Planning Guide for Tribal Energy Sovereignty

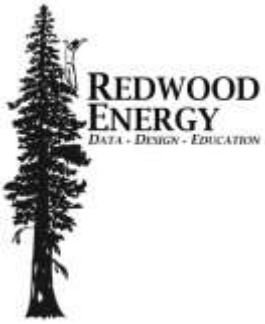
Prepared for:

Bear River Band of Rohnerville Rancheria

266 Keisner Road
Loleta, CA 95551

December 14, 2016

Prepared by:



Freshwater Environmental Services

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ATTACHMENTS

Planning Guide for Tribal Energy Sovereignty

December 14, 2016

1.0 Summary Recommendations for Tribal Energy Sovereignty

The goal of this documents is to allow for Energy Sovereignty, whereby a Native Sovereign Nation or Tribe can own its renewable energy, and stop burning fossil fuels. This document in intended to be used by local Tribal entities who wish to eliminate fossil fuel use in buildings with their locally available, renewable energy resources such as solar power, wind power, and bio-mass. It includes a description of how existing Tribal buildings use energy, how to switch methane gas ("natural gas") burning equipment to high performance electric equipment and then generate that electricity with local renewable resources.

Background

This planning guide is based on a recent 2016 energy analysis and energy sovereignty design for the Bear River Band of the Rohnerville Rancheria located in Loleta, CA, in the Pacific Northwest. The Bear River Casino and Hotel is one of Humboldt County's largest employers, with 400 staff, and the Casino, in turn, is a significant energy user. The Bear River Band Tribal Council received a California Grant to help pursue energy sovereignty, disconnecting from the gas and electric grids with a combination of on-site renewable energy and energy storage.

The Bear River Band has been implementing their mission, "to promote balance between quality of life, self-sufficiency, sustainability and cultural awareness for Bear River" in part with a drive towards an energy sovereign micro-grid with support from the Department of Energy, the Schatz Energy Research Center, Humboldt State University and most recently with a local Zero-Net Energy Design firm, Redwood Energy, to create a Master Plan with options presented for achieving energy sovereignty.

The 150-acre Rohnerville Rancheria of the Bear River Band is in Humboldt County, CA, at 41 N Latitude, in line with cities like Denver, Chicago and New York, and Tribal Nations like the Uintah of Utah and Kickapoo of Kansas. The Bear River Band live on a windy river valley next to the foggy Pacific Ocean. The Band have an excellent wind resource, but their site produces 2/3rds the amount of energy as the same solar array would in southern California.

All-Electric Energy Sovereignty Options

In order to plan a 100% renewably powered micro-grid, an hourly, daily and monthly schedule for energy use vs. production must be created to ensure energy is always supplied. To plan for energy sovereignty, two sets of information are necessary:

1. Existing and post-retrofit energy use data to created a detailed understanding of energy consumption
2. Site-based solar energy and wind energy data to create a detailed plan for energy production and energy storage to meet demand

Solar energy, wind energy and biomass energy each presents technical and financial challenges, and there is a five-fold range of installation costs depending on what balance of energy resources is devised—the most expensive moments are those times when there is a mismatch between supply and demand, requiring larger solar and wind arrays, a biomass generator, or requiring larger batteries.

Before the Band can meet all their annual 12 MWh energy use with renewable energy, the Band first must "fuel switch" their buildings from methane gas ("natural gas") burning appliances to energy-efficient electric appliances that can be energized with electricity that is made and stored on-site. Next, they must generate renewable energy with a mix of solar arrays, wind turbines, batteries and/or local wood resources ("biomass"), with batteries likely involved to secure the grid enough to cut off ties with PG&E, or a similar grid energy provider, and become a true "micro-grid."

Figure 1: Examples of commercial-scale all-electric heat pumps for HVAC and DHW(left) , residential heat pump water heaters (center) and high-quality induction stoves (right).

- **Energy Efficient Fuel Switching** from fossil fuel burning equipment to more efficient electric equipment will cut building energy consumption by ***30-60%***, and allow the buildings to use electric energy that can be produced renewably on-site. Using efficient electric equipment, such as ***heat pumps***, for heating, cooling, domestic hot water, cooking and laundry drying reduces environmental pollution, and is the least-cost strategy for reducing energy use overall. While efficiency is part of the solution for the Bear River Band, the ***casino machines*** themselves are 70+% of the Bear River Band's total energy use, and there are not sufficient opportunities yet for efficiency measures. No Federal Energy Star resources have been devoted to making casino gaming machines more efficient, nor can they be cost-effectively powered down—they make as much money in two days as it costs to pay for electricity to operate them for a year. ***Consequently, the Band's long-term focus must be on energy generation***.

- **Solar Energy** for a solar-only micro-grid using the best, 21.5% efficient solar power requires 40 acres of solar panels, more land than the 5-10 acres the Bear River Band has available for an array. Because solar energy is 2.5 times more abundant during the summer than winter, and only available during the day**.** When a micro-grid relies on just a solar array, it must be sized to meet 100% the demands even when days are short and dim, and 40% as strong as the summer.

Figure 2: Large-scale (90 MW) Solar Array currently producing electricity in France.

- **Wind Energy** is most abundant at night in the Eel River Valley and therefore complements solar power, but local weather means wind strength is lowest during the months of August and September, at just 1/7th its peak energy production, which are unfortunately two of the peak energy use months for the Bear River Band. Each of the smaller 100kW wind turbine requires 1 to 5 acres to function correctly, and an all-wind grid sized for August would require more than 400 wind towers. Additionally, while low-speed models of wind turbines are available, Shell Wind's previous and incomplete efforts to get environmental approvals raised concerns about endangered bird species that must be addressed when planning utility-scale turbines. The below graphs shows an optimized mix of solar, wind and battery. The 3.2 MWh of wind turbines requiring at least 30 acres and as many as 150 acres, and 11MW of solar requiring about 20 acres, with an 18MWh battery bank for storage that would sit in nine modestly sized storage containers. This lowest-cost mix requires more land than the Bear River Band has available, but land purchases are an option.

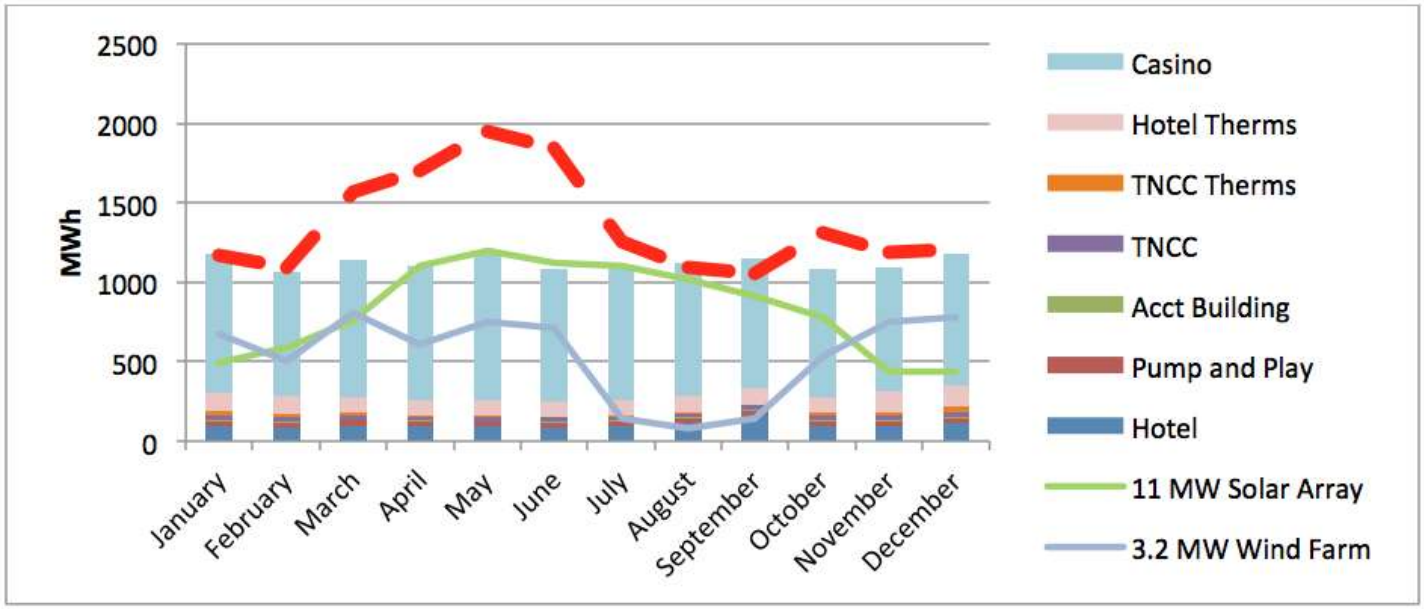

Figure 3: Bear River's Energy Sovereign Micro-grid with Solar power, Wind power, and Battery storage.

- **Wood Energy:** Wood is composed of stored solar energy, collected by trees at a 9% efficiency (compared to PV solar at 21.5%), and can be stored for years without significantly degrading, unlike rechargeable electric batteries. To meet peak loads in August and September, span the brief hours of both low wind and solar production, or simply burn a steady rate to support the steady demand of the casino, a "biomass generator" is relatively easy to install and operate. However, it does require trained operators and access to wood fuel. Wood chips are locally available from wildfire reduction programs and waste from lumber mills, but Humboldt County historically has relied on 30% of its local power from biomass generators in Scotia, Fairhaven and Blue Lake, and smaller, quickly fired biomass generators could fit the Band's energy needs. Current wholesale biomass fuel cells to the grid at $.09/kWh, more expensive than wholesale solar or wind electricity sales to the grid at $.04-.06/kWh, but a small biomass generator will allow for less reliance on electric batteries, solar or wind power by the Band. The Bear River Band does not own forest lands, so local wood fuel would need to be purchased. ***Tribes can expect to pay about $1 million/year to operate a 1MW bio-mass generator.***

  Residential wood burning stoves will also continue to be a residential energy resource for the Band, and there is no recommendation to change that from an energy perspective. However, there are health consequences to wood burning stoves from greater indoor air pollution, increased asthma particularly. Using stoves more for pleasure and less for the primary heating resource will help some people's health.

2.0 Financial Resources for Micro-Grid Development

There are many sources of funding and indirect financing of energy efficiency and solar retrofits in housing and commercial buildings in California. The best single resource is a US government funded website, www.dsireusa.org, which is kept current under contract with the Department of Energy and effectively tracks incentives of all types.

Within the Federal Government there are many resources scattered through the USDA, Bureau of Indian Affairs, EPA, Department of Energy and HUD, as well as a limited number of California State resources. They change each year, but are growing in number and funding. This Financing report includes options for Residential, Commercial and Community Scale Micro-Grid funding.

Residential Funding

- The single best program in California for retrofitting low-income housing to Energy Sovereignty/Zero Net Energy is the State of California's Low Income Weatherization Program. It is heavily funded for the foreseeable future with Cap and Trade revenue, and will pay for most or all of the efficiency measures and solar for retrofitted low income housing. This is the only program that funds both efficiency and solar retrofits, and it focuses on gas-to-electric retrofits to reduce CO_2 pollution.
- *Low Income Housing Tax Credits* distributed by the California Tax Credit Allocation Committee and HUD's *Indian Housing Block Grant Program* (authorized under NAHASDA) are the primary funding vehicles of new and retrofitted Native Nation housing.
- The USDA's *American Indian and Alaska Native Programs* provide financial support through housing grants, low-interest loans (usually 1-3%) and loan guarantees that ensure the USDA repays 90% of the loan should the recipient default. Loan guarantees empower the recipient to negotiate more favorable terms for their conventional bank loan, usually .5%-1% less interest.
- The IRS provides 30% tax credits, which are sellable to investors with tax burdens, for both renewable energy and solar efficiency measures. If they are sold on a tax credit market or used by the Owner, they reduce the cost of the array by 1/3rd.
- Indian Community Development Block Grant (ICDBG) can provide partial financial support to residential projects for planning and infrastructure.
- Investor Owned Utilities like PG&E additionally offer rebates for solar arrays, with usually equal 1/3rd of the cost of the residential array. When coupled with IRS Renewable Energy 30% tax credits, the final system cost is less than half the billed cost.

Commercial Funding

- Investor Owned Utilities like PG&E have rebate programs to encourage efficiency in lighting, commercial cooking, water heating, etc. They may be available through an intergovernmental agency like the Redwood Coast Energy Authority, which is responsible for Humboldt County's business retrofit efforts, or directly available through PG&E or a similar utility in other areas.
- The US Dept of Energy provides loan guarantees for commercial energy efficiency retrofits like those in a hotel or casino, effectively reducing the loan rate by .25% to .5% when offered through a conventional bank.
- The USDA "Rural Energy for America Program" offers a number of loan and loan guarantee programs for commercial building retrofits

Community Scale Micro-Grid Funding

- The USDA's main funding program for community-scale energy systems is called the *Rural Energy for America Program Renewable Energy Systems & Energy Efficiency Improvement Loans & Grants*. The support up to $500,000 in grants and $25,000,000 in subsidized loans, as well as loan guarantees, for large scale renewable energy systems and large-scale energy efficiency retrofits.
- The *County of Humboldt* has taken on the role of providing renewable energy to former PG&E customers via the Community Choice Energy business structure, and will take its first steps in the fall of 2016 to deliver renewably sourced energy purchased on the open market while developing local renewable energy capacity. While the Nation is transitioning to cutting ties with the PG&E grid, it may

be able to partner with the County and gain financing for solar, wind and biomass generation, should the excess be shared with Humboldt energy customers.

- The Department of Energy's *Indian Energy Program* provides partial grant funding for large-scale renewable energy development, as well as loan guarantees to support the balance of expense. The below image is from the DOE's website, illustrating their financial participation in community scale wind turbine projects.

Figure 4: Groundbreaking ceremony for the Seneca Nation's 1.5 MW wind turbine.

- HUD's *Indian Community Development Block Grant* (ICDBG) is again an important source of grant funding for technical planning of the micro-grid, wind turbines or solar field.
- The Department of the Interior *Division of Energy and Mineral Development* has an annual funding program that tribes can apply to for wind energy pre-development studies.
- *Private funding* in the form of Power Purchase Agreements are also widely available—private investors develop large scale wind and solar energy projects that function as small private solar utilities for an apartment complex or community. The Power Purchase Agreement allows the system Owner to recoup their investment by selling the purchaser electricity at a rate less than PG&E's. Well-known companies willing to invest their own funds to develop energy supplies for customers include SunPower and Solar City. It is not "free" energy—the cost of development is repaid through ongoing utility bills to the actual Owners of the array or wind turbines, usually 1/3rd less than the PG&E utility rates.

3.0 Baseline Energy Assessment

Baseline energy audits along with utility bill analyses are the first steps in determining how to create self-sustaining energy for your community.

1-Year of Utility Bill Data

For the utility bill analysis, gather historic data for at least one-year of Electric and Gas Bills, broken down by buildings and by months to understand the actual demand throughout the year. This data will ultimately be the most valuable information in determining the energy consumption at existing conditions. If the equipment is mostly non-electric, or older equipment, expect to see 25% - 50% drop in energy consumption after completing a Zero-Net Energy, all-electric, energy efficiency retrofit.

Baseline Energy Audits

Energy audits consist of hiring an experienced professional to inspect the building for existing conditions, analyze utility bills, collect site data for energy modeling and provide recommendations for improvement. The baseline energy audits should go into greatest depth with those buildings use the most energy. In this case we spent a great deal of time understanding the Casino, which uses 80% of the energy delivered to the Bear River Band.

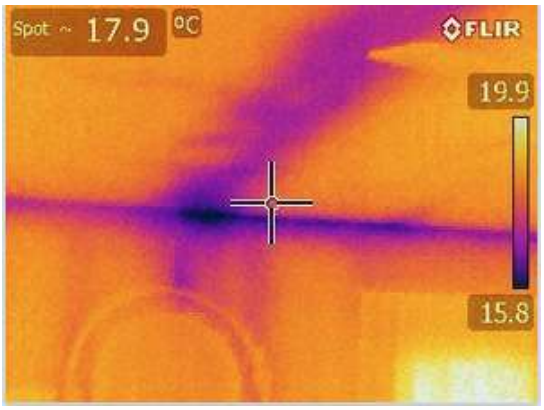

Figure 5: An infrared photograph showing a Bear River Band house with a leaky bedroom addition.

Audits should be performed by a trained and experienced professional with a Building Auditing Certification from a group like Build It Green, Building Performance Institute (BPI), ASHRAE, Energy Star for Homes, LEED, HERS, etc. Audits should be performed using the Energy Star Inspection Protocols, which consist of entering every 1/7 homes, +1 extra for Residential spaces. All commercial buildings should be audited, especially Casino's. Trained volunteers working under a professional's oversight can help decrease the costs of auditing large properties.

Energy Modeling

Energy modeling is a necessary tool in creating Zero-Net Energy communities, which requires an experienced Energy Consultant to review building plans and create models of energy consumption under different retrofit scenarios. If Architectural building plans do not exist, they will need to be manually re-created to perform the energy models.

4.0 Energy Efficiency Retrofit Recommendations

After the baseline analysis has been performed, the next step is to identify the least cost ways to reduce energy use so that a renewable energy system is affordable. This will likely be a combination of retrofits to LED lighting, increasing insulation where feasible and installing high performance electric heat pumps for HVAC and domestic hot water equipment. High performance heat pumps cost less to operate than the highest efficiency gas equipment, so savings are immediate. High performance heat pumps are inexpensive to retrofit, and less costly to install than gas in new construction.

The retrofit recommendations should be guided by the 7th generation principle, using the least amount of resources and providing the least environmental impact, while creating buildings that will last multiple generations.

Figure 6: Example of a residential heat pump at left which heats and cools, 50-gallon heat pump water heater at center, and induction stoves at right that is even more responsive and capable than a gas burner.

<u>Recommendations to achieve energy sovereignty should include:</u>

- Fuel-switching from gas equipment to high performance, all-electric equipment to save on utility costs—gas is ***not*** less expensive when compared to the most efficient electric equipment.
- Building envelope improvements
    - Seal all holes and cracks in foundation, walls, and roof with No and Low VOC caulk and foam products.
    - R-21 walls, R-49 roofs, R-19 crawlspace or sub-floor insulation is ideal in most CA climates. Cork insulation and recycled newspaper/cellulose insulation are best practice products compared to foam and fiberglass.
- Fixing any unhealthy and/or unsafe conditions (mold, asbestos, lead remediation)
- Installing Energy Star appliances and Energy Star LED lighting
- Edible landscapes to provide food security, preferably with no-irrigation planting strategies and use of native species to support wildlife and ecological resiliency

5.0 Energy Sovereignty Building Code

New Construction and Existing Construction ZNE Retrofits

The ***Energy Sovereignty Building Code*** (attached, Appendix I & II) is a Best Practices Building Code for New Construction and Existing Construction ZNE retrofits. This Building Code is intended to help local Tribes create healthy, resilient, sustainable and energy independent Tribal communities, using the least environmentally harmful materials and methods. The Energy Sovereignty Building Code is photo-based to clarify technical language that is often difficult to interpret in the field without pictures, which are worth a thousand words and can be worth many thousands of dollars of avoided mistakes.

6.0 Energy Generation and Storage Plan

In order to plan a 100% renewably powered micro-grid, an hourly, daily and monthly schedule for energy use vs. production must be created to ensure energy is always supplied.

Two sets of information are necessary:

3. Existing and predicted post-retrofit energy use data to created a detailed understanding of energy consumption
4. Local solar energy and wind energy data to create a detailed plan for energy production and energy storage

6.1 Renewable Energy

The primary source of energy generation for energy sovereignty will be photovoltaic (PV) panels. In especially windy regions, wind turbines will be additional opportunities for energy generation. Since the sun patterns are more consistent and reliable than the wind patterns, the micro-grid should be mostly powered by solar panels.

A 1 MW solar farm will need roughly 1-acre of land dedicated to generating electricity.

6.2 Energy Generation Strategies

Below are examples of how we mapped energy use, beginning with daily use for the Casino, illustrating strategies to meet the daily energy use for an entire year of variable wind and solar energy. Because electric batteries are extremely expensive, great attention was paid to how to increase energy production to meet nighttime energy use, rather than increase the system cost five-fold by installing batteries and increasing system sizing to address the 20% energy loss associated with batteries. ***The economics of continual production vs. intermittent production and storage strongly favor continual production***, particularly when the energy loads are significant yet fairly stable at all hours of the day, such as with a Casino's loads seen directly below.

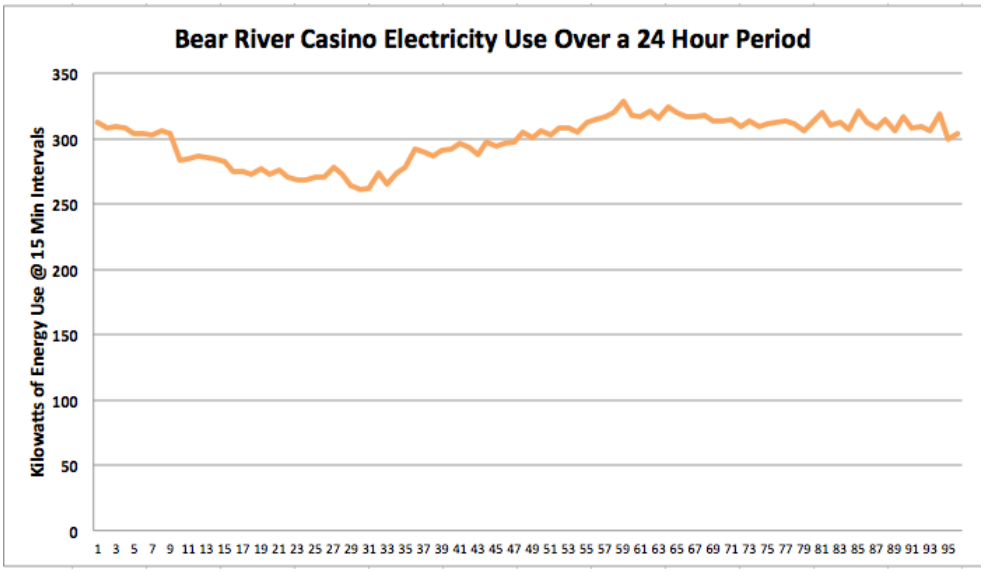

Figure 7: A Casino's energy use is primarily the gaming equipment plug loads, and is relatively stable over 24 hours and stable energy use. Each casino machine uses as much as a large house, adding up to 10MWh annually, which is 80% of the total energy load for.

