILIENCY
Fire Resistance

Fire Resistant Exterior Walls and Roofs
Lime plaster as fire resistant siding finish. Metal raised seam roofing is fire resistant. Minimize combustible materials attached to the house; no wood decks, no wood fences. Minimize exterior vents, protect with vent screens finished with intumescent paint on metal 1/8 screen opening screens.
RESILIENCY

Land

Water
As drought frequency increases, land needs water for healthy plants. Grey and rainwater used for irrigation helps plants. Healthy plants help make the landscape more fire resistant.

Compost
Composting toilets (optional) and kitchen waste composting systems supply nutrients for the soil and increase soil carbon sequestration.

Fire Resistant House
Making house fire resistant means house will not burn in wildfire and will not contribute to carbon emissions, and will not further impact the land and climate.
Please ask questions

You can email me at

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