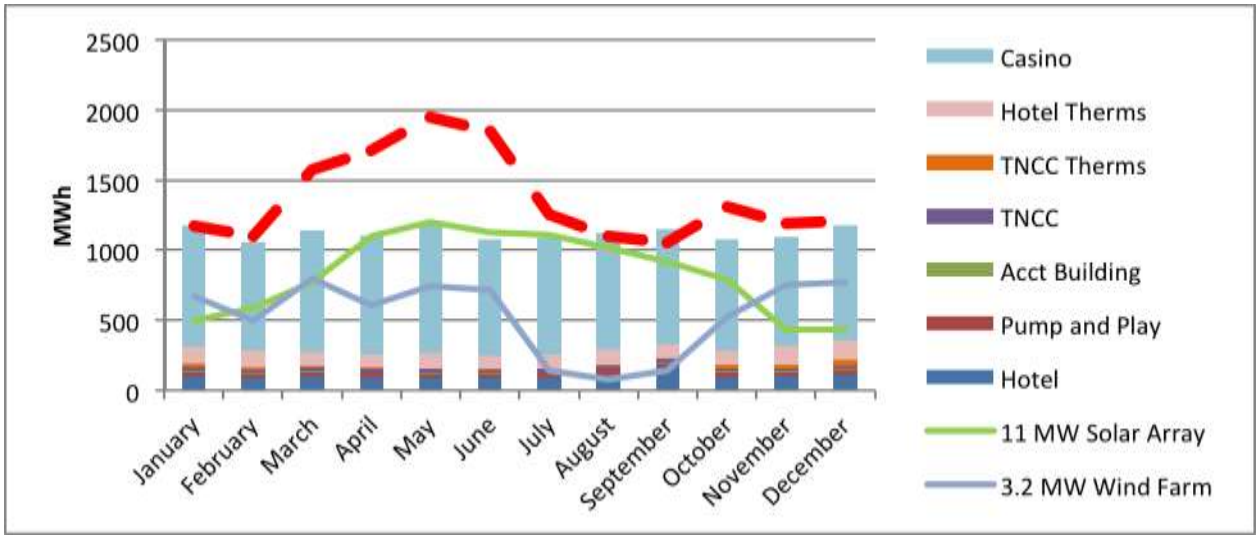

Figure 8: A solar and wind microgrid design that does not use biomass, but instead requires an 18MW battery bank to meet 100% of the hourly energy use, an 11MW solar array, 3.2MW wind turbine array and meets both monthly and hourly needs. <u>Estimated Cost: $53M.</u>

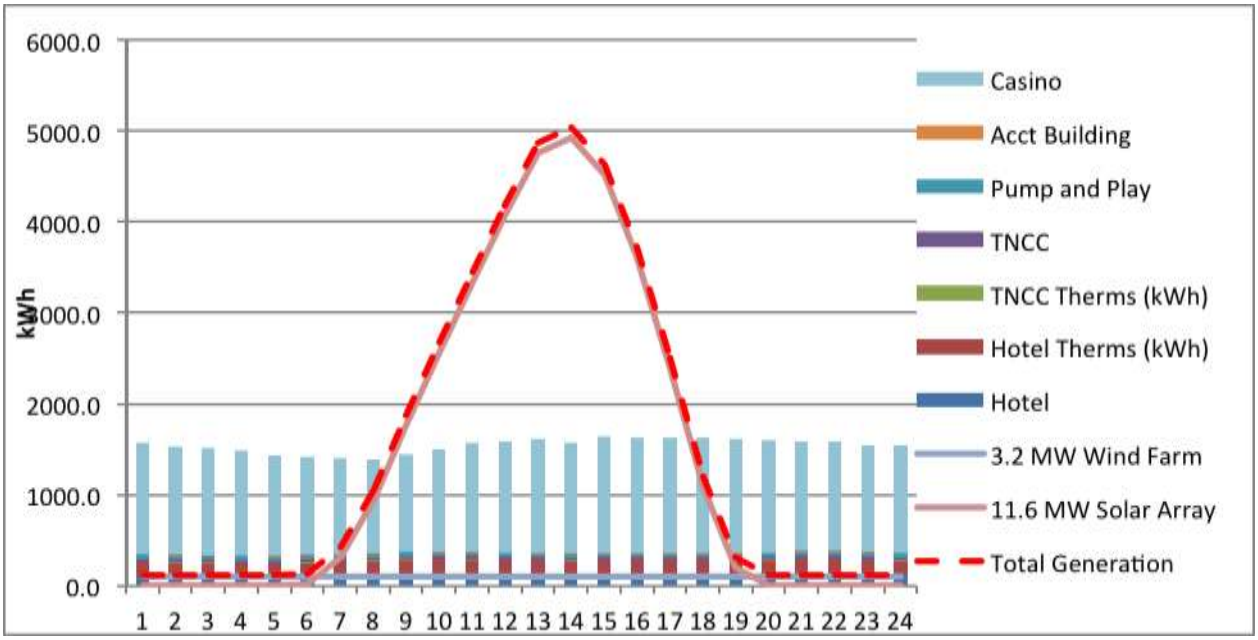

Figure 9: The hourly production profile for an August day, when wind is at its quietest all year. The wind, solar and battery system size is driven by the requirement to meet all loads, all day even on the day of least energy production, so the midday spike of solar energy must be sized large enough to be stored to meet the other 2/3rds of the day when solar production is low.

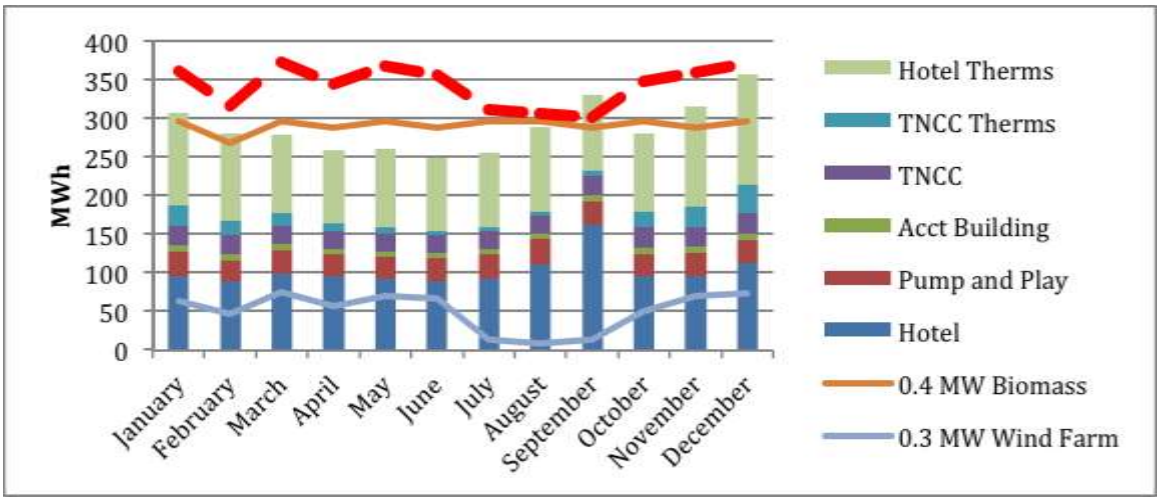

Figure 11. The least cost scenario is a 1MW biomass system for the Casino (not shown above) to meet the predictable hourly loads, and a .3MW wind farm with another .4MW biomass plant to meet the loads of other tribal buildings. Estimated Cost: $9M to build and $1M per year to operate the biomass generators.

6.3 Energy Storage

There are large cost differences between various strategies to meet the energy demands with on-site production and storage. Batteries are the most expensive and potentially environmentally damaging system component to reaching energy sovereignty. The large quantities of necessary batteries should be low-toxicity and low-fire risk, like those made by Aquion (pictured below) with saltwater and non-toxic metal anodes.

Figure 12: Saltwater batteries are the most environmentally friendly option, are cost comparable to lithium-ion batteries, hold Cradle-to-Cradle certification, have 99% roundtrip efficiency, and last up to 10 years with 100% discharge capabilities.

7.0 Additional Resources

Appropedia

www.Appropedia.org

Peer-to-peer educational website for sharing a wide range of alternative, regionally appropriate, green building techniques. The website includes thousands of projects and expertise contributions with step-by-step instructions, and forums for collaboration and knowledge-sharing.

ENERGY SOVEREIGNTY BUILDING CODE

EXISTING CONSTRUCTION

TEMPLATE FOR COMMUNITIES IN CLIMATE ZONE 1, AS DEFINED BY THE CALIFORNIA ENERGY COMMISSION (CEC)

AUGUST 2016

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00 EXECUTIVE SUMMARY

This Energy Sovereignty Building Code template was funded through a California North Coast Grant offered by the Strategic Growth Council, and issued with help from the North Coast Resource Partnership and the West Coast Watershed.

The Energy Sovereignty Building Code promises Zero-Net Energy (ZNE) homes and commercial buildings that help maintain a large interconnected and balanced micro-grid powered by solar and wind power for Tribal Nations located in the Pacific Northwest territories of North America. This Building Code was written based on the Best Practices in Sustainability, Performance, Health and Safety to create energy sovereignty for communities in the California Energy Commission (CEC) Building Climate Zone 1.

Zero-Net Energy (ZNE) means that a building or community creates as much on-site renewable energy as is consumed by the building or community over the course of one year. The all-electric micro-grid is entirely energy independent, fueled only by renewable energy, with on-site energy storage in non-toxic Aquion saltwater batteries.

The following Organizations directed many guiding principles you will find within this Building Code:

- **(BIG)Build It Green** Green Point Rated (GPR) New and Existing Construction Rating System
- **Energy Star** HVAC Manuals and Rater Checklist, Revision 8
- **(ILFI)International Living Futures Institute** Living Building Challenge Certification and Red List Approved Products Guide
- **(EPA) Environmental Protection Agency** WaterSense and Indoor Air Plus
- **(DOE) Department of Energy** Zero Energy Ready Checklist
- **Enterprise Green Communities** Multifamily Affordable Housing New and Existing Certifications
- **Samoa Green Home Guide**, Sean Armstrong, Danco Communities
- **Redwood Energy** Project Comparison of 8 Zero-Net Energy Affordable Housing Communities in CA, Climate Zone 1

00 EXECUTIVE SUMMARY

In an effort to promote local job/skills training and opportunities for Tribal Members, the Energy Sovereignty Building Code requires funding be set aside for a Job Training Program for Tribal Members.

- For all internal work, Tribal Members shall receive priority job opportunities in addition to extensive Green Building Training before construction crews can begin Construction.
- At least (10) Tribal Members should be recruited by the Tribal Council and given the opportunity to participate in an extensive ZNE Building Education Program for at least 1-year geared towards Job Training. Members will be trained and Certified to perform the Construction and PV installation work and long-term Maintenance duties for all components of the Building Code.

1 SITE AND DESIGN

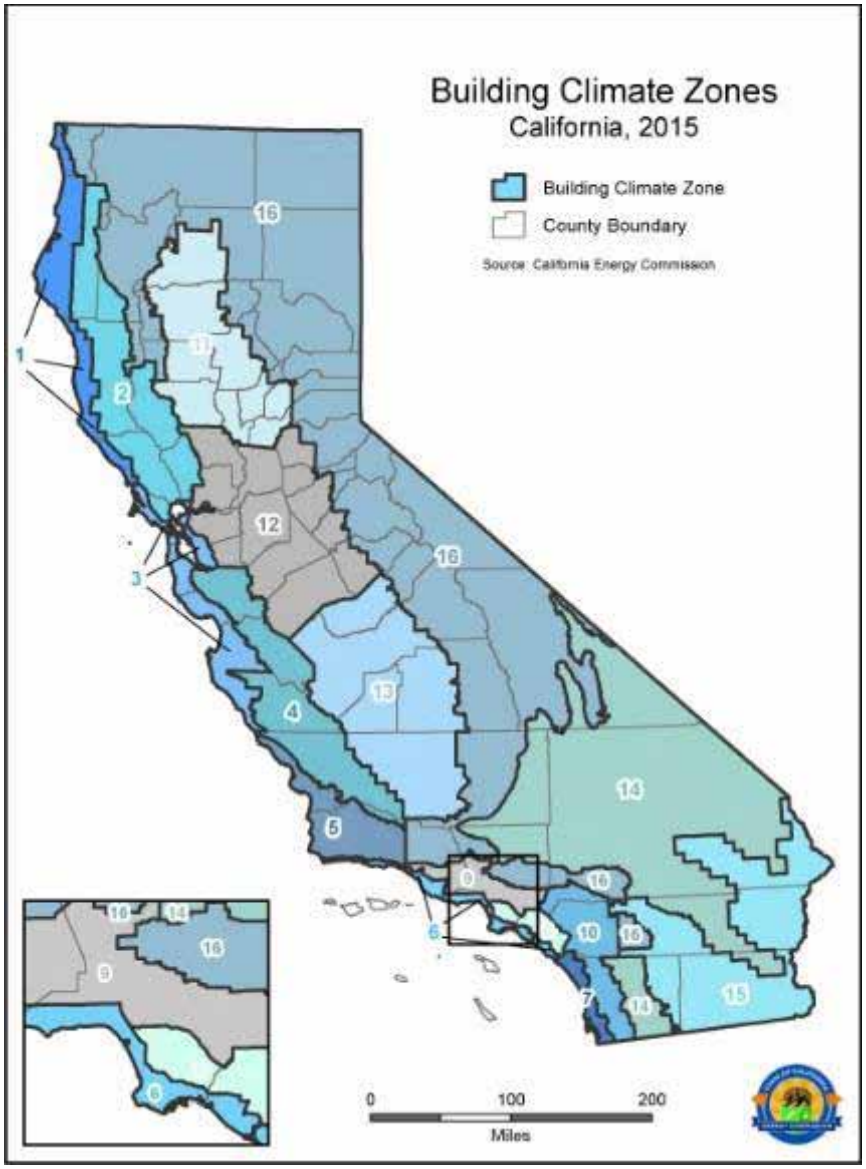
1.1 Stormwater and Infiltration

- Rain gardens

1.2 Waste Diversion

1.3 Permeable Hard Surfaces

1.4 Zero Net Carbon



1.1 STORMWATER

Stormwater control and infiltration

Stormwater from imperious features (roof, sidewalk, etc.) shall be directed towards infiltration features and away from the foundation to prevent moisture damage. This can be accomplished by choosing one or more of the following:

- Rain gardens (gravel basin planted with wetland plants) –see next page for more details on Rain gardens
- Bioswales (a shallow, wide ditch planted with wetland plants)
- Detention ponds (a deep and wide infiltration basin)
- Living roofs on outbuidings such as the garage

Rain gardens utilize a natural, healthy soil profile with good infiltration rates of 1”/hour or more.

Bioswales help mitigate flooding by directing the water downhill and is used in place of traditional concrete gutters.

Detention ponds with filtration plants can help the water as it enters, sending clean water to the undergound aquifer.

Living roofs absorb rainwater, reducing the amount of runoff from a building. They require structural reinforcements and a super sealed moisture barrier.

1.1 STORMWATER- HOW TO DESIGN RAINGARDENS

Foundation Drainage towards Rain Garden

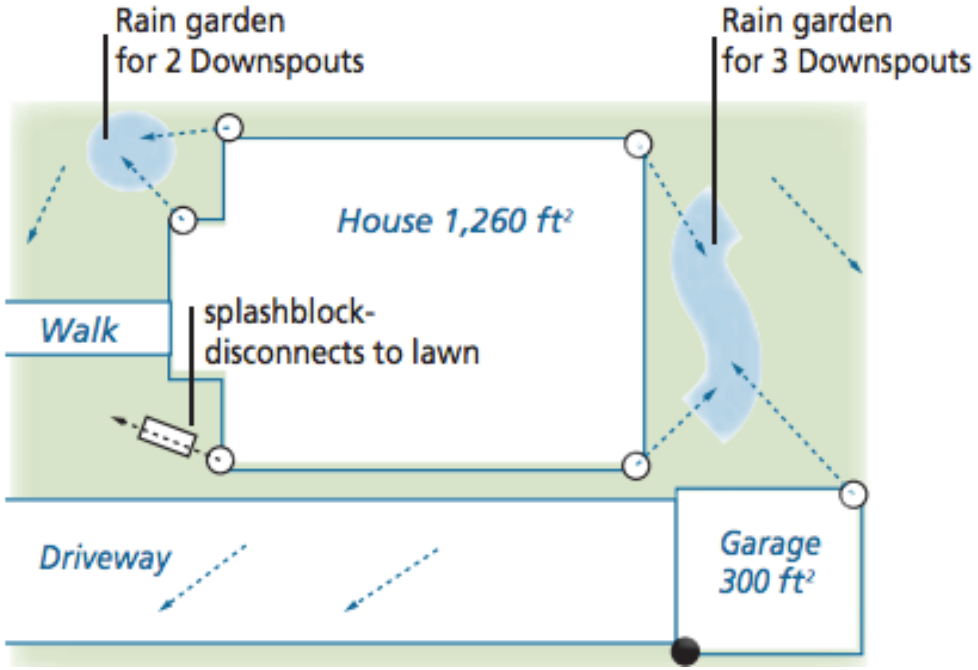
Plan each home with built-in stormwater drainage to a rain garden.

To properly size a rain garden, follow the 10% rule, as shown below:

Make sure your rain garden is large enough to drain the water directed to it within 36 hours. This keeps water from stagnating and mosquitoes from breeding. Size your rain garden to be at least 10% of the area that drains to it.

* For example, if 500 square feet of rooftop drains to your rain garden, the rain garden should be at least 50 square feet.

roof area	*sizing factor*	*rain garden size*
500 sq. ft.	x 10%	= 50 sq. ft. (or 5′ x 10′)



1.2 WASTE DIVERSION

Construction and Demolition Waste

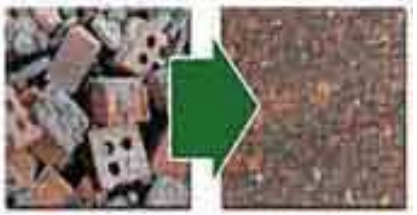
- **Provide a recycling bin for construction waste that can divert a minimum of 60% of construction materials as measured by volume or weight from the landfill. This will save both construction costs and the environment. Diverted materials can include:**
  - Framing wood and unpainted drywall can be chipped on-site and tilled into the ground
  - Rock, asphalt and cement are all reused locally for road base
  - Metal waste is a high value recycled material
  - Paper & cardboard are much less expensive to recycle than landfill
  - Topsoil & trees that cannot be saved can be sold or donated for reuse in the community
  - Carpet is less expensive to recycle than landfill

Wood becomes Mulch

Drywall becomes a gypsum soil amendment

Shingles become aggregate

Masonry becomes landscaping material/ fill



1.3 PERMEABLE HARD SURFACES

Permeable Hard Surfaces

- Asphalt roadways and driveways shall be a permeable road type, typified by 2’ of un-compacted river run gravel with 4-6” of asphalt with a larger grade of rock and more bitumen to allow water to penetrate into the road bed. This road section is used on all Caltrans roadways. Pavers or pervious concrete shall be used for all hard surfaces instead of solid asphalt that block water from returning to the soil.

Pervious concrete

Permeable pavers

Pervious vs. Impervious

1.4 ZERO NET CARBON

Mitigation

- **Purchase a one-time carbon offset of 200 tons of CO2 per home equivalent for the embodied carbon footprint of the construction project. In 2016 the price of a single ton of CO2 sequestration credit is $12, and the entire home offset would be $2400 in forestry investment.**

This carbon offset cash can be invested locally in forests maintained by the City of Arcata, purchased online as part of the larger California Cap and Trade carbon market, or developed onsite by the Tribal Nation via planting Redwood groves and similar native trees on open land.

Redwood Trees are among the fastest-growing trees on Earth, storing carbon at the fastest rate yet studied by Botantists—by the time they have grown to two feet in diameter in 20-30 years, they have sequestered 1 Ton of CO2 in their wood. One house, creating 200 Tons of CO2 equivalent gases during construction, represents about 100 redwood trees grown for 50-60 years.

2 LANDSCAPING

2.1 Code Minimum

2.1 CODE MINIMUM

- No petrochemical fertilizers or pesticides shall be used on-site.
- Use organic gardening practices at all times
- Invest in fruit trees around all homes and throughout the Nation to provide an abundant food forest for all Tribal Members. There are many fruit tree varieties that grow in the region, including the following varieties, to name just a few:
    - Panamint Nectarine
    - Frost Peach
    - Pink Pearl Apple
    - Sweet Scarlet Goumi
    - Muscat Table Grapes.
- Keep plants away from the exterior siding of all buildings using the following rule of thumb:
    - Plant stems no closer than 36” from the building foundation, and trim bushes, grass, plants, etc. back so they are at least 6” away from the building envelope at all times.

3 BUILDING ENVELOPE

3.1 Code Minimum Summary

3.2 Introduction

3.3 Additions / Alterations

3.4 Foundation

- Repair
- Alterations

3.5 Walls

- Air-sealing
- Insulation

3.6 Windows and Doors

- Code minimum
- Recommended products

3.7 Ceiling and Roof

- Code minimum
- Insulation

3.8 Flashing and Moisture Control

3.9 Insulation

3.1 BUILDING ENVELOPE CODE MINIMUM SUMMARY

Component	R-Value
Foundation	R-4 beneath floor in crawlspace or above floor cork insulation under finish floors
Walls	R-21 in 2x6 walls + R-8 insulated siding (cork product) or R-8 insulation beneath siding
Attic	R-49

Component	U-Value	Solar Heat Gain Coefficient
Window	≤ 0.30 to keep heat inside the residence	≥ 0.5 to encourage passive solar heating in winter
Door	≤ .2 insulated door	Not Applicable to doors

Performance Test	Performance Standard	Method
Sealed Building Envelope	See Chapter 8	Visual inspection of sealed envelope before enclosing exterior walls
Insulation	See Chapter 8	Visual inspection of all insulation installation before adding drywall
Air tightness	See Chapter 8	Pressurizing house fan (“blower door) to measure leakiness
HVAC air flow	See Chapter 8	HERS Testing of supply and return air flow
Rooftop flashing	See Chapter 8	Third party verification of flashing installation

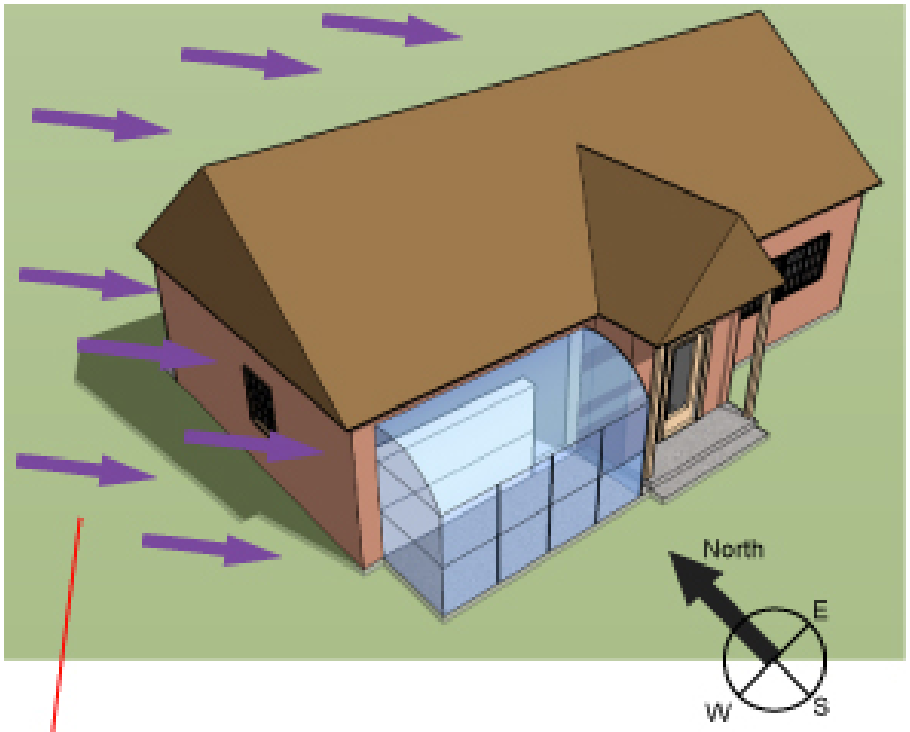
3.2 BUILDING ENVELOPE INTRODUCTION

The Building Envelope is essentially the shell of the building, or the parts of the building that are exposed to the outdoor elements. The Building Envelope includes the foundation, walls, windows, doors, and the roof.

To build a Zero-Net Energy Home that can sustain itself on a limited solar energy budget in the cold winter months, the Building Envelope must be well-insulated, tightly sealed and well ventilated. Additionally, the building should provide natural daylight for occupant health and happiness as well as heat gain on sunny days.

Add a sunroom on the West side of the homes to store heat in the evenings when the sun sets, and provide a space for Tribal Members to grow their own food year-round.

- **Insulation-** Adding insulation
- **Windows-** In most cases, replacing windows in the home is not a cost effective process. If Unless funding from free weatherization RCEA programs are offered or if the exterior siding is deteriorating; then windows in the existing home need replacing.
    - The replaced windows must follow the new construction building code standards. This includes: flashing to window sills, pine-framed windows that re-use existing glass windows, and caulk sealant surrounds the window sills with a sealed building envelope around new window upgrades.



Prevailing winds from the north and the west have the potential to infiltrate the house if tight construction is not used. When attempting to secure joints, it may be prudent to start on those sides of the house.

3.3 ADDITIONS / ALTERATIONS

Sun Room

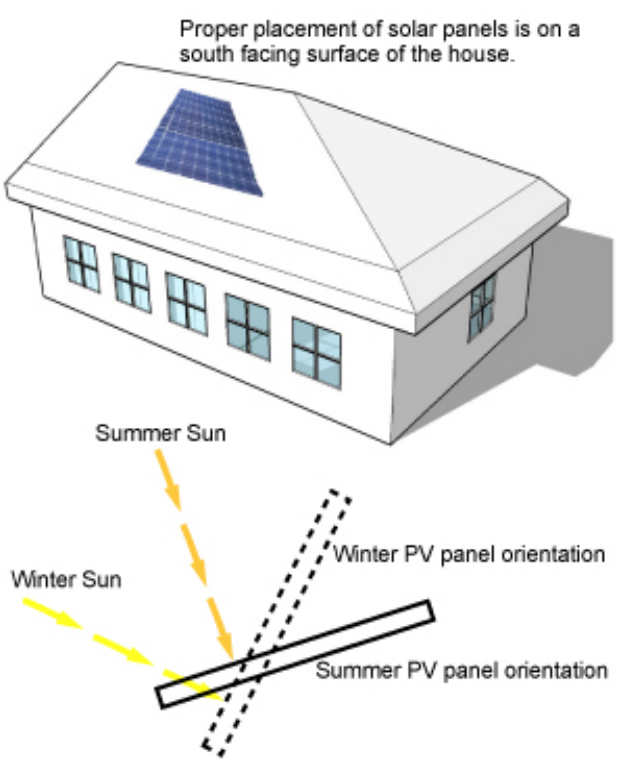
- Add a sun room on West-facing wall, if possible.

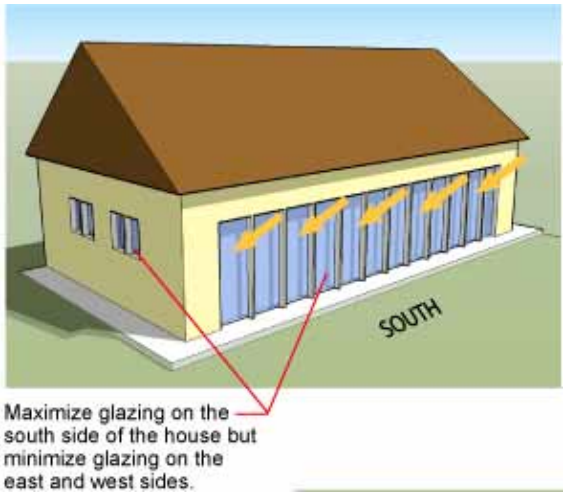
Windows

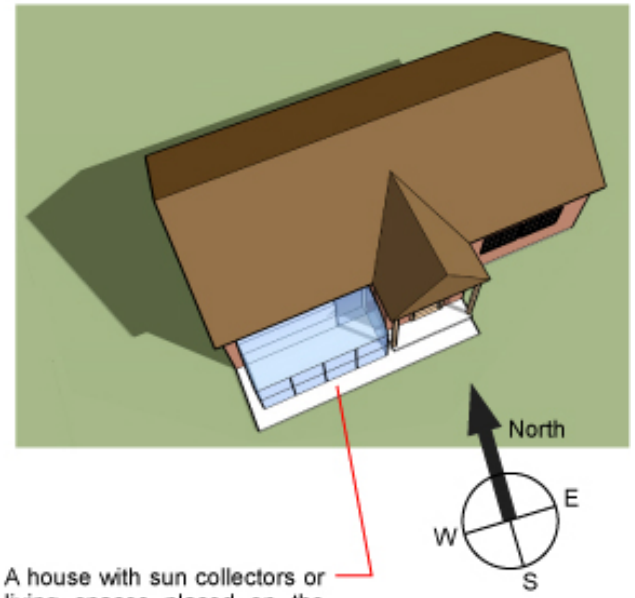
- Minimize operable windows facing Northwest into high-speed winds.
- Add plenty of South-facing windows and minimize North-facing windows.

Solar-Ready Rooftop

- The house should have at least 700sf of usable Southeast to Southwest facing roof for solar electric panels.







3.4 FOUNDATION, REPAIR

Fix Cracks in Foundation

- For cracks up to ¼” in exterior foundation walls, seal with cement grout or epoxy injection. If cracks come back, then it might be a settlement issue and need foundation repair by a foundation expert.
- For cracks larger than ¼” or deep cracks that may or may not be load-bearing, contact a foundation expert to assess the work that would need to be done.

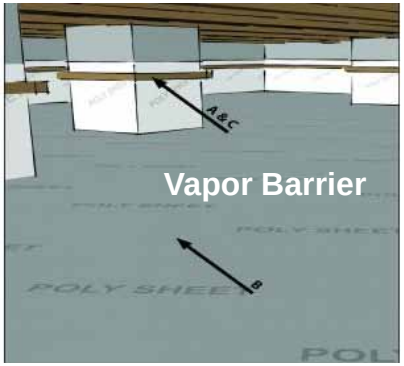
Solution: Epoxy injection

Example: Foundation crack of potential concern

3.4 FOUNDATION, ALTERATIONS

Vapor barrier

- Cover entire crawlspace floor with a durable ***6 mil thick plastic sheeting***
    1. For proper installation, overlap the sheets, pin them to the ground, seal the seams with tape and then apply mastic over the tape. Next, carry the vapor barrier up the foundation wall above the level of the exterior soil.



Air Barrier and Insulation

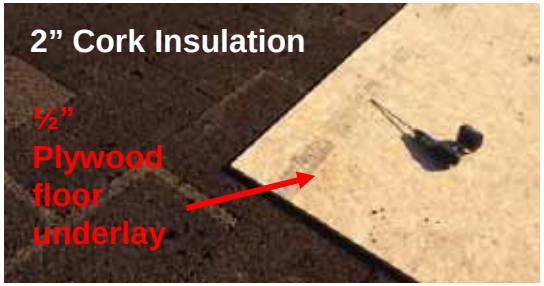
- Seal all floor joist above crawlspace with ***open-cell spray foam*** insulation
    1. Install open-cell foam with a thickness layer of at least 5” in between all floor joist above the crawlspace

Structural Pest Control

- Use Structural Pest Controls on Interior and Exterior spaces
    1. Add corrosion-proof ***rodent/bird screens*** for openings that cannot be caulked and/or sealed
    2. Seal entire building envelope to keep out unwanted pests
    3. Keep wood siding at least ***12 inches above the soil*** to ensure no pests (termites) will reach the wood siding

Floor Insulation

- Add at least R-4 insulation to the floor under the floor joists or above.
- For above-floor installations (recommended), ***add 2” cork insulation to R-4*** below a ½” plywood flooring underlayment.

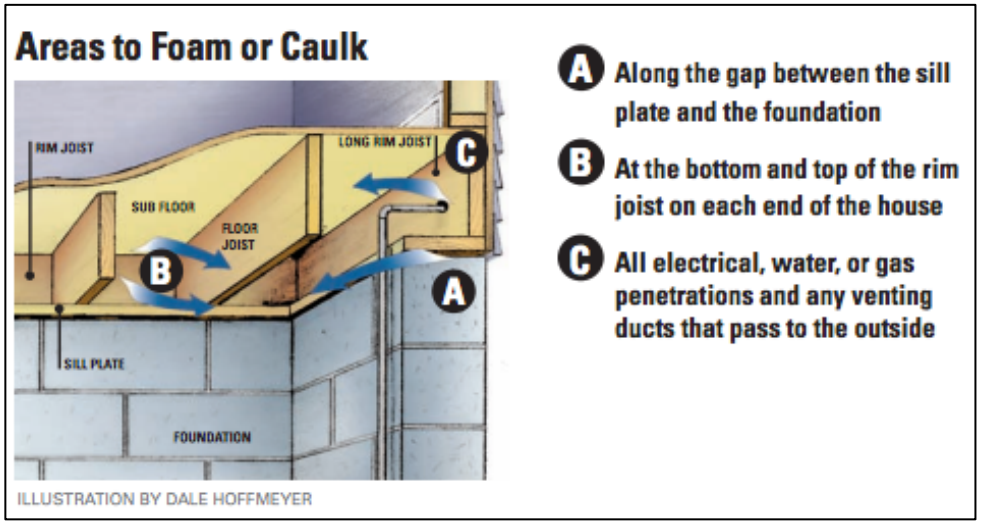


3.5 WALLS, AIR-SEALING

- **Air seal above-grade cracks, gaps, and intersections adjacent to conditioned space to minimize air leakage.**
  - Air seal between the sill plate and the sub-floor with caulk, foam, or an equivalent material
  - Air seal the bottom and top of rim joists on each end of the house
- **Add sealants around vents and flashing.**
- **Seal all gaps and holes with caulk or spray foam to air seal the home.**
  - Caulk is best for sealing gaps or cracks that are ¼ inch or less.
  - Spray foam is best to fill gaps from ¼ inch – 3 inches.
  - Seal penetrations like holes for wires, water supply pipes, water drain pipes, etc.

Sealed above-grade sill plates

Un-sealed sill plates



3.5 WALLS, INSULATION

R-21 Wall Insulation

Add insulation to existing walls to achieve **R-21 walls** by choosing ***one of the following*** methods:

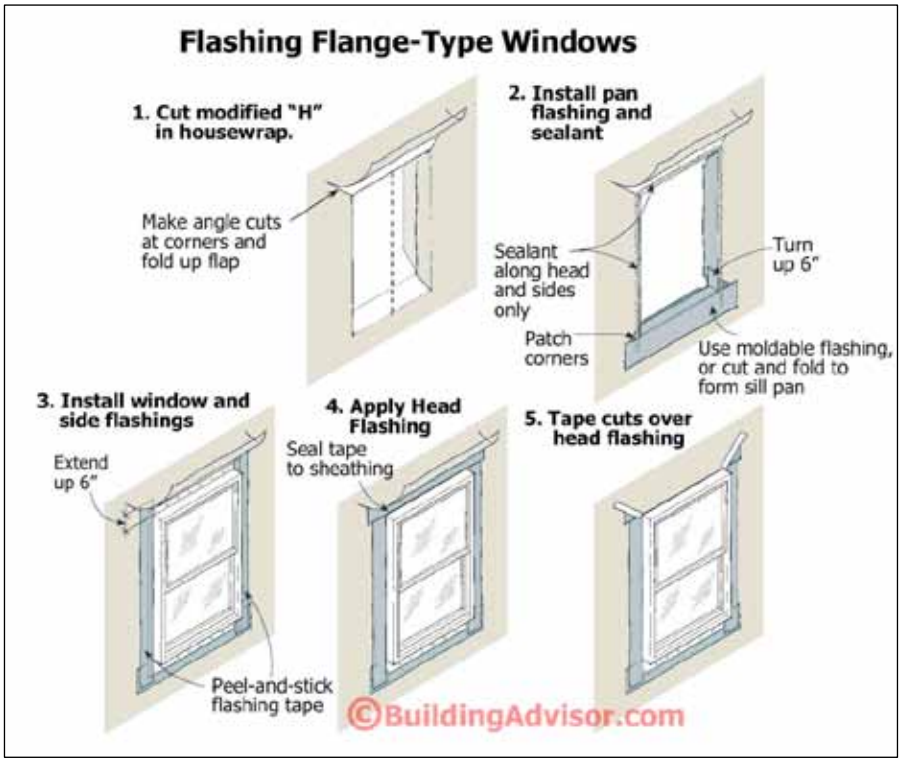
- Interior: Add R-8 interior wall insulation with 2” cork siding applied to the interior walls
- Add recycled-cotton batt insulation to wall cavity to achieve R-21 walls
- Exterior: Add R-8 exterior wall insulation beneath siding, if siding is damaged beyond repair and needs to be replaced

Exterior Cork Siding

Recycled Cotton batt insulation

3.6 WINDOWS AND DOORS, CODE MINIMUM

- **If windows are being replaced; make best effort to keep glass and reframe with pine-framed windows**
    1. Add flashing under window sill and keep a continuous seal to the vapor barrier
    2. Ensure a continuous sealant of flashing and insulation around window frame
- **If glass is damaged or the entire window must be replaced:**
    1. Use solid-wood window framing. Paint and maintain wood window frames or use fiberglass exterior cladding.
    2. Passive solar-friendly insulated windows with a U-Value = 0.30 or less, SHGC=0.5 or more.
        - No low-e coating on the windows, which increases heating loads by blocking the warming effect of sunlight and disrupts natural sleep by blocking infrared radiation
- **If windows are not being replaced,**
    1. Use solid-wood window framing. Paint and maintain wood window frames or use fiberglass exterior cladding.
    2. Seal the perimeter with a no-VOC caulk sealant



3.6 WINDOWS AND DOORS, RECOMMENDED PRODUCTS

Recommended Product		Product Brand and Source
Furnishings	LouverShade (Light harvesting window cover)	Louver shade (CA)
Doors	Graham Serenity Wood Door, Graham Serenity Wood Door, Malman Serenity Wood Door, Malman Thermal Fused Door, Fiberglass Reinforced Polyester Door (FRP)	ASSA-ABLOY (Iowa, USA)

3.7 CEILING AND ROOF, CODE MINIMUM

Roof, Code Minimum

- ***Class D*** "High wind speed" shingles for peak 90mph winds: Tested to ASTM D3161
- ***Dark colored shingles*** to keep the house warm in the winter, such as CertainTeed "Patriot" shingles
- Cover all penetrations with ***flashing*** (Recommend copper flashing)
- ***Add sealants around vents and flashing***
- **Attic hatch door shall have R-49 insulation**

Attic Ventilation

- Attic must have sufficient ventilation:
  1. 1/150 method used to provide adequate amount of ventilation.
  2. Attic space is 1600 square feet, approximately 10.7 square feet of vents is required

3.7 CEILING AND ROOF, INSULATION

Attic Insulation

- Attic insulation to be at least R-49 insulation. Use either eco-friendly batt insulation or naturally eco-friendly blown-cellulose insulation, at least 15.3 inches thick.
- Attic hatch door to have R-49 insulation
- Add a styrofoam baffle or a piece of cardboard to act as a baffle, which will allow airflow and prevent ice-damming in the attic.

Access Hatch, with Deck, Fully Blown to R-49.

Blowing cellullose insulation to R-49 in attic

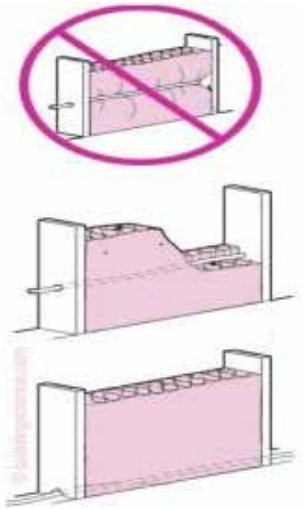
3.8 FLASHING AND MOISTURE CONTROL

- Flashing to be installed underneath roofing materials to prevent moisture from traveling through the building joints.
- Properly flash all roofs, windows, doors, utility penetrations, deck connections to the structure, and any other joints where water may enter the home.
- Water should naturally flow away from the building through the use of overhangs, downspouts and sloped yards.
- Flashing to be installed properly on all penetrations and joints such as windows, doors, siding, roofing, roof valleys, decks, sill plates, railings, balconies, chimneys, pipes, vents and utility penetrations.

Quality Insulation installation

- Gently wrap an even layer of recycled cotton batt insulation on all external walls, with no gaps or compressed areas.
- Add blown-in cellulose insulation to the attic spaces or add a continuous, even layer of recycled cotton batt-insulation, with no gaps or compressed areas.
- Pre-cut batt insulation to fit wall cavities, sliced to fit around wires, pipes, and any other wall obstructions.

Component	Code Minimum R-Value
Walls	**R-21 + R-8**
Slab	**R-8**
Attic	**R-49**



4 HVAC

4.1 Code Minimum

4.2 Ducts

- Quality installations
- Duct sealing

4.3 Heating

- Option 1
- Option 2
- Option 3 Multifamily /Commercial

4.4 Whole House Ventilation

4.6 Air Balancing

4.7 Controls

4.1 CODE MINIMUM

Generating heat for Tribal ZNE homes is best done with a heat pump water heater, the same device that will also heat the domestic hot water. A heat pump water heater produces heat efficiently, and more importantly stores it in an insulated tank for use when the sun goes down. The heat energy is then best delivered with a hydronic fan coil through insulated ducts, with the balanced ventilation system exhausting air through an Energy Recovery Ventilator to recapture ~25% of exhaust heat.

Water heating is discussed in the HVAC section because in the ZNE homes, the water heaters act as thermal batteries, storing energy overnight with heat gained during the day that can be used for water or space heating in the home. High temperature heat pump water heaters can store water up to 180°F to hold energy in water rather than a traditional electric battery. When this system is combined with a thermostatic mixing valve, no water exiting the tank will be above 120°F, keeping residents safe from scalding. These high temperature thermal batteries are a fraction of the cost of electric batteries and will help maintain a balanced micro-grid, creating community-wide energy sovereignty.

During low-power events when the micro-grid is stressed, residents will be able to turn off their water heaters and use stored energy for at least 12 hours to supply air and water heating, making a more flexible energy balance for the micro-grid.

EXISTING COMPONENTS	ALTERATIONS	ALTERATIONS CODE MINIMUM
Ducts	**Duct Insulation**	**R-4**
Gas Furnace	**Heat Pump with ducted fan coil**	**HSPF 12+, SEER 19+**
Gas Water Heater	**Heat Pump Water Heater**	**GE Geospring Heat Pump OR Sanden CO_2 Heat Pump**
Ventilation	**Add Energy Recovery Ventilator (ERV)**	**1.0 Sone or Less**
Fireplace	**Ductless mini-split**	**HSPF 12+**
Radiant Flooring	**Disconnect existing boiler**	**None**

4.2 DUCTS

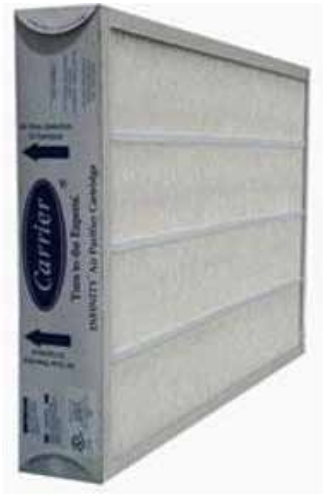
Locating the Ducts

- All ducts shall be located in ***conditioned space***

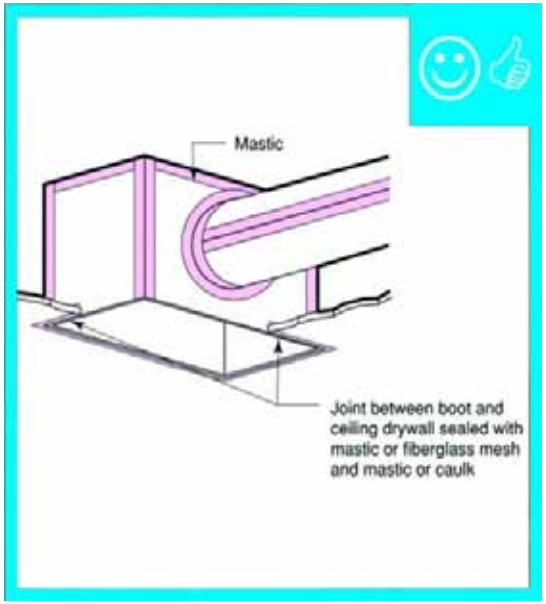
Installing the Ducts

- Use ***duct mastic*** on all duct joints, duct seams, and all return and supply ducts
    1. Duct mastic to be applied “as thick as a nickel”
- All ducts must have at least ***R-4 insulation***
- All duct systems sized according to ***ACCA Manual D*** (HVAC-D 5).
- Seal joint between boot and ceiling drywall with ***fiberglass mesh and mastic or caulk***
- Ducts shall be ***cleaned thoroughly*** prior to installing registers, grilles, and diffusers, and verify HVAC filters are new and clean.
    1. Bathroom and Kitchen: MERV 12 filters
    2. Main HVAC system: MERV 16 filters

R-4 Insulated Duct



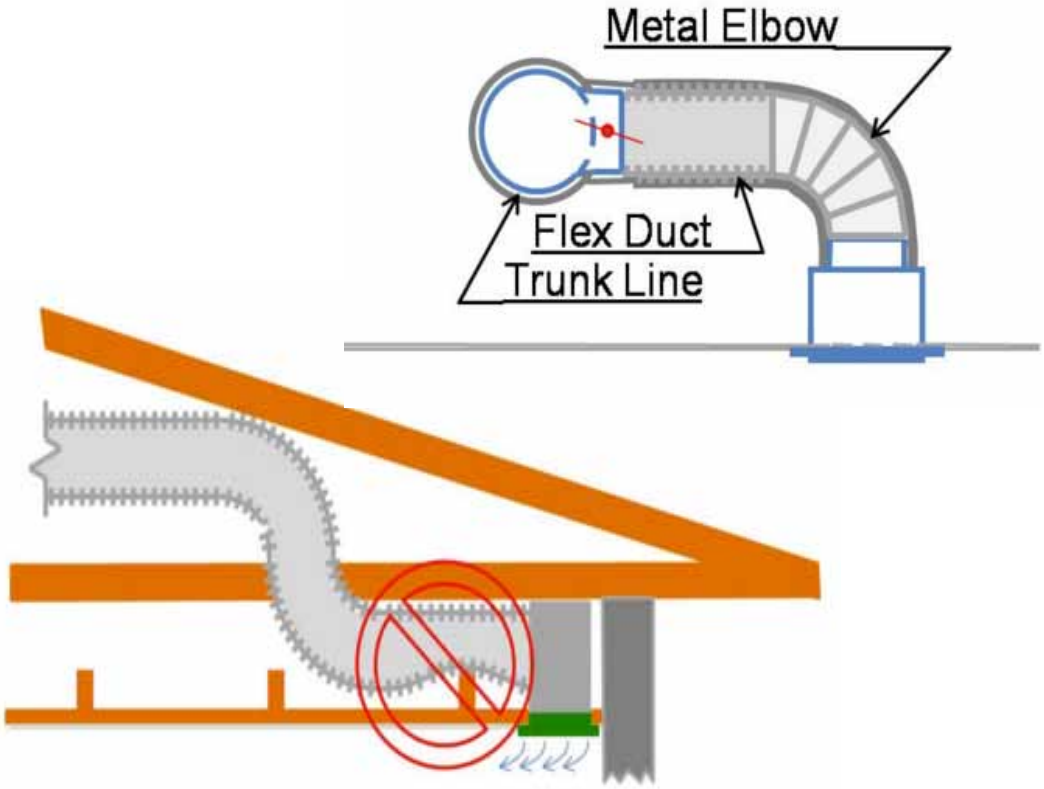
Merv 16 filter



Quality Duct Installation: Duct Mastic

4.2 DUCTS, QUALITY INSTALLATIONS

- **Install ductwork without kinks, sharp bends, or excessive coiled flexible ductwork in spaces that fit them without compacting them. This slows air flow and wastes energy.**
- **Support flexible duct at intervals:**
  - Install supports at a minimum of every 5 ft. to prevent sagging
  - Install support at least 1 in. wide, without compressing the ducts and the duct installation.
- **If there is fear of compressing the flex duct when making a 90-degree turn in a tight space, use a metal elbow**
  - Use a metal duct elbow instead of flex duct at boot connections to prevent compression



No excessive bends in flex ducts

4.2 DUCTS, SEALING

Create durable, airtight duct seams

- Before ducts are sealed, duct seams need to be mechanically fastened (using sheet-metal screws for galvanized ducts and compression straps for flex duct).
- To secure seams in round galvanized ducts up to 12 inches in diameter, use at least three #8 screws per joint. To secure ducts over 12 inches in diameter, use five #8 screws per joint.
- For securing joints in rectangular galvanized duct, use at least one #8 screw per side.
- Install mastic “as thick as a nickel.”
- Cracks or seams wider than 1/16 or 1/8 inches need to be repaired with fiberglass mesh as well as mastic.
- Don’t forget to seal collar connections between plenums and duct take-offs.

Seal joints in flex ducts

- The duct boot or coupling should be inserted at least 2 inches into the end of the ducts. The fitting should be attached to the inner sleeve or the flex duct with a drawband (clamp) or #8 screws.
- Seal the joint between the inner section of the duct and the fitting with high-quality mastic.
- Seal the exterior vapor-barrier sleeve with a drawband and tape.

Duct Quality Insulation: Duct Mastic

4.3 HVAC, OPTION 1

Code Minimum

- **HSPF= 12+**
- **SEER= 19+**

(2) Electric Heat Pump Water Heaters with high temperature heat storage functionality.

Tank #1 for Water heating, set to 140 °F - 180 °F, as needed for demand.
Tank #2 for Space heating, set to 180 °F, as needed for energy storage.

80+ gallons
Located in garage, install to manufacturers specifications.
Timeredtimed to run only during the day.period

Unico Air delivery and return Fan Coil Unit uses high speed and low volume delivery. Located in drop-ceiling or interior closet.

Energy Recovery Ventilator (ERV) recovers heat, energy and moisture. Located in drop-ceiling.

Install a MERV 16 filter, unless Manufacturers specifications say otherwise.

Highly efficient ceiling fan, located in the living room for cooling. Recommended Product: Big Ass Fan

4.3 HVAC, OPTION 2

Code Minimum

- **HSPF= 12+**
- **SEER= 19+**

(1) Sanden CO2 Water Heater with high temperature heat storage functionality and Heat Pump Compressor for space heating only.

Tank for Water and Space heating set to 180 °F, as needed for demand and energy storage.

80+ gallons
Located in garage, install to manufacturers specifications. Timeredtimed to run only during the day.period

Unico Air delivery and return Fan Coil Unit, uses high speed and low volume delivery. Located in drop-ceiling or interior closet.

Energy Recovery Ventilator (ERV) recovers heat, energy and moisture. Located in drop-ceiling.

Install a MERV 16 filter, unless Manufacturers specifications say otherwise.

Highly efficient ceiling fan, located in the living room for cooling. Recommended Product: Big Ass Fan

4.3 HVAC, OPTION 3, MULTIFAMILY / COMMERCIAL HVAC OPTION

Code Minimum

- Follow CEC values for COP values and temperatures proposed by AHRI for large heat-pump boilers, as follows:

Outside air temp	COP	Water Temperature
17	1.95	120
47	2.65	120
100	3.5	120

*For DHW use, the unit must also be able to produce hot water when the air temperature is 100°F.

Recommended: Aermec system to provide Heating and Air Conditioning and Water Heating for all. It is an air to water heat pump and can be sized up to hundreds of tons.

Alternatively, the Panasonic City Multi R2 high temperature model can be used to handle the energy loads. It is an air to refrigerant heat pump and increases in 10-ton increments.

4.4 VENTILATION, WHOLE HOUSE

Whole House Ventilation Code Minimum

- HVAC equipment efficiency rating shall be greater than SEER= 19
- Install Low Sone Supply and Exhaust fans, 1.0 Sone or less
- Energy Recovery Ventilator (ERV)
  - A spot energy recovery ventilator (ERV) recovers heat, energy and moisture.
  - Not to be installed into any bathrooms or kitchen of the home to ensure moisture control within the system.

MERV 12 Filter Box

Living Space	1,920 (ft^2)
Bedrooms	3
Air flow required (cfm)	49.2
System air flow (cfm)	200

ASHRAE 62.2-2007:
[Conditioned Area / 100] + [(7.5) * (Number of Bedrooms+1)]

Required CFM ASHRAE Standard and the supplied air flow

Recommended Product		Product Brand and Source
Whole House Ventilation	Energy Recovery Ventilator (ERV)	Panasonic Whisper Comfort Sport FV-04VE1

4.4 VENTILATION, BATHROOM AND KITCHEN

Ventilation Code Minimum

- Local mechanical exhaust ventilation is forced outdoors in the Bathroom and Kitchen, meeting ASHRAE 62.2.
- Install vent fans in Kitchen, Bathroom and Laundry room.
- Install vents in gable ends or a combination of soffit and ridge vents.

Bathroom:

- "Panasonic WhisperGreen", or equivalent exhaust fan.
- Air sources fed through a filter box with a MERV 12 filter prior to being ducted into the bathroom.
- Bathroom exhaust fans shall have an exhaust rate of at least 50 CFM.

Kitchen:

- "Broan Elite RM50000", or equivalent range hood that is vented directly to the outdoors.
- Ducting is split into a T joint, where air is blown underneath the kitchen cabinet through a 3 x 12 inch rectangular duct and a 5 inch in the ceiling.

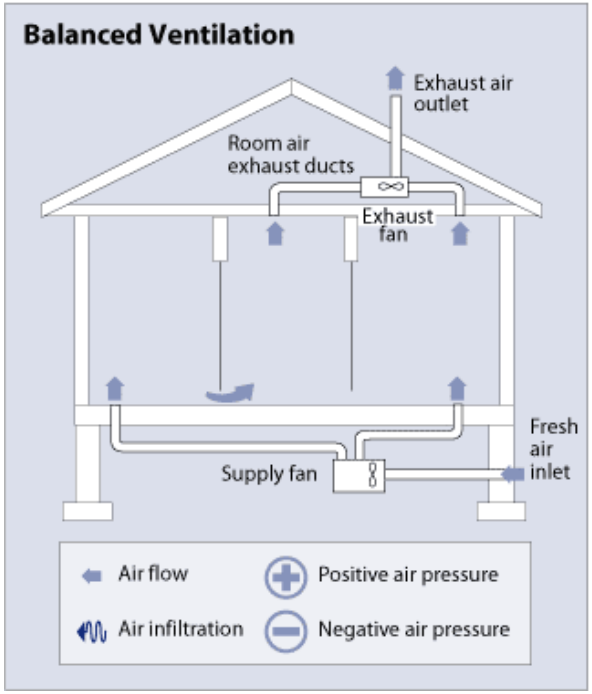
4.5 AIR BALANCING

EnergyStar

ASHRAE 62.1-62.2

Pressure Balance Options:

- Bedroom pressure –balanced using any combination of transfer grills, jump ducts, dedicated return ducts, and/or undercut doors to achieve a Rater measured pressured differential ≤ 3 Pa



Ducted Returns

Guide describing how to install ducted returns to provide conditioned air to all parts of the house and return stale air to the furnace for reconditioning.

Transfer Grilles

Guide describing how to install transfer grilles at each bedroom ensure a continuous flow of heating and cooling even when the doors are closed.

Jump Ducts

Guide describing how to install jump ducts at each bedroom ensure a continuous flow of heating and cooling even when the doors are closed.

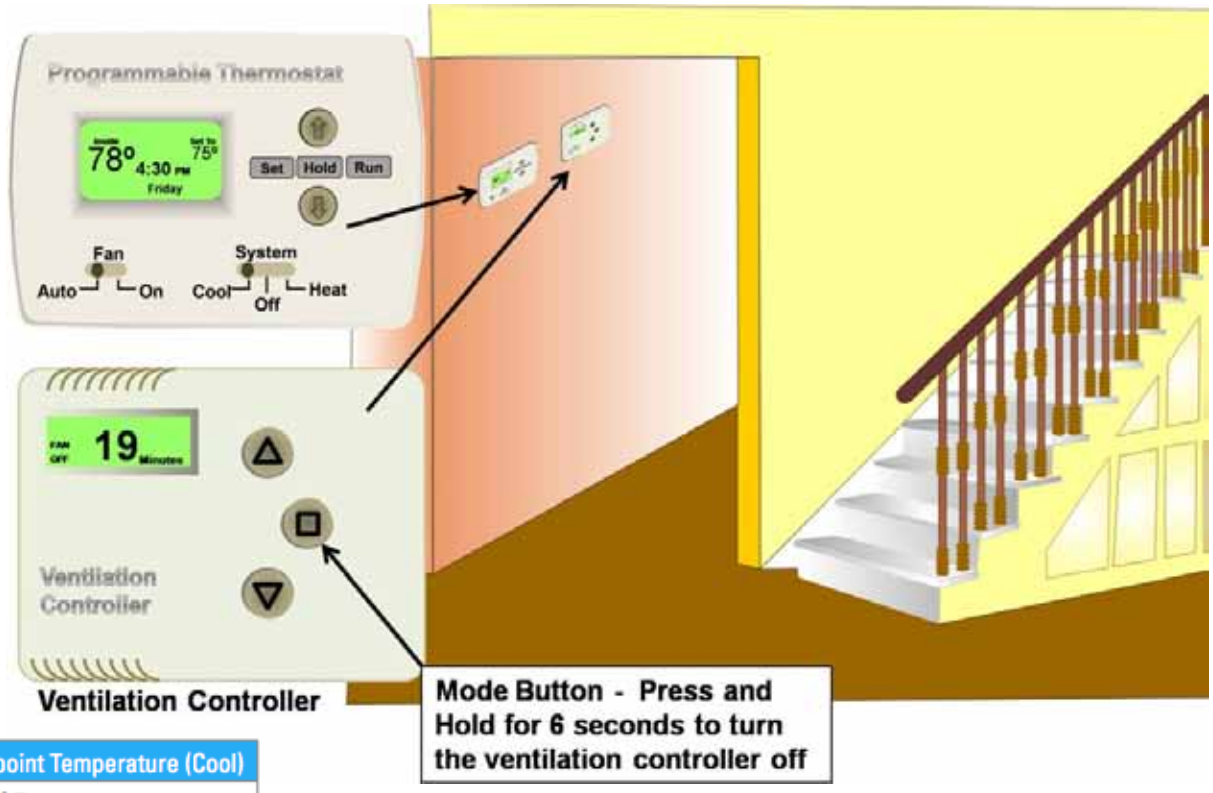
Undercut Doors

Guide describing how to cut the doors at each bedroom ensure a continuous flow of heating and cooling even when the doors are closed.

4.6 CONTROLS

- **Programmable thermostat**
  - Install Energy Star rated programmable/ setback thermostats in the hallway with recommended temperature for heating and cooling season.
- **Carbon Monoxide (CO) and Volatile Organic Compound (VOC) overrides**
  - Install controls that regulate fan speed based on the level of VOC and CO concentration in a space to promote Indoor Air Quality.
- **Clearly label ventilation controls for occupants with Energy Star recommended temperatures (pictured below)**

Greenheck VOC Controls

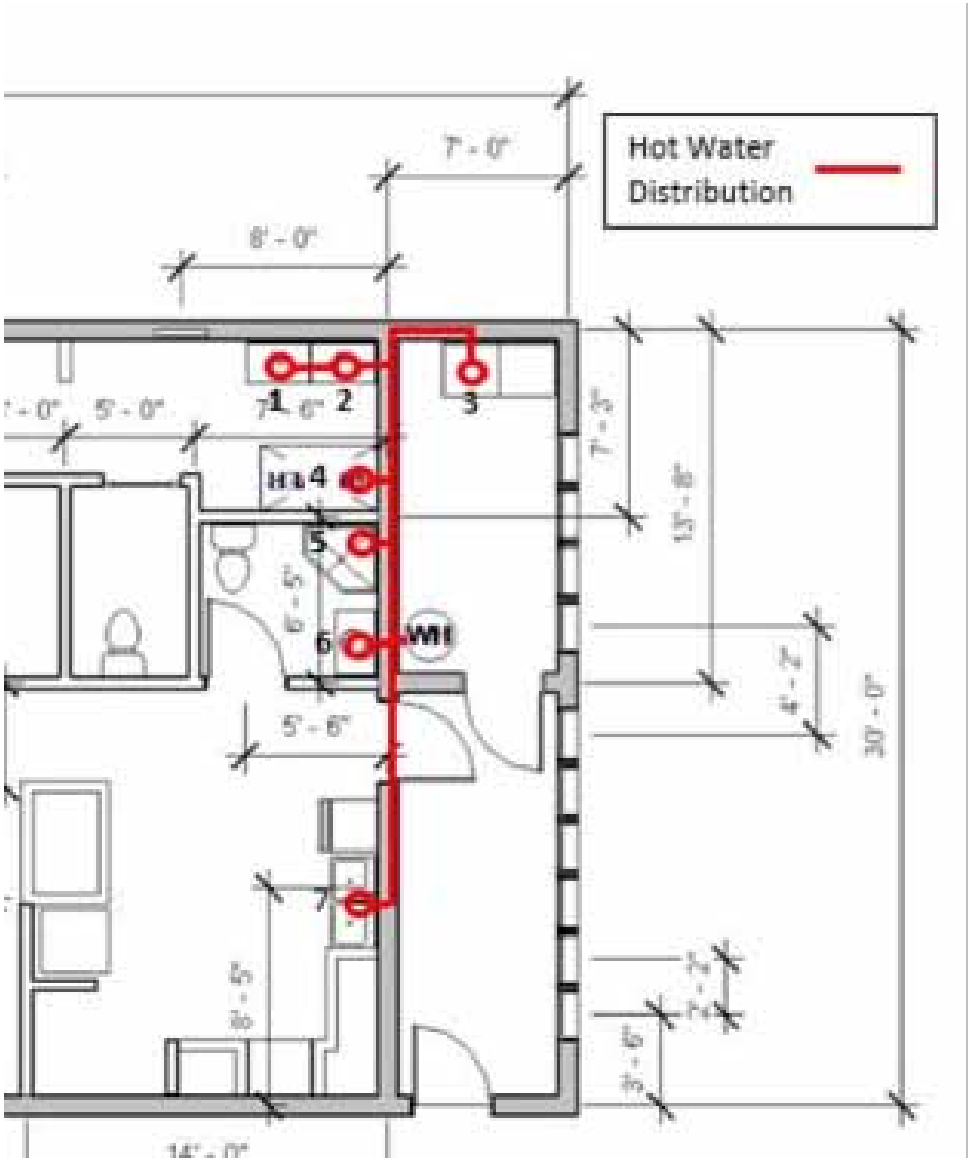


Setting	Time	Setpoint Temperature (Heat)	Setpoint Temperature (Cool)
Wake	6:00 a.m.	< 70° F	> 78° F
Day	8:00 a.m.	Setback at least 8° F	Setup at least 7° F
Evening	6:00 p.m.	< 70° F	> 78° F
Sleep	10:00 p.m.	Setback at least 8° F	Setup at least 4° F

5 PLUMBING

5.1 Code Minimum

5.2 Efficient Fixtures



5.1 CODE MINIMUM

- Water use and release from homes must work in harmony with the natural flows of the site and its natural environment and 100% of the projects water must come from rainwater catchment or from closed loop water systems, purified without the use of chemicals.
- All stormwater and water discharge, including grey and black water must be treated onsite and managed through re-use, closed loop system, or infiltration.
- If replacing, all new hot water pipes must be 3/8” to reduce wasted hot water with 1” R-4 insulation around the pipes.
- If rebuilding house, ideally all hot water fixtures should be located near the Water Heater tank (example below) to reduce wasted hot water in transit.

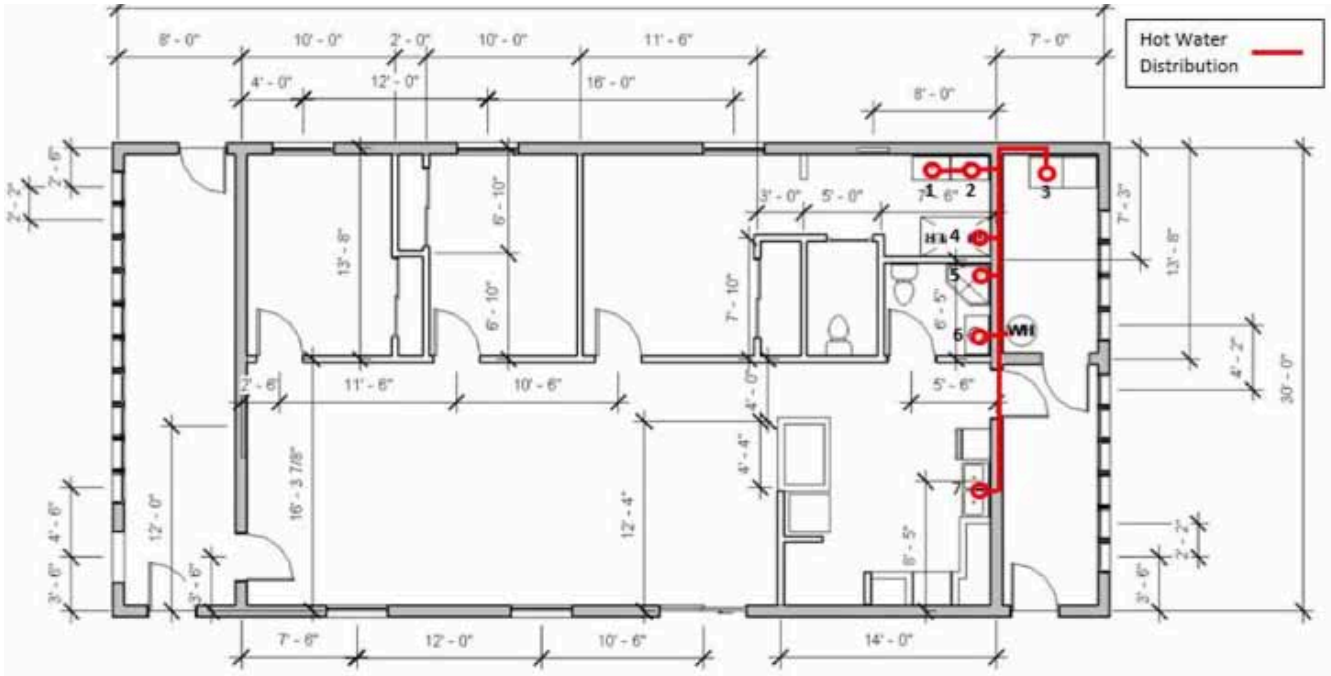


Figure 24. Hot water distribution layout

#1-7: Hot water fixtures

5.2 EFFICIENT FIXTURES

Bathroom sink faucets

- WaterSense Labeled, Less than 1 gpm.

Kitchen sink faucets

- Swivel aerator with a pause valve.

Shower head fixture

- Evolve 1pgm or less.

Toilets

- ToTo brand 1.28 gpf or less, PVC-free.

Recommended Product		Product Brand and Source
Toilet/Water Fixtures	Eco Drake 1.28 gpf Toilet, PVC-Free	TOTO USA (Georgia)

6 LIGHTING AND APPLIANCES

6.1 Code Minimum

6.2 Built-In Entertainment

6.3 Controls and Energy Monitors

6.1 LIGHTING AND APPLIANCES, CODE MINIMUM

- Replace appliances for only EnergyStar rated lights and appliances such as refrigerators, dishwashers, clothes washers and bathroom fans.
- For Cooking, replace all cooking stoves with Induction Stoves**.**





APPLIANCE	ENERGY STAR MIN. STANDARD (EFS=Exceeds Federal Standard)	BEYOND ENERGY STAR
Refrigerator	EFS by 20%	Frigidaire & Miele models EFS by up to 33%. SunFrost RF-12 (locally manufactured) EFS by 46%
Dishwasher	EFS by 41%	Bosch & Asko models EFS by over 141%
Clothes washer	EFS by 37%	Whirlpool, LG, Samsung models EFS by over 110%

6.2 BUILT-IN ENTERTAINMENT EQUIPMENT

- Built-in entertainment centers shall be installed in the living room of every home to promote the use of Energy Star Televisions and Built-in speakers.

Samsung
UN58H5005AF, UN58H5202AF

MSRP	$799.99
Screen Size	58
Resolution	1920 x 1080
Display Type	LCD
Automatic Brightness Control?	Yes
Annual Energy Use (kWh)*	70
Annual Cost to Operate**	$8

Features:

- Full HD 1080p Reveals a More Stunning TV Experience
- Enjoy the Details in Fast Moving Images with Clear Motion Rate 120
- Experience a Better Color Spectrum with Wide Color Enhancer Plus

Samsung
UN55J6200AF, UN55J6520AF

MSRP	$699.99
Screen Size	54.64
Resolution	1920 x 1080
Display Type	LCD
Automatic Brightness Control?	Yes
Annual Energy Use (kWh)*	69.3
Annual Cost to Operate**	$7.97

Features:

- LED TVs perform well in all lighting conditions
- 1080p resolution for stunning HD images
- Motion Rate 120
- Smart TV delivers a huge world of entertainment
- ConnectShare Movie
- Intelligent energy management

Energy Star Televisions

6.3 CONTROLS AND ENERGY MONITORS

LIGHTING

- Install light switch dimmers on interior lights.
- Install motion sensors on outdoor lights that automatically turn on when people walk by the home and automatically dim to low light levels when no motion is sensed. Connect these lights with photocell sensors that automatically turn on when the sun is setting and turn off when the sun is rising.

ENERGY MONITORING

- Install *Canary Instruments* Energy Monitor, or equivalent, in common area of each home to visualize real-time home energy consumption.

7 HEALTH AND MATERIALS

7.1 Code Minimum

7.2 Red List Materials

7.3 Wood Products

7.4 Entryway Design

7.5 Non-Toxic Paint

7.6 Finishes, Caulks, Sealants

7.7 Thermal and Moisture Control

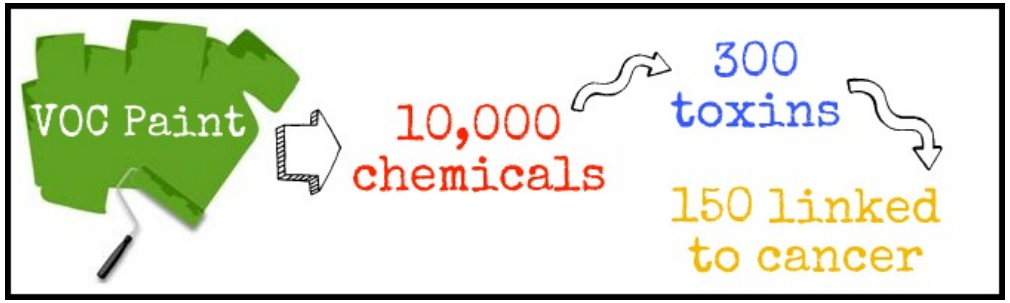
7.8 Flooring

7.9 Pest Control

7.10 Recommended Product List

7.1 HEALTH, CODE MINIMUM

- No-VOC Paints to be used in construction.
- No Formaldehyde products to be used in construction.
- Design to comply with ASHRAE 62.2, and Balance air systems within 25% of ASHRAE standard.s
- Results from Indoor Air Quality test must pass before occupancy and nine months after occupancy.
- Smoking is prohibited with the project boundary.
- Do not install building materials with visible signs of water damage or mold.
- Do not enclose interior walls when insulation or framing members have high moisture content.
- Install a corrosion-resistant drain pan properly draining to a conspicuous point of disposal.
- Use corrosion resistant fasteners and hardware stainless steel, hot-dipped galvanized, and ceramic-coated products.
- Reference the International Living Futures Institute Declare Products Database for approved products to be used in Construction that include transparent product ingredients, source, and recyclability ratings (***https://living-future.org/declare-products***)



7.2 RED LIST MATERIALS

- Materials will be found on the “Declare Products” Database. This database provides the chemical content of each product provided by the manufacturer to keep harmful toxins out of the home.
- The following “Red List” contains a list of (11) materials, chemicals and elements known to pose serious risks to human health and the natural environment. For this reason, these materials shall not be purchased for the project.

- Alkylphenols
- Asbestos
- Bisphenol A (BPA)
- Cadmium
- Chlorinated Polyethylene and Chlorosulfonated Polyethlene
- Chlorobenzenes
- Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs)
- Chloroprene (Neoprene)
- Chromium VI
- Chlorinated Polyvinyl Chloride (CPVC)
- Formaldehyde (added)
- Halogenated Flame Retardants (HFRs)
- Lead (added)
- Mercury
- Polychlorinated Biphenyls (PCBs)
- Perfluorinated Compounds (PFCs)
- Phthalates
- Polyvinyl Chloride (PVC)
- Polyvinylidene Chloride (PVDC)
- Short Chain Chlorinated Paraffins
- Wood treatments containing Creosote, Arsenic or Pentachlorophenol
- Volatile Organic Compounds (VOCs) in wet-applied products[22]

7.3 WOOD PRODUCTS

- At least 50% of all structural wood used on each home shall be sustainably harvested from local sources and/or FSC-Certified wood.

Additional Recommended Products		Product Brand and Source
Wood	REII Landscaping Fence	The Reuse Everything Institute (Pennsylvania)
Wood	Nordic Joist, Nordic Lam, Nordic X-Lam	Nordic Engineered Wood (QC, Canada)

7.4 ENTRYWAY DESIGN AND SHOE STORAGE

- At the entryway of each home, design a built-in shoe rack to reduce the likelihood of tracking contaminants into the home. The design on the left can be a simple add-on, where the honeycomb design on the right is a more custom built-in storage option inspired by nature.

7.5 NON-TOXIC PAINT

PAINT:

- Use No-VOC *Milk Paint* throughout Interior and Exterior of the home. The definition “Zero-VOC” still allows products to contain 5 grams of toxic chemicals or every liter of product, but Milk Paint truly contains No-VOC’s.
- Local milk (i.e. Humboldt Creamery) is recommended.

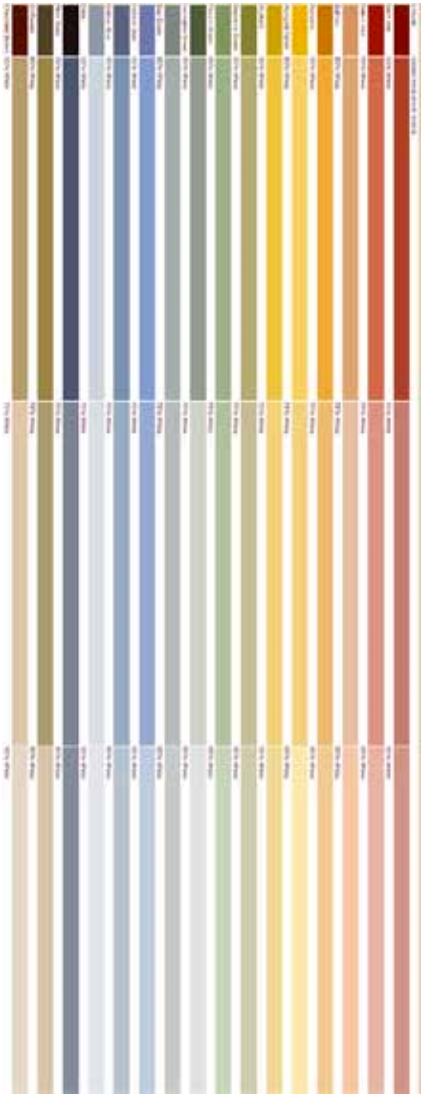
The Genuine Old-Fashioned Home-Made MILK PAINT

*Naturally **safe** Historic Paints since 1974*

ADVANTAGES	
Produces an authentic Colonial or Shaker finish	Adheres to almost all clean, porous surfaces
Environmentally safe, non-toxic and anti-bacterial	Non-flammable
Dead flat finish.	Solvent free
Fast drying	Odorless when dry
Comes in deep rich colors	Longest lasting paint known
Colors can be blended, by the user, to produce many tints and shades.	Permanent colors; will not fade
Easily cleaned up with water	

PHYSICAL CHARACTERISTICS	
Color: Comes in sixteen historical colors. Also available as a translucent base to which pigment can be added for an infinite variety of hues, tones and shades.	**Non-Flammable**
State: Dry Powder	**Non-Combustible**
Mixing Medium: Water	**Environmental Safety**: Biodegradeable and non-toxic
Mixing Temperature: Mixes best with warm water	**Thinner**: Water
VOC's: None - entirely solvent free	**Clean Up**: Soap and Water
Odor: Faint milky odor when wet, odorless when dry	**Drying Time**: Dry to the touch, 30 mins To re-coat, wait two hours. Cures and hardens over time.
Shelf Life: In sealed bag, indefinitely. As liquid, overnight, seal and refrigerate.	

AVAILABLE SIZES		
one pint	6 oz. powder, plus water	covers approximately 35 square feet
one quart	12 oz. powder, plus water	covers approximately 75 square feet
one gallon	48 oz. powder, plus water	covers approximately 300 square feet



7.6 FINISHES, CAULKS AND SEALANTS

CAULKS AND SEALANTS:

- Use Zero-VOC caulks and sealants throughout.

CABINETS, PARTICLEBOARD, ETC.

- Utilize third-party certified low-emission pressed wood materials that are designed to reduce human exposure indoors to individual VOCs.
    - Beware: Particle board and pressed wood materials commonly use formaldehyde. Purchase No formaldehyde products only.

Recommended Product		Product Brand and Source
Wood	Cabinets	Neil Kelly Cabinets (Portland,OR)
Wood	Collins Pine FreeForm Particleboard	Collins Companies (Oregon)

7.7 THERMAL AND MOISTURE CONTROL

- **Seal all homes with Low-VOC Joint and Seam Filler thoroughly to seal building envelope.**

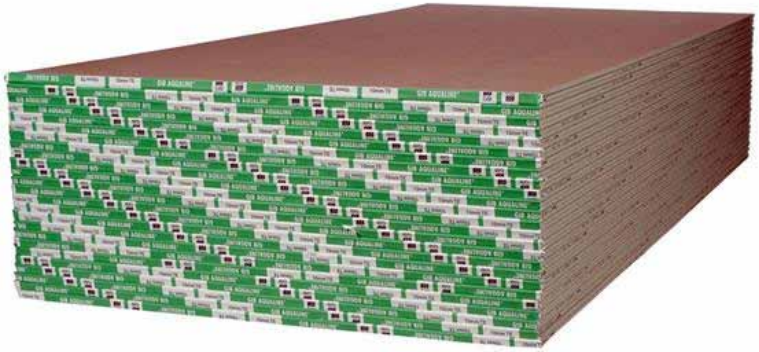
Recommended Product		Product Brand and Source
Thermal and Moisture Protection (Home Exterior)	WrapShield SA Self-Adhered System (A primerless self-adhered water-resistive vapor-permeable air barrier sheet membrane system with liquid flashing, 20 year warranty)	VaproShield (Chicago, USA)
Thermal and Moisture Protection	Prosoco R-Guard Joint & Seam Filler, FastFlash, Cat 5, AirDam, Cat 5 Rain Screen	PROSOCO (Kansas, USA)

7.7 MOISTURE CONTROL

- **BUILDING MATERIALS:**
  Do not install building materials with visual signs of mold.

- **BATHROOMS: Use *GIB Aqualine***
  Plasterboard product, or equivalent, 13mm on the bathroom walls for moisture-resistant backing materials under ceramic tile. If using a single fiberglass shower enclosure, there is no need for extra backing material.

- **BATHROOM TUB:**
  Provide an extra 4” of tile surrounding the shower enclosure to protect walls from future water damage.



Recommended Product		Product Brand and Source
Finishes	10mm, 13mm GIB Aqualine Plasterboard, GIB Braceline/ Noiseline Plasterboard (13 mm GIB Aqualine® is specifically designed for bathrooms, laundries and kitchens. Its water resistant core contains special polymers to help prevent moisture penetration.)	Winstone Wallboards (NZ)

7.8 FLOORING

- Use only resilient flooring throughout the home
- Entryways shall contain traditional designs chosen by the community by alternating shades of color in the installation (see example of bear River's Hotel hallway below)

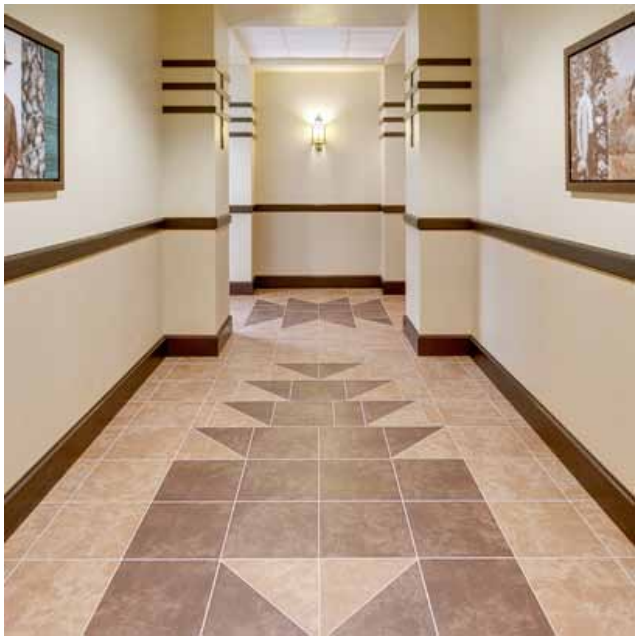
KITCHEN AND BATHROOMS

- Install Ceramic "Green Tile" in Kitchen and Bathrooms with Portland cement-based thin-set mortar and grout OR Marmoleum/ Linoleum sheet flooring with Low-VOC adhesive (Recommend Forbo i885m adhesive).

ENTRY, LIVING ROOM, HALLWAYS, BEDROOMS

- Install FSC-Certified locally milled Blue Pine wood with a natural beeswax sealant OR Ceramic Tile for Thermal Mass OR Cork Floors.

Soft wood Blue Pine Floors

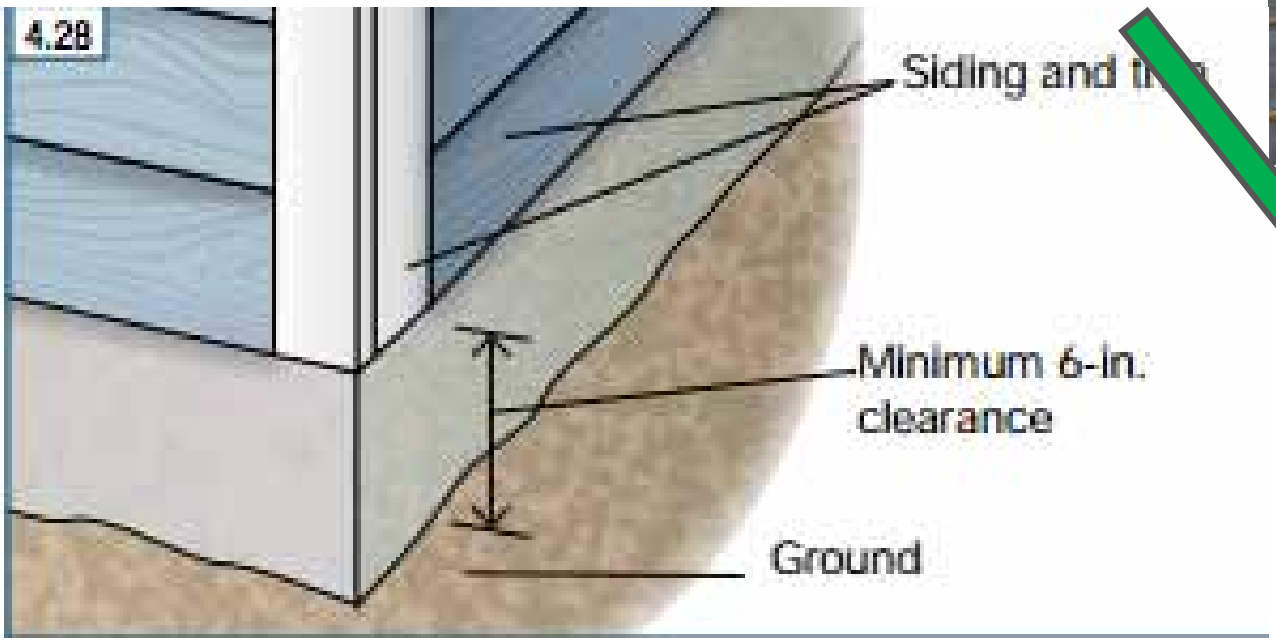


Bear River Rancheria Hotel tile design in hallway

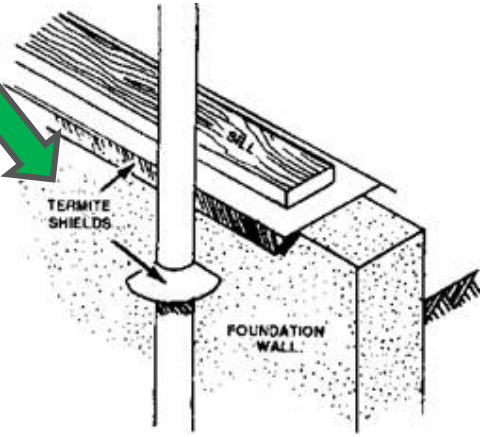
7.9 PEST CONTROL

- Seal all penetrations and joints between the foundation and exterior wall assemblies.
- Install corrosion-proof rodent/bird screens (e.g., copper or stainless steel mesh) for all building openings that cannot be sealed and caulked (e.g., ventilation system intake/exhaust outlets and attic vent openings).
- For additions, add Termite Shield around pipes and penetrations at the foundation level of the home to block termites from crawling up into the home.
- Wall Siding shall be no less than 6” above the ground level to keep wood from rotting and resist pest intrusion.

Termite Shields



Wall siding 6” above ground



Termite Shields

7.10 RECOMMENDED PRODUCT LIST

- **The following products are Approved Declare Products, and are recommended to be used in Existing Building's Retrofit Construction.**

Section	Product Type	Brand
Finishes	Exterior Oil	Natural House Company (NZ)
Finishes	ethos Modular Flooring, Powerbond ethos Cushion	Tandus Centiva (Georgia)
Finishes	EcoGrille (FSC Pacific Albus) wood ceiling panel, 1100 Cross Piece Grille/2100 Panelized Linear (FSC Hemlock)	9Wood (Oregon)
Finishes	ECOS WoodShield Interior Stain, Zero-VOC, ECOS WoodShield Satin Varnish, ECOS Interior Wall Paints	Imperial Paints (South Carolina)
Finishes	Linoleum Harmonium xf^2	Tarkett (Italy)

7.10 RECOMMENDED PRODUCT LIST

- **The following products are Approved Declare Products, and are recommended to be used in Existing Building's Retrofit Construction.**

Section	Product Type	Brand
Insulation (New construction, use unfaced)	EcoBatt Unfaced, Knauf Insulation IB Board	Knauf Insulation (USA)
Insulation (Attic for new construction)Finishes	GreenFiber Cellulose Insulation	US GreenFiber (USA)
Thermal and Moisture Protection	Havelock Wool Insulation	Havelock Wool (Nevada, USA)
Thermal and Moisture Protection	ENRGY 3 .E- Johns Manville Roofing Insulation Board	Johns Manville (Indiana, USA)

8 PERFORMANCE

8.1 Quality of Installation

8.2 Building Performance Verification

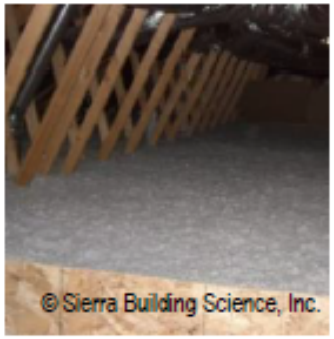
8.1 QUALITY INSULATION INSTALLATION

- **Verification of *Sealed building envelope* prior to exterior walls being enclosed.**
- **Verification of *quality of insulation installation* prior to interior walls being enclosed.**

Some components of QII to highlight include:

Sealing the Air Barrier: Seal all gaps around windows, doors, behind tubs and showers, etc. Caulk or seal all gaps in the air barrier greater than 1/8" with foam.

Correctly Sized Batts: Batt insulation should be cut to fit snugly at the sides and ends without gaps or buckling. It should not double over or be compressed and should be friction fit to cavities, or otherwise supported. Batt insulation should be split to fit around wiring or plumbing, and trimmed to fit around junction boxes.



Required U-factors (& associated R-Values equivalents) for Envelope Systems: Designers shall specify U-factors for assemblies shown in the Residential Appendix. Installers must follow specifications in order to meet QII requirements.

8.2 BUILDING PERFORMANCE VERIFICATION, PRIOR TO OCCUPANCY

- **Verification of *Sealed building envelope* prior to exterior walls being enclosed.**
- **Verification of *quality of insulation installation* prior to interior walls being enclosed.**
- **Building Envelope HERS testing to verify no more than *2.5 air changes per hour @50 psi* through the building envelope.**
- **HERS Blower Door Test to verify *duct leakage less than 6%.***
- **Supply and Return *air flow HERS testing .***
- **Mechanical Ventilation HERS testing for *refrigerant charge.***
- **Third party verification for rooftop *flashing.***

HERS Duct Blaster Test

HERS Blower Door Test

9.1 RENEWABLE ENERGY

9.1 Code Minimum for Homes

9.2 Energy Storage

Southern View of 25 MW Solar Farm

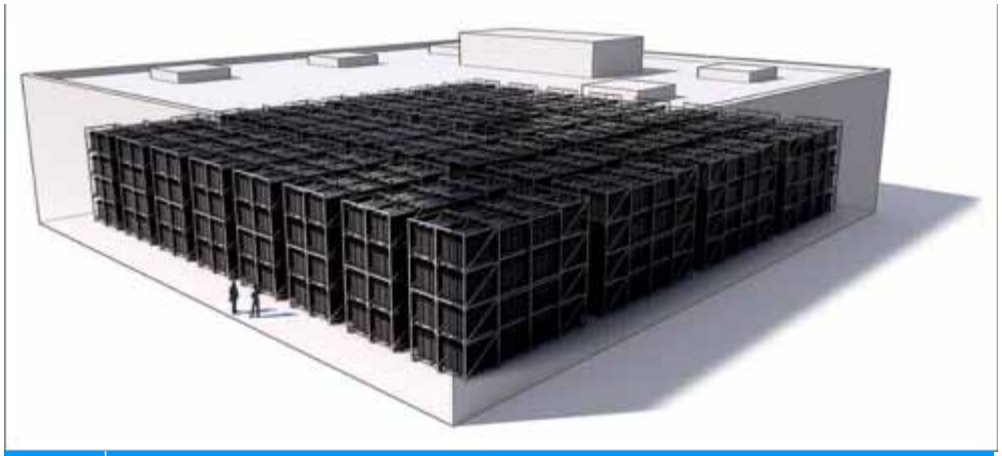
9.1 PV PANELS

- A 1,500 square foot house requires 12 kW's of PV to supply energy throughout the winter.
- The combined Aquion saltwater battery for each home must be sized to 11.5 kWh's.
- All Solar Panel and Roof Rack Installations shall be completed by Tribal Members after receiving proper training and certification through GRID Alternatives or a similar training and certification program.
- Install solar panels in a basket weave pattern along the hillside, much like the Wiyot baskets and basket cap designs. Is this a suggestion? Is this mandatory? Feels weird…

Elizabeth Conrad Hickox, Karuk (Karok) / Wiyot, 1872-1947, or Louise Hickox, Karuk (Karok), 1896-1967 Basket
About 1925
Wild grape root, myrtle sticks, hazel, maidenhair fern, yellow-dyed porcupine quills, and stag horn lichen

9.2 BATTERY STORAGE

The energy sovereignty Micro-Grid will work in conjunction with Aquion brand deep-cycle batteries for energy storage. The Aquion batteries are non-toxic, saltwater batteries, adaptable to commercial and utility-scale systems that could consistently carry the energy loads of Tribal Nations and communities.



Step 4	Determine Lifecycle cost of ownership				
Type	# Cycles	Wh Storage	Total Wh life of battery bank	Cost of Bank	Cost per kWh
Lead Acid	1500 x	27,789Wh	= 41.6MWh	$8,000	$0.19
Aquion AHI	3500 x	14,033Wh	= 49.1MWh	$8,400	$0.17

Aspen 48M Battery

The Aspen 48M is a parallel string of twelve Aspen 48S batteries configured as a single, palletized battery unit.
They can be connected in series up to 1,000 volts DC.

OPERATION & PERFORMANCE

Chemistry: Aqueous Hybrid Ion (AHI™)
Energy: 25.9 kWh (at a 20 hr discharge)
Cycle Life: 3,000 cycles (to 70% retained capacity)
Operating Temperature: -5 to 40°C ambient Certifications
Nominal Voltage: 48 V
Usable Depth of Discharge: 100%
Round Trip Efficiency: >90%

PHYSICAL CHARACTERISTICS

Dimensions: 1,159 x 1,321 x 1,504 mm (45.6 x 52.0 x 40.0″)
Weight: 1,504 kg (3,309 lbs)

CERTIFICATIONS

Cradle to Cradle Certified™ Bronze
UL recognition in process
CE marked

WARRANTY

Limited Warranty: 5-year full plus 3-year prorated

10 EDUCATION

10.1 Resident Education

10.1 RESIDENT EDUCATION

- **Install Energy Monitors in each home that will provide real-time energy information with immediate feedback to Residents on their energy use. We recommend the Canary Instruments/Nexi device that plugs into the wall outlet and changes colors to indicate High energy use (red), average (yellow) and conservative energy use (green).**
- **The Tribal Council shall provide Community Meetings for Tribal Members twice every month for the first 3-months of occupancy to educate home owners and renters on their new homes. Additionally, provide home owners and renters with a brief packet highlighting the same topics discussed in-person.**
    - Education and Training should include a brief presentation touching on the following topics:
        - Renewable energy, energy storage, HVAC and DHW equipment and how it is linked to energy storage and demand, HVAC controls, indoor air quality, and how to maintain the homes.

ENERGY SOVEREIGNTY BUILDING CODE

NEW CONSTRUCTION

TEMPLATE FOR COMMUNITIES IN CLIMATE ZONE 1, AS DEFINED BY THE CALIFORNIA ENERGY COMMISSION (CEC)

NOVEMBER, 2016

00 TABLE OF CONTENTS

00 EXECUTIVE SUMMARY

This Energy Sovereignty Building Code template was funded through a California North Coast Grant offered by the Strategic Growth Council, and issued with help from the North Coast Resource Partnership and the West Coast Watershed.

The Energy Sovereignty Building Code promises Zero-Net Energy (ZNE) homes and commercial buildings that help maintain a large interconnected and balanced micro-grid powered by solar and wind power for Tribal Nations located in the Pacific Northwest territories of North America. This Building Code was written based on the Best Practices in Sustainability, Performance, Health and Safety to create energy sovereignty for communities in the California Energy Commission (CEC) Building Climate Zone 1.

Zero-Net Energy (ZNE) means that a building or community creates as much on-site renewable energy as is consumed by the building or community over the course of one year. The all-electric micro-grid is entirely energy independent, fueled only by renewable energy, with on-site energy storage in non-toxic Aquion saltwater batteries.

The following Organizations directed many guiding principles you will find within this Building Code:

- **(BIG)Build It Green** Green Point Rated (GPR) New and Existing Construction Rating System
- **Energy Star** HVAC Manuals and Rater Checklist, Revision 8
- **(ILFI)International Living Futures Institute** Living Building Challenge Certification and Red List Approved Products Guide
- **(EPA) Environmental Protection Agency** WaterSense and Indoor Air Plus
- **(DOE) Department of Energy** Zero Energy Ready Checklist
- **Enterprise Green Communities** Multifamily Affordable Housing New and Existing Certifications
- **Samoa Green Home Guide**, Sean Armstrong, Danco Communities
- **Redwood Energy** Project Comparison of 8 Zero-Net Energy Affordable Housing Communities in CA, Climate Zone 1

00 JOB CREATION WITHIN THE BUILDING CODE

In an effort to promote local job/skills training and opportunities for Tribal Members, the Energy Sovereignty Building Code requires funding be set aside for a Job Training Program for Tribal Members.

- For all internal work, Tribal Members shall receive priority job opportunities in addition to extensive Green Building Training before construction crews can begin Construction.
- At least (10) Tribal Members should be recruited by the Tribal Council and given the opportunity to participate in an extensive ZNE Building Education Program for at least 1-year geared towards Job Training. Members will be trained and Certified to perform the Construction and PV installation work and long-term Maintenance duties for all components of the Building Code.

1 SITE AND DESIGN

1.1 Location and Home Size

- Site
- Wetlands
- Home Sizes

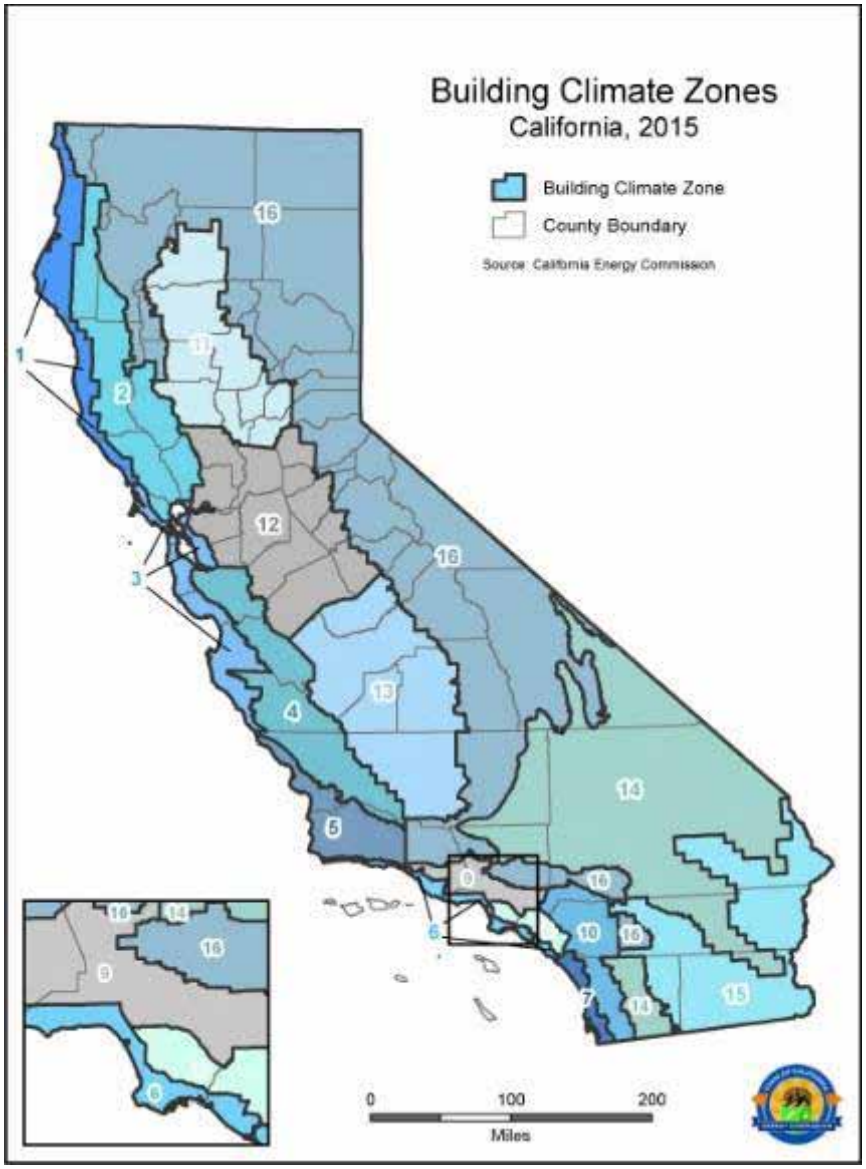
1.2 Stormwater and Infiltration

- Rain gardens

1.3 Waste Diversion

1.4 Permeable Hard Surfaces

1.5 Zero Net Carbon



1.1 LOCATION AND HOME SIZE

Site

- No buildings shall be built within the 100-year flood plain, as defined by the most current FIRM map published by FEMA, the Federal Emergency Management Agency of the U.S. government.

Wetlands

- Maintain at least 50' distance from the documented edge of a wetland. A wetland has the combination of obligate wetland species and redoxomorphic characters to the soil such as gleying (deep blue/grey color change) of soil and/or rust bits from consistent water-logging.

Single Family Home Size: Design all future construction homes no larger than:

- Studio = 500 square feet
- 1 Bedrooms= 750 square feet
- 2 Bedrooms= 1050 square feet
- 3 Bedrooms= 1,300 square feet
- 4 Bedrooms= 1,600 square feet

Multifamily Apartment Size: Design all future construction homes no larger than:

- Studio = 500 square feet
- 1 Bedrooms= 700 square feet
- 2 Bedrooms= 900 square feet
- 3 Bedrooms= 1,150 square feet
- 4 Bedrooms= 1,350 square feet

1.2 STORMWATER

Stormwater control and infiltration

Stormwater from imperious features (roof, sidewalk, etc.) shall be directed towards infiltration features and away from the foundation to prevent moisture damage. This can be accomplished by choosing one or more of the following:

- Rain gardens (gravel basin planted with wetland plants) –see next page for more details on Rain gardens
- Bioswales (a shallow, wide ditch planted with wetland plants)
- Detention ponds (a deep and wide infiltration basin)
- Living roofs on outbuildings such as the garage or on extended overhangs to provide bird habitat

Rain gardens utilize a natural, healthy soil profile with good infiltration rates of 1”/hour or more.

Bioswales help mitigate flooding by directing the water downhill and is used in place of traditional concrete gutters.

Detention ponds with filtration plants can help the water as it enters, sending clean water to the undergound aquifer.

Living roofs absorb rainwater, reducing the amount of runoff from a building. They require structural reinforcements and a super sealed moisture barrier.

1.2 STORMWATER- HOW TO DESIGN RAINGARDENS

Foundation Drainage towards Rain Garden

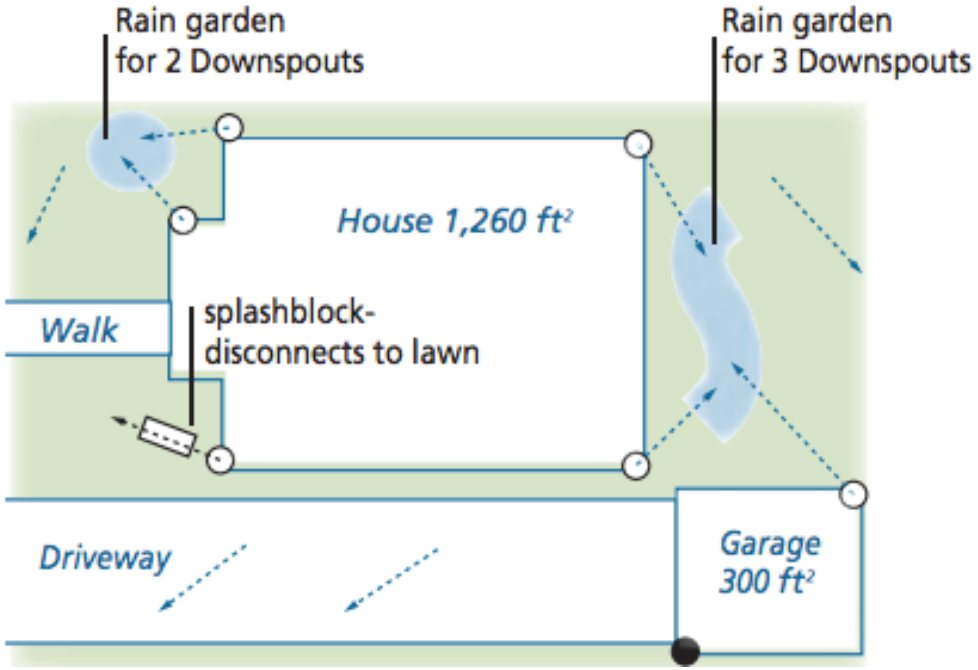
- Plan each home with built-in stormwater drainage to a rain garden.

To properly size a rain garden, follow the 10% rule, as shown below:

Make sure your rain garden is large enough to drain the water directed to it within 36 hours. This keeps water from stagnating and mosquitoes from breeding. Size your rain garden to be at least 10% of the area that drains to it.

* For example, if 500 square feet of rooftop drains to your rain garden, the rain garden should be at least 50 square feet.

roof area	*sizing factor*	*rain garden size*
500 sq. ft.	x 10%	= 50 sq. ft. (or 5′ x 10′)



1.3 WASTE DIVERSION

Construction and Demolition Waste

- **Provide a recycling bin for construction waste that can divert a minimum of 60% of construction materials as measured by volume or weight from the landfill. This will save both construction costs and the environment. Diverted materials can include:**
  - Framing wood and unpainted drywall can be chipped on-site and tilled into the ground
  - Rock, asphalt and cement are all reused locally for road base
  - Metal waste is a high value recycled material
  - Paper & cardboard are much less expensive to recycle than landfill
  - Topsoil & trees that cannot be saved can be sold or donated for reuse in the community
  - Carpet is less expensive to recycle than landfill

Wood becomes Mulch

Drywall becomes a gypsum soil amendment

Shingles become aggregate

Masonry becomes landscaping material/ fill

1.4 PERMEABLE HARD SURFACES

Permeable Hard Surfaces

- Asphalt roadways and driveways shall be a permeable road type, typified by 2’ of un-compacted river run gravel with 4-6” of asphalt with a larger grade of rock and more bitumen to allow water to penetrate into the road bed. This road section is used on all Caltrans roadways. Pavers or pervious concrete shall be used for all hard surfaces instead of solid asphalt that blocks water from returning to the soil.

Pervious concrete

Permeable pavers

1.5 ZERO NET CARBON

Mitigation

- **Purchase a one-time carbon offset of 200 tons of CO_2 per home equivalent for the embodied carbon footprint of the construction project. In 2016 the price of a single ton of CO_2 sequestration credit is $12, and the entire home offset would be $2400 in forestry investment.**

This carbon offset cash can be invested locally in forests maintained by the City of Arcata, purchased online as part of the larger California Cap and Trade carbon market, or developed onsite by the Tribal Nation via planting Redwood groves and similar native trees on open land.

Redwood Trees are among the fastest-growing trees on Earth, storing carbon at the fastest rate yet studied by Botantists—by the time they have grown to two feet in diameter in 20-30 years, they have sequestered 1 Ton of CO_2 in their wood. One house, creating 200 Tons of CO_2 equivalent gases during construction, represents about 100 redwood trees grown for 50-60 years.

2 LANDSCAPING

2.1 Code Minimum

2.1 LANDSCAPING, CODE MINIMUM

- No petrochemical fertilizers or pesticides shall be used on-site.
- Use organic gardening practices at all times
- Invest in fruit trees around all homes and throughout the Nation to provide an abundant food forest for all Tribal Members. There are many fruit tree varieties that grow in the region, including the following varieties, to name just a few:
    - Panamint Nectarine
    - Frost Peach
    - Pink Pearl Apple
    - Sweet Scarlet Goumi
    - Muscat Table Grapes.
- Keep plants away from the exterior siding of all buildings using the following rule of thumb:
    - Plant stems no closer than 36” from the building foundation, and trim bushes, grass, plants, etc. back so they are at least 6” away from the building envelope at all times.

3 BUILDING ENVELOPE

3.1 Code Minimum Summary

3.2 Introduction

3.3 Building Orientation

3.4 Foundation

- Drainage and vapor barrier
- Pest controls
- Slab edge insulation

3.5 Framing

- Code minimum
- Wiring through wall studs
- Interior wall intersections
- Corners
- Windows

3.6 Walls

- Rain-screens
- Air-sealing
- Insulation
- Drywall splicing
- Exterior flashing

3.7 Windows and Doors

- Code minimum
- Flashing
- Recommended products

3.8 Ceiling and Roof

- Code minimum

3.9 Flashing and Moisture Control

3.10 Insulation

3.1 BUILDING ENVELOPE CODE MINIMUM SUMMARY

Component	R-Value
Foundation	R-4 on top of slab, beneath flooring
Walls	R-21 in 2x6 walls + R-8 insulated siding (cork product) or R-8 insulation beneath siding
Attic	R-49

Component	U-Value	Solar Heat Gain Coefficient
Window	≤ 0.30 to keep heat inside the residence	≥ 0.5 to encourage passive solar heating in winter
Door	≤ .2 insulated door	Not Applicable to doors

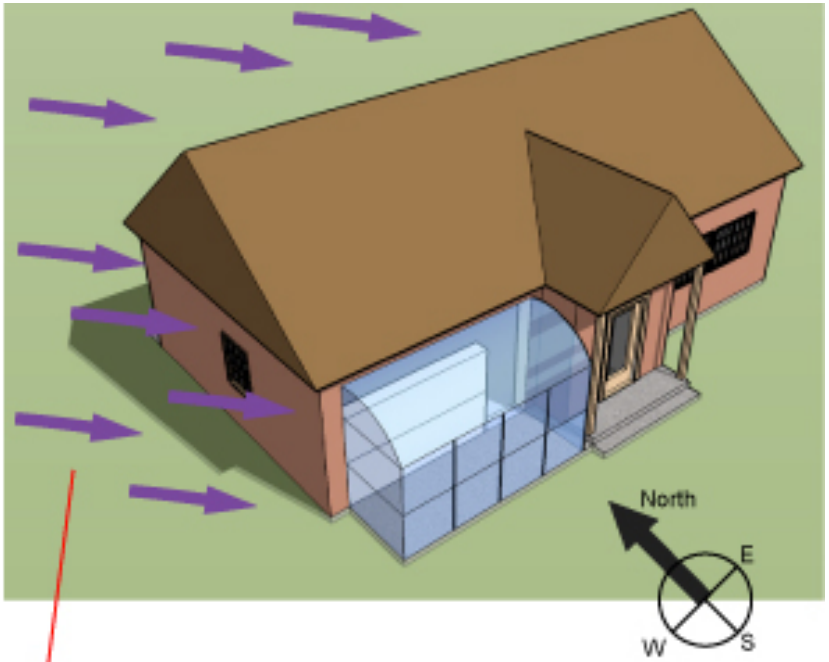
Performance Test	Performance Standard	Method
Sealed Building Envelope	See Chapter 8	Visual inspection of sealed envelope before enclosing exterior walls
Insulation	See Chapter 8	Visual inspection of all insulation installation before adding drywall
Air tightness	See Chapter 8	Pressurizing house fan (“blower door) to measure leakiness
HVAC air flow	See Chapter 8	HERS Testing of supply and return air flow
Rooftop flashing	See Chapter 8	Third party verification of flashing installation

3.2 BUILDING ENVELOPE INTRODUCTION

The Building Envelope is essentially the shell of the building, or the parts of the building that are exposed to the outdoor elements. The Building Envelope includes the foundation, walls, windows, doors, and the roof.

To build a Zero-Net Energy Home that can sustain itself on a limited solar energy budget in the cold winter months, the Building Envelope must be well-insulated, tightly sealed and well ventilated. Additionally, the building should provide natural daylight for occupant health and happiness as well as heat gain on sunny days.

Add a sunroom on the West side of the homes to store heat in the evenings when the sun sets, and provide a space for Tribal Members to grow their own food year-round.

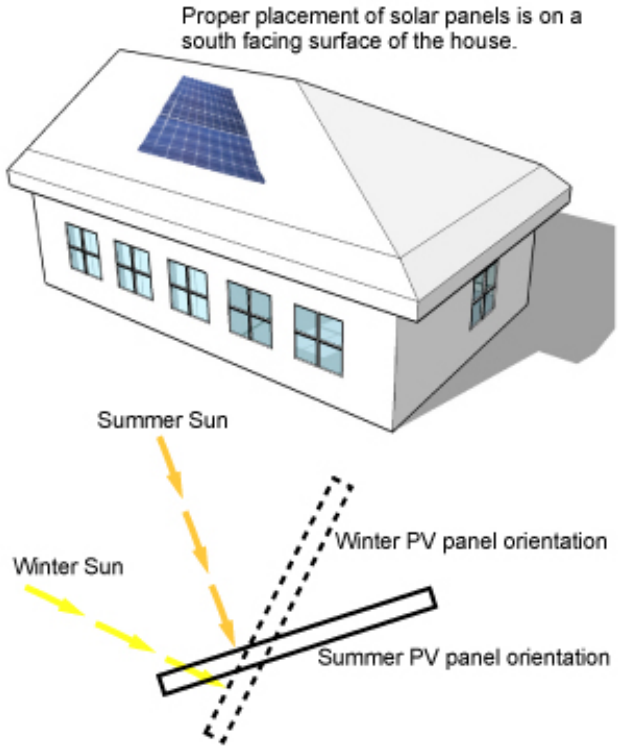


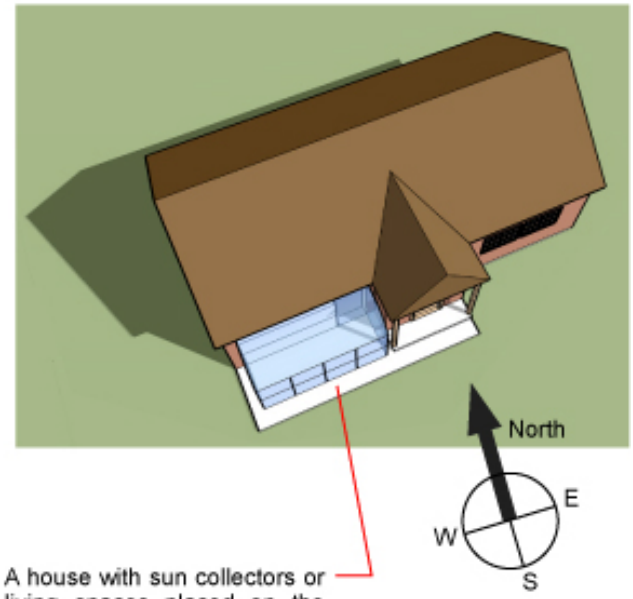
Prevailing winds from the north and the west have the potential to infiltrate the house if tight construction is not used. When attempting to secure joints, it may be prudent to start on those sides of the house.

3.3 BUILDING ORIENTATION

December has only ~40% of the solar energy as in June, yet Energy Sovereign homes must make all their energy year round. In order for residents to have enough affordable energy in the winter, houses must take advantage of their solar resource. Strategies include:

- A 1500 square foot house will take ~12kW of photovoltaic panels to be Energy Sovereign.
- Create solar array-friendly spaces able to hold 4kW on each of three aspects of the roof—East, South and West—to ensure energy generation from sunrise to sunset.
- Minimize operable windows facing Northwest into high-speed winds, and minimize windows facing North to reduce heat loss in the winter while ensuring sufficient daylight for bedrooms for residents to have healthy sleep patterns.
- Build enclosed sun porches to the East and West for passive solar heat gain, laundry line-drying in the winter, and comfortable semi-outdoor spaces to enjoy the sunrise and sunset.



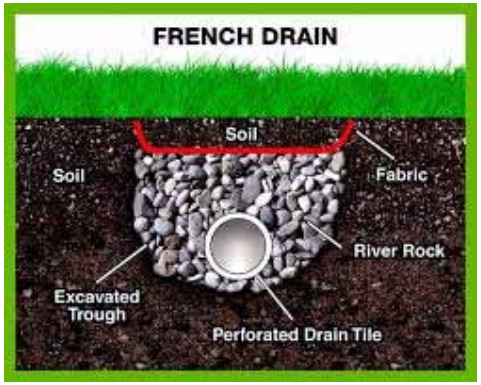


A house with sun collectors or living spaces placed on the south or southeast side won't have to rely on mechanical heating or electric lighting as much as a similar house of different orientation.

3.4 FOUNDATION, DRAINAGE AND VAPOR BARRIER

Foundation drainage

- Install a French Drain system outside the foundation wall and in the crawl space to divert any bulk water.



Vapor Barrier

- Install a vapor barrier below the concrete slab to seal the home from moisture intrusion at the ground level.

There **is no** polyethylene sheeting installed between the ground and the slab.

There **is** a polyethylene sheeting installed to provide a capillary break between the ground and slab.

3.4 FOUNDATION, PEST CONTROL

Structural Pest Control

- Use Structural Pest Controls during Construction

1. Install a ***metal mesh Termite Shield*** (“Termishield”) around all foundation slab penetrations (such as pipes) and at the junction of the foundation or piers and the wall framing.
2. Install a ***continuous rigid metal Termite Shield*** around exterior perimeter at the junction of the foundation or piers and the wall framing.
3. Keep framing and siding materials at least 12 inches from the soil to ensure no pests (termites) will reach these materials

*Remember to keep wood elements separate from concrete and soil to keep the wood from rotting over time.

TermiShield

3.4 FOUNDATION INSULATION, EDGES AND CORNERS

Air Barrier / Floor Insulation

- For Crawlspaces:
    1. Seal all floor joists with *open-cell spray foam insulation* at least 5.5 inches thick to act as an air barrier

- For Slab on-grade:
    1. Add R-4 insulation with 2” of cork insulation above slab

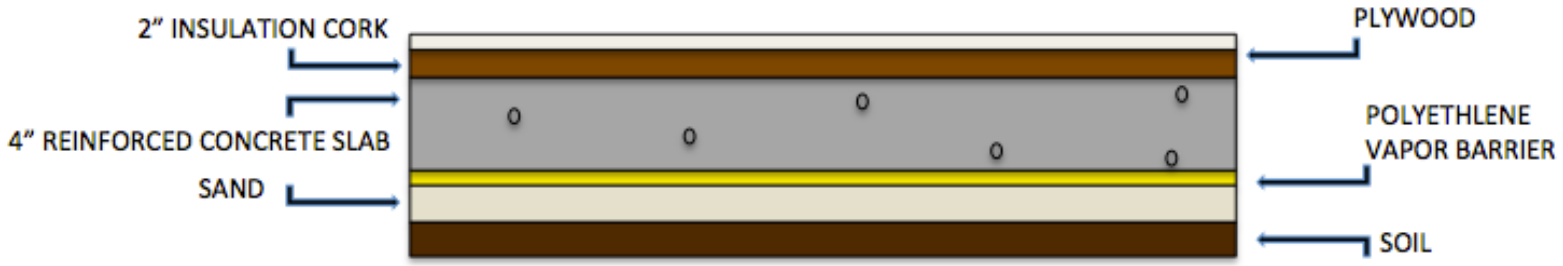
Floor Insulation

- The top or bottom* of the slab must be insulated to at least R-4 cork or rigid foam insulation on top of the slab. This insulation is below a ½” plywood flooring underlayment.

OR

- R-4 rigid foam insulation directly below the slab.

*When Side Walls are insulated with exterior rigid insulation from the soil to the walls, it can create a corridor, for termites to leave the soil and access the walls, so this method is recommended against.

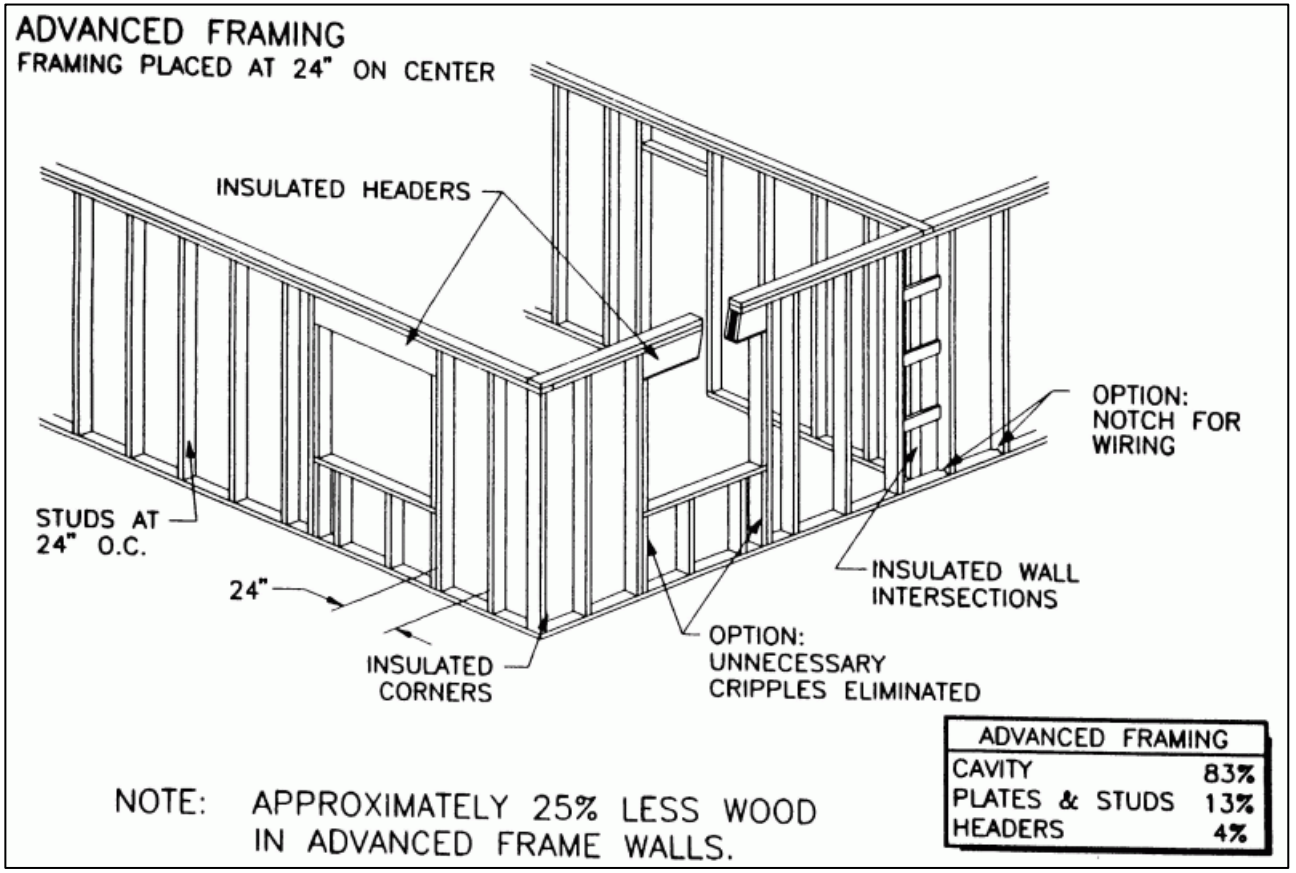


From the bottom up, here’s how the layers should go: soil, sand, polyethylene, concrete, cork siding, and plywood.

3.5 FRAMING, CODE MINIMUM

Structural Framing Code Minimum

- Joists, rafters and 2x6 studs at 16” on center where structural framing allows
- Non-load bearing door and window headers sized for load
- **FSC Certified Wood**
  - Dimensional lumber, studs and timber (i.e. Douglas-fir)
  - Panel products
- **Advanced Framing Techniques shall be used wherever possible**



3.5 FRAMING, WIRING THROUGH THE WALL STUDS

- Cut a hole on one end of framing studs and string electrical wiring through the hole at the floor level, making it easier to properly install wall insulation.
- Seal the studs to the plywood wall enclosure with low-VOC or no-VOC caulk to seal the building from the outdoor elements.

3.5 FRAMING, INTERIOR WALL INTERSECTIONS

Wall Intersections

- Insulate Wall Intersections to *R-21*

-Leave 1” gap at partition walls to slip insulation behind stud

OR

-Use “ladder blocking” to preserve open space behind partition wall studs

OR

-Drill holes into the framing to fill the cavity and fill with blown foam insulation (result of not planning ahead for the first two options)

1” gap to slip insulation behind stud

Ladder blocking to fit insulation behind studs

3.5 FRAMING, CORNERS

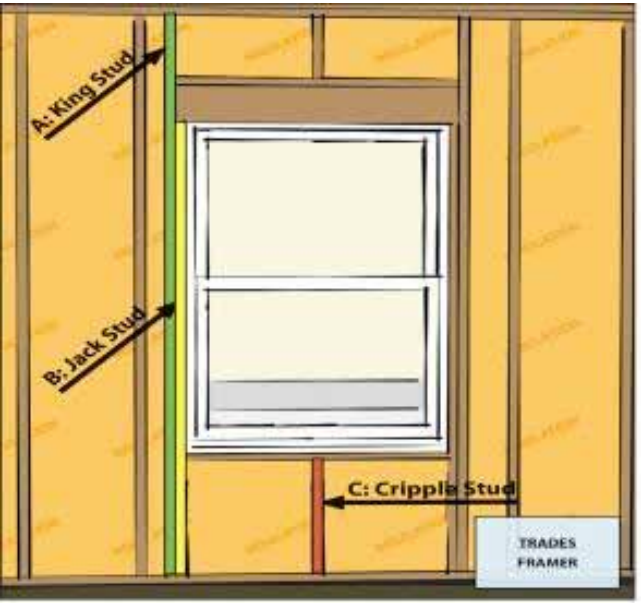
Corners

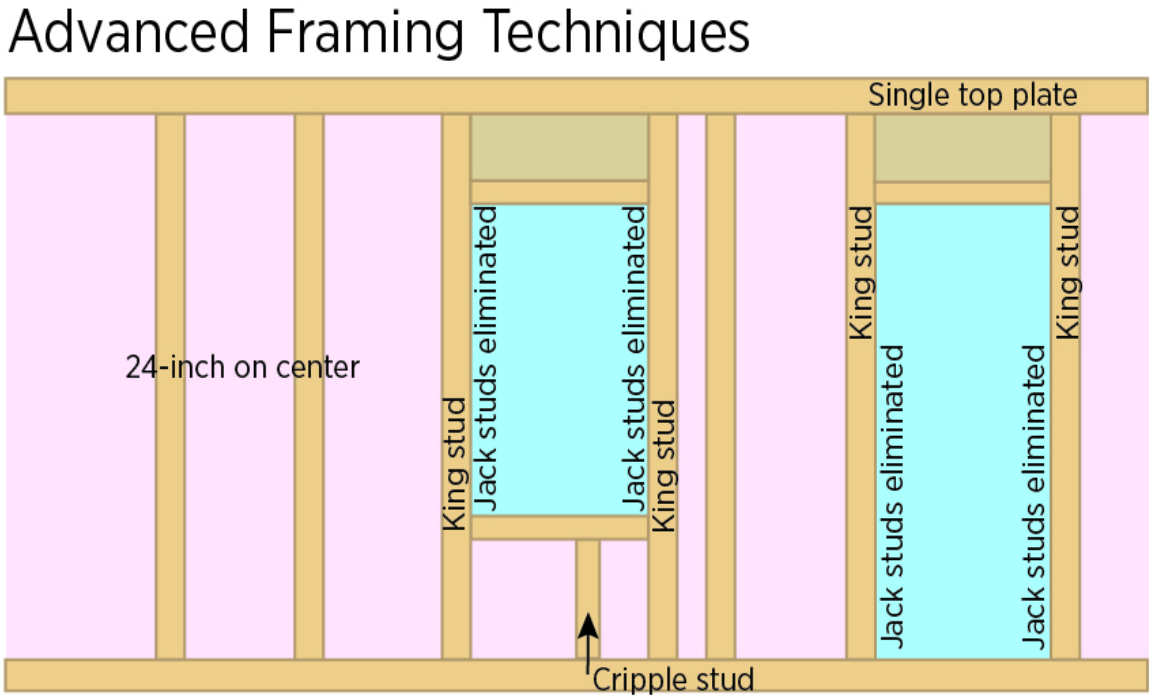
- Create a 2-Stud Corner on all exterior wall intersections to provide insulation that will prevent thermal bridging through the studs. This can be done by:
    1. Cutting and fitting rigid foam insulation
    2. Spraying foam into an air gap to completely fill the opening

3.5 FRAMING, WINDOWS

Advanced Window Framing

- Limit framing at all windows and doors to one pair of Kind Studs plus one pair of Jack Studs per window opening to support the header and sill to reduce “thermal bridging” through unnecessary framing. Use Cripple studs only as needed to maintain on-center stud spacing.

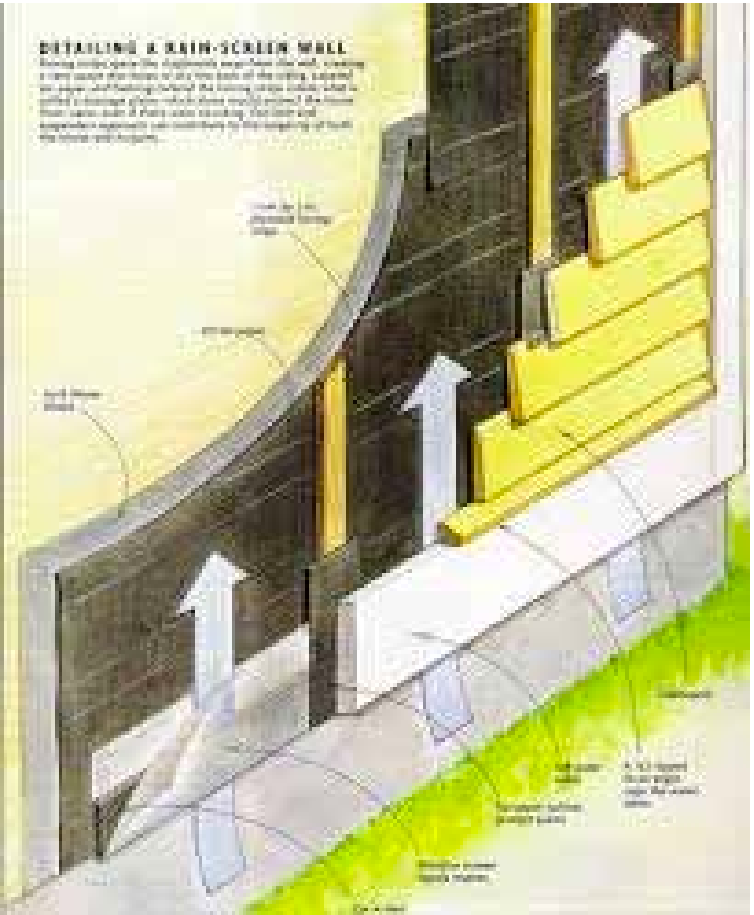




3.6 WALLS, RAIN-SCREENS

- **Install Rain-screen Walls (Resources in Appendix)**
- **Vapor barrier (e.g. tar paper) is required beneath siding, including commonly overlooked areas:**
  - Attic knee walls and skylight shaft walls
  - Walls adjoining porch roofs or attached garages
- **Interior/Exterior wall intersections insulated to R-21, the same as all other external walls**
- **Join horizontal tar paper with 6” overlap, vertical tarpaper by 2” overlap**

*See Appendix for Installing a Rain-screen with felt paper



The building felt is not installed on the entire house.

The building felt is installed on all exterior walls and provides a complete drainage system.

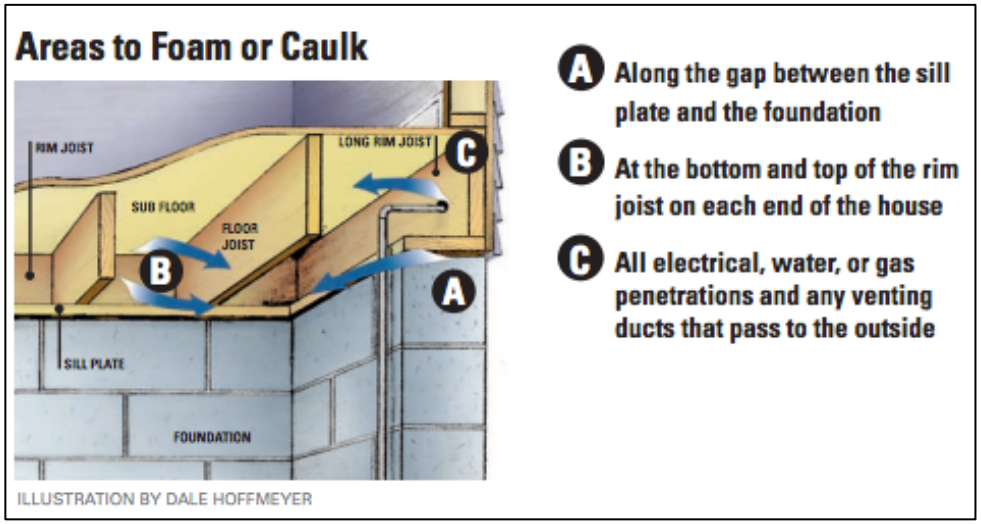
Constructing a rain screen is somewhat costly and labor intensive. Installation is unconventional, so it requires rethinking of some details. Window and door trim must be padded out. Flashing should be extended back to the sheathing beyond the air space and under the housewrap. Door hinges may need to be extended, so doors can be fully opened. Roof overhangs at gable ends must be extended to cover thicker wall sections. The bottom of the air space must be covered with screening to prevent critters from entering the vent chamber. These and other accommodations are certainly doable, but involve more labor and materials than typical construction. In my opinion, rain screens are required fare for wet, wind-blown areas like the Pacific Northwest, exposed coastal environments and hilltop exposures. But, this approach is not required or cost-effective for most climates and construction budgets.

3.6 WALLS, AIR SEALING

- **Air seal above-grade cracks, gaps, and intersections adjacent to conditioned space to minimize air leakage.**
  - Air seal between the sill plate and the sub-floor with caulk, foam, or an equivalent material
  - Air seal the bottom and top of rim joists on each end of the house
- **Add sealants around vents and flashing.**
- **Seal all gaps and holes with caulk or spray foam to air seal the home.**
  - Caulk is best for sealing gaps or cracks that are ¼ inch or less.
  - Spray foam is best to fill gaps from ¼ inch – 3 inches.
  - Seal penetrations like holes for wires, water supply pipes, water drain pipes, etc.

Sealed above-grade sill plates

Un-sealed sill plates



3.6 WALLS, INSULATION

- **Wall Insulation = R-21 in walls + R-8 exterior siding**
- **Recommended products: Blown cellulose within walls, Thermacork exterior siding**

Blown-in cellulose, quality insulation installation

3.6 WALLS, DRYWALL SPLICING

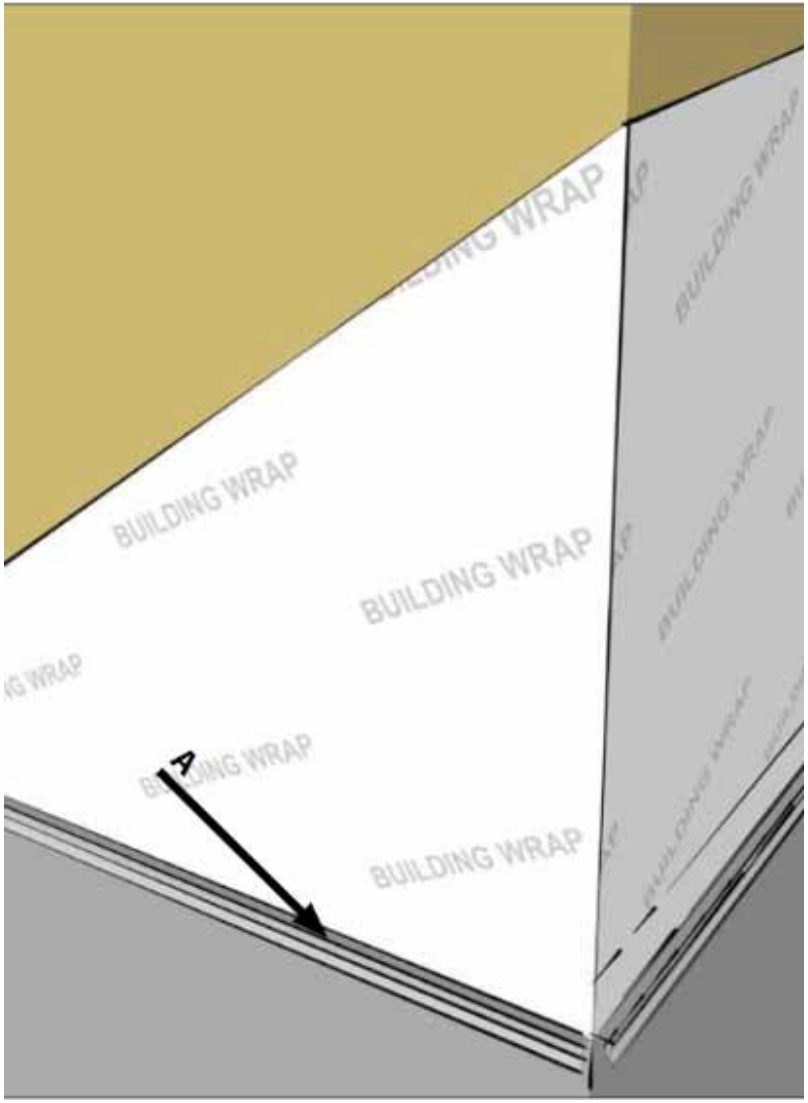
- After insulation installation has been verified by a HERS Rater, install the drywall.
- Drywall splicing allows you to install drywall continuously without landing on a stud. Splice scrap wood to use for continuous drywall installation.

3.6 WALLS, EXTERIOR FLASHING

Install flashing at the bottom of all exterior walls with weep holes included for masonry veneer and weep screed for stucco cladding systems, or equivalent drainage system

- If installing masonry veneer, install weep holes at all flashing locations such as the base of walls, above all window and door lintels, and above shelf angles.

- **Create a fully sealed continuous drainage plane behind exterior cladding laps over the flashing detail above. Additional bond-break drainage plane layer provided behind all stucco and non-structural masonry cladding wall assembles.**
  - Monolithic weather-resistant barrier (i.e., house wrap) sealed or taped at all joints.



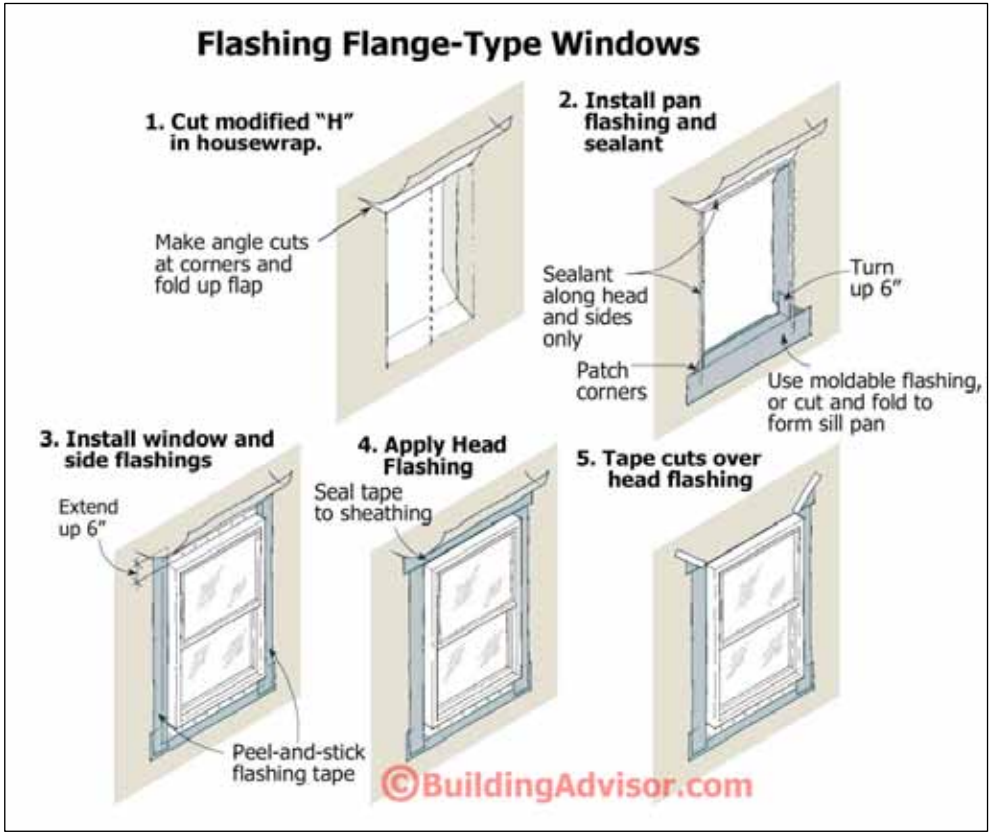
3.7 WINDOWS AND DOORS, CODE MINIMUM

- **Passive solar-friendly insulated windows with a U-Value = 0.30 or less, SHGC=0.5 or more.**
- **Do not use low-e coating on the windows, as the coating increases heating loads by blocking the warming effect of sunlight, and disrupts natural sleep by blocking infrared radiation**
- **Use solid-wood window framing. Paint and maintain wood window frames or use fiberglass exterior cladding.**
- **Ensure a continuous sealant of flashing and insulation around window frame**

3.7 WINDOWS AND DOORS, FLASHING

- **Add flashing under window sill. Flashing around windows and doors shall be sealed to the vapor barrier**

1. Install pan flashing at sills
2. Install side flashing that extends over the pan flashing
3. Install top flashing that extends over the side flashing



3.7 WINDOWS AND DOORS, RECOMMENDED PRODUCTS

Recommended Product		Product Brand and Source
Furnishings	LouverShade (Light harvesting window cover)	Louver shade (CA)
Doors	Graham Serenity Wood Door, Graham Serenity Wood Door, Malman Serenity Wood Door, Malman Thermal Fused Door, Fiberglass Reinforced Polyester Door (FRP)	ASSA-ABLOY (Iowa, USA)

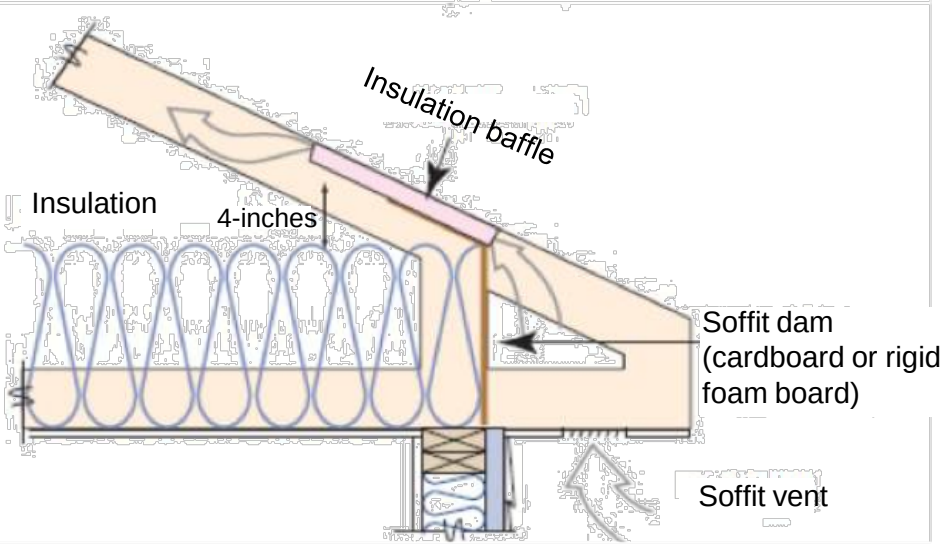
3.8 CEILING AND ROOF, CODE MINIMUM

- **Build an 18” Raised Heel Energy Truss to allow proper insulation in the attic.**
- **Roof overhangs are 1 ½ feet all-around the house.**
- **<u>Class D</u> “High wind speed” shingles for peak 90mph winds: Tested to ASTM D3161.**
- **Dark colored shingles to keep the house warm in the winter, such as CertainTeed “Patriot” shingles.**
- **Attic hatch door shall have R-49 insulation.**

<u>Attic Ventilation</u>

- Attic must have sufficient ventilation:
  1/150 method used to provide adequate amount of ventilation.
  Attic space is 1600 square feet, approximately 10.7 square feet of vents is required
- Install vents in gable ends or a combination of soffit and ridge vents.

Energy Truss
With full height insulation
(recommended)



3.8 CEILING AND ROOF, INSULATION

Attic Insulation

- Attic insulation to be at least R-49 insulation. Use either eco-friendly batt insulation or naturally eco-friendly blown-cellulose insulation, at least 15.3 inches thick.
- Attic hatch door to have R-49 insulation.
- Add a styrofoam baffle or a piece of cardboard to act as a baffle, which will allow airflow and prevent ice-damming in the attic.

Access Hatch, with Deck, Fully Blown to R-49.

Blowing cellullose insulation to R-49 in attic

3.9 FLASHING AND MOISTURE CONTROL

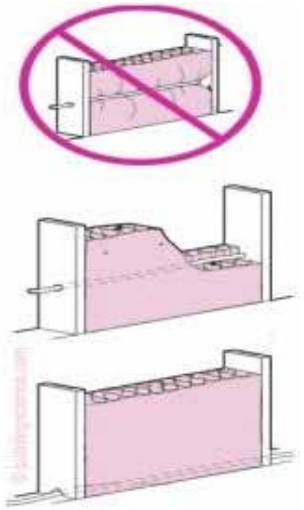
- Flashing to be installed underneath exterior siding and roofing materials to prevent moisture from traveling through the building joints.
- Properly flash all roofs, windows, doors, utility penetrations, deck connections to the structure, and any other joints where water may enter the home.
- Water should naturally flow away from the building through the use of overhangs, downspouts and sloped yards.
- Flashing to be installed properly on all penetrations and joints such as windows, doors, siding, roofing, roof valleys, decks, sill plates, railings, balconies, chimneys, pipes, vents and utility penetrations.

3.10 INSULATION

Quality Insulation installation

- Gently wrap an even layer of recycled cotton batt insulation on all external walls, with no gaps or compressed areas.
- Add blown-in cellulose insulation to the attic spaces or add a continuous, even layer of recycled cotton batt-insulation, with no gaps or compressed areas.
- Pre-cut batt insulation to fit wall cavities, sliced to fit around wires, pipes, and any other wall obstructions.

Component	Code Minimum R-Value
Walls	**R-21 + R-8**
Slab	**R-8**
Attic	**R-49**



4 HVAC

4.1 Code Minimum

4.2 Ducts

- Quality installations
- Duct sealing

4.3 Heating

- Option 1
- Option 2
- Option 3 Multifamily /Commercial

4.4 Ventilation

- Whole house
- Bathroom and kitchen

4.5 Air Balancing

4.6 Controls

4.1 CODE MINIMUM

Generating heat for Tribal ZNE homes is best done with a heat pump water heater, the same device that will also heat the domestic hot water. A heat pump water heater produces heat efficiently, and more importantly stores it in an insulated tank for use when the sun goes down. The heat energy is then best delivered with a hydronic fan coil through insulated ducts, with the balanced ventilation system exhausting air through an Energy Recovery Ventilator to recapture ~25% of exhaust heat.

Water heating is discussed in the HVAC section because in the ZNE homes, the water heaters act as thermal batteries, storing energy overnight with heat gained during the day that can be used for water or space heating in the home. High temperature heat pump water heaters can store water up to 180°F to hold energy in water rather than a traditional electric battery. When this system is combined with a thermostatic mixing valve, no water exiting the tank will be above 120°F, keeping residents safe from scalding. These high temperature thermal batteries are a fraction of the cost of electric batteries and will help maintain a balanced micro-grid, creating community-wide energy sovereignty.

During low-power events when the micro-grid is stressed, residents will be able to turn off their water heaters and use stored energy for at least 12 hours to supply air and water heating, making a more flexible energy balance for the micro-grid.

COMPONENT	CODE MINIMUM
Duct Insulation	R-4
Heat Pump	HSPF=12+, SEER=19+
Heat Pump Water Heater	EF=3.0+
Energy Recovery Ventilator (ERV)	1.0 Sones or less

4.2 DUCTS

Locating the Ducts

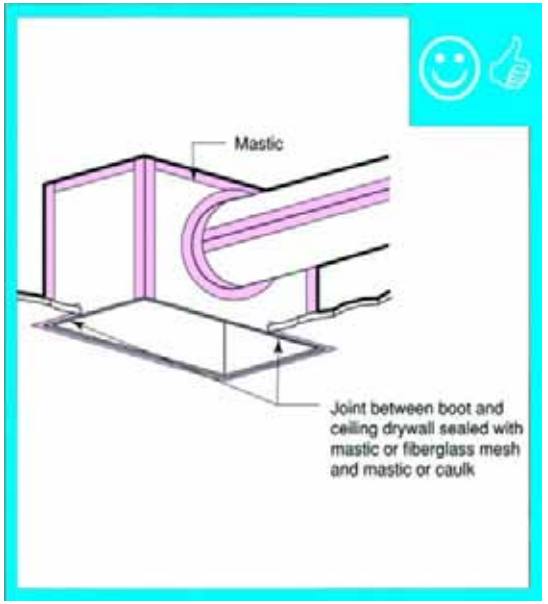
- All ducts shall be located in ***conditioned space***.
- Supply ducts located in ***drop ceiling***.
- Return ducts at ***baseboard level*** to exhaust dust and VOCs from flooring materials.

Installing the Ducts

- Use ***duct mastic*** on all duct joints, duct seams, and all return and supply ducts.
    1. Duct mastic to be applied “as thick as a nickel”.
- All ducts must have at least ***R-4 insulation.***
- All duct systems sized according to ***ACCA Manual D*** (HVAC-D 5).
- Seal joint between boot and ceiling drywall with ***fiberglass mesh and mastic or caulk***.
- Ducts shall be ***cleaned thoroughly*** prior to installing registers, grilles, and diffusers, and verify HVAC filters are new and clean.
    1. Bathroom and Kitchen: MERV 12 filters
    2. Main HVAC system: MERV 16 filters

R-4 Insulated Duct

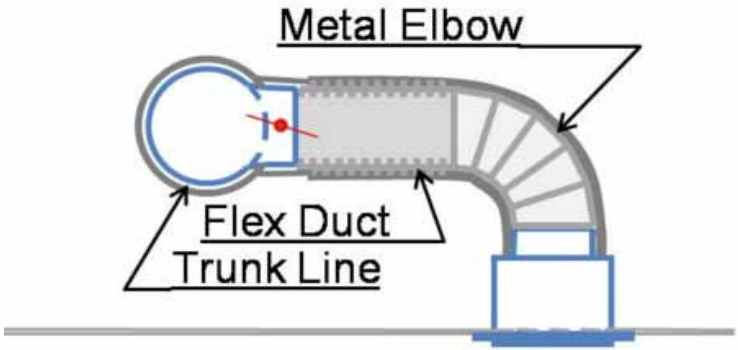
Baseboard level Return Ducts

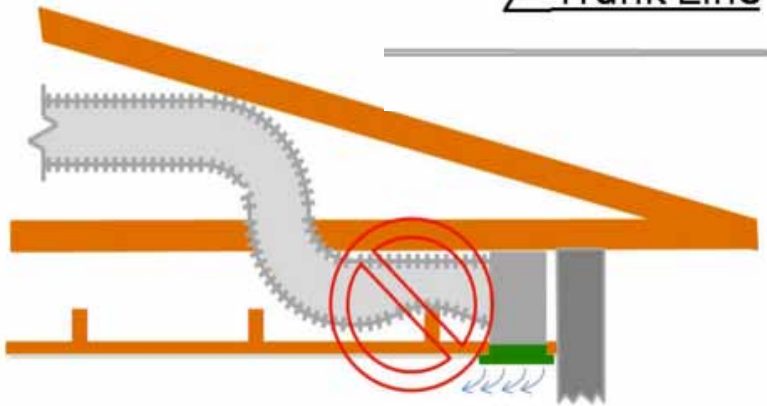


Quality Duct Installation: Duct Mastic

4.2 DUCTS, QUALITY INSTALLATIONS

- **Install ductwork without kinks, sharp bends, or excessive coiled flexible ductwork in spaces that fit them without compacting them. This slows air flow and wastes energy.**
- **Support flexible duct at intervals:**
  - Install supports at a minimum of every 5 ft. to prevent sagging.
  - Install support at least 1 in. wide, without compressing the ducts and the duct installation.
- **Provide sufficient cavity space for ducts**.
  - The height and width of a dropped soffit used to house ductwork should be the duct diameter plus the thickness of the insulation to prevent compression of the duct.
- **If there is fear of compressing the flex duct when making a 90-degree turn in a tight space, use a metal elbow**.
  - Use a metal duct elbow instead of flex duct at boot connections to prevent compression.





No excessive bends in flex ducts

4.2 DUCTS, SEALING

Create durable, airtight duct seams

- Before ducts are sealed, duct seams need to be mechanically fastened (using sheet-metal screws for galvanized ducts and compression straps for flex duct).
- To secure seams in round galvanized ducts up to 12 inches in diameter, use at least three #8 screws, per joint. To secure ducts over 12 inches in diameter, use five #8 screws per joint.
- To secure joints in rectangular galvanized duct, use at least one #8 screw per side.
- Install mastic “as thick as a nickel”.
- Seams or cracks wider than 1/16 or 1/8 inch must be sealed/ repaired with fiberglass mesh as well as mastic.
- Seal collar connections between plenums and duct take-offs.

Seal joints in flex ducts

- Insert duct boot or coupling at least 2 inches into the end of the duct. Attach fitting to the inner sleeve of the flex duct with a drawband (clamp) or #8 screws.
- Seal the joint between the inner section of flex duct and the fitting with high-quality mastic.
- Seal the exterior vapor-barrier sleeve with a drawband and tape.

Quality Duct Installation: Duct Mastic

4.3 HVAC, OPTION 1

Code Minimum

- **HSPF= 12+**
- **SEER= 19+**

(2) Electric Heat Pump Water Heaters with high temperature heat storage functionality.

Tank #1 for Water heating, set to 140 °F - 180 °F, as needed for demand.
Tank #2 for Space heating, set to 180 °F, as needed for energy storage.

80+ gallons
Located in garage, install to manufacturers specifications.
Timed to run only during the day.

Unico Air delivery and return Fan Coil Unit, uses high speed and low volume delivery. Located in drop-ceiling or interior closet.

Energy Recovery Ventilator (ERV) recovers heat, energy and moisture. Located in drop-ceiling.

Install a MERV 16 filter, unless Manufacturers specifications say otherwise.

Highly efficient ceiling fan, located in the living room for cooling. Recommended Product: Big Ass Fan

4.3 HVAC, OPTION 2

Code Minimum

- **HSPF= 12+**
- **SEER= 19+**

(1) Sanden CO2 Water Heater with high temperature heat storage functionality and Heat Pump Compressor for space heating only.

Tank for Water and Space heating set to 180 °F, as needed for demand and energy storage.

80+ gallons
Located in garage, install to manufacturers specifications.
Timed to run only during the day.

Unico Air delivery and return Fan Coil Unit, uses high speed and low volume delivery. Located in drop-ceiling or interior closet.

Energy Recovery Ventilator (ERV) recovers heat, energy and moisture. Located in drop-ceiling.

Install a MERV 16 filter, unless Manufacturers specifications say otherwise.

Highly efficient ceiling fan, located in the living room for cooling. Recommended Product: Big Ass Fan

4.3 HVAC, OPTION 3, MULTIFAMILY / COMMERCIAL HVAC OPTION

Code Minimum

- Follow CEC values for COP values and temperatures proposed by AHRI for large heat-pump boilers, as follows:

Outside air temp	COP	Water Temperature
17	1.95	120
47	2.65	120
100	3.5	120

*For DHW use, the unit must also be able to produce hot water when the air temperature is 100°F.

Recommended: Aermec system to provide Heating and Air Conditioning and Water Heating for all. It is an air to water heat pump and can be sized up to hundreds of tons.

Alternatively, the Panasonic City Multi R2 high temperature model can be used to handle the energy loads. It is an air to refrigerant heat pump and increases in 10-ton increments.

4.4 VENTILATION, WHOLE HOUSE

Whole House Ventilation Code Minimum

- HVAC equipment efficiency rating shall be greater than SEER= 19
- Install Low Sone Supply and Exhaust fans, 1.0 Sone or less
- Energy Recovery Ventilator (ERV)
  - A spot energy recovery ventilator (ERV) recovers heat, energy and moisture.
  - Not to be incorporated into any bathrooms or the kitchen of the home to ensure moisture control within the system.

MERV 12Filter Box

Living Space	1,920 (ft^2)
Bedrooms	3
Air flow required (cfm)	49.2
System air flow (cfm)	200

ASHRAE 62.2-2007:
[Conditioned Area / 100] + [(7.5) * (Number of Bedrooms+1)]

Required CFM ASHRAE Standard and the supplied air flow

Recommended Product		Product Brand and Source
Whole House Ventilation	Energy Recovery Ventilator (ERV)	Panasonic Whisper Comfort Sport FV-04VE1

4.4 VENTILATION, BATHROOM AND KITCHEN

Ventilation Code Minimum

- Local mechanical exhaust ventilation is forced outdoors in the Bathroom and Kitchen, meeting ASHRAE 62.2.
- Install vent fans in Kitchen, Bathroom and Laundry room.
- Install vents in gable ends or a combination of soffit and ridge vents.

Bathroom:

- "Panasonic WhisperGreen", or equivalent exhaust fan.
- Air sources fed through a filter box with a MERV 12 filter prior to being ducted into the bathroom.
- Bathroom exhaust fans shall have an exhaust rate of at least 50 CFM.

Kitchen:

- "Broan Elite RM50000", or equivalent range hood that is vented directly to the outdoors.
- Ducting is split into a T joint, where air is blown underneath the kitchen cabinet through a 3 x 12 inch rectangular duct and a 5 inch in the ceiling.

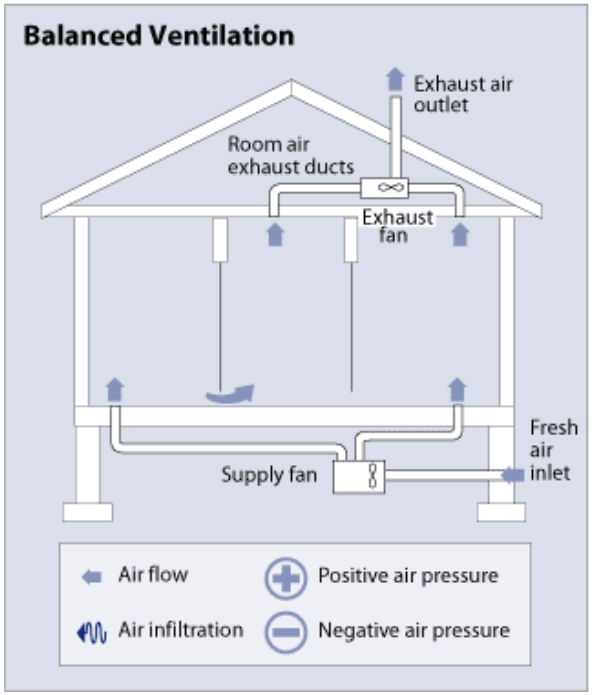
4.5 AIR BALANCING

EnergyStar

ASHRAE 62.1-62.2

Pressure Balance Options:

- Bedroom pressure –balanced using any combination of transfer grills, jump ducts, dedicated return ducts, and/or undercut doors to achieve a Rater measured pressured differential ≤ 3 Pa



Ducted Returns

Guide describing how to install ducted returns to provide conditioned air to all parts of the house and return stale air to the furnace for reconditioning.

Transfer Grilles

Guide describing how to install transfer grilles at each bedroom ensure a continuous flow of heating and cooling even when the doors are closed.

Jump Ducts

Guide describing how to install jump ducts at each bedroom ensure a continuous flow of heating and cooling even when the doors are closed.

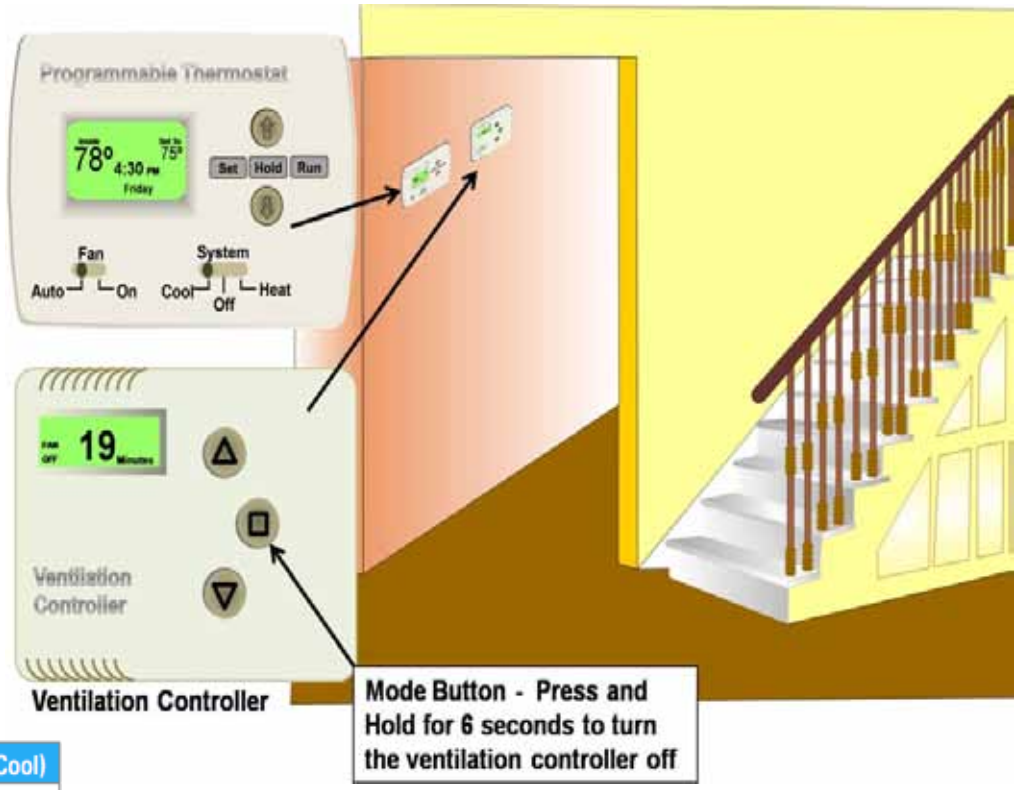
Undercut Doors

Guide describing how to cut the doors at each bedroom ensure a continuous flow of heating and cooling even when the doors are closed.

4.6 CONTROLS

- **Programmable thermostat**
  - Install Energy Star rated programmable/ setback thermostats in the hallway with recommended temperature for heating and cooling season.
- **Carbon Monoxide (CO) and Volatile Organic Compound (VOC) overrides**
  - Install controls that regulate fan speed based on the level of VOC and CO concentration in a space to promote Indoor Air Quality.
- **Clearly label ventilation controls for occupants with Energy Star recommended temperatures (pictured below)**

Greenheck VOC Controls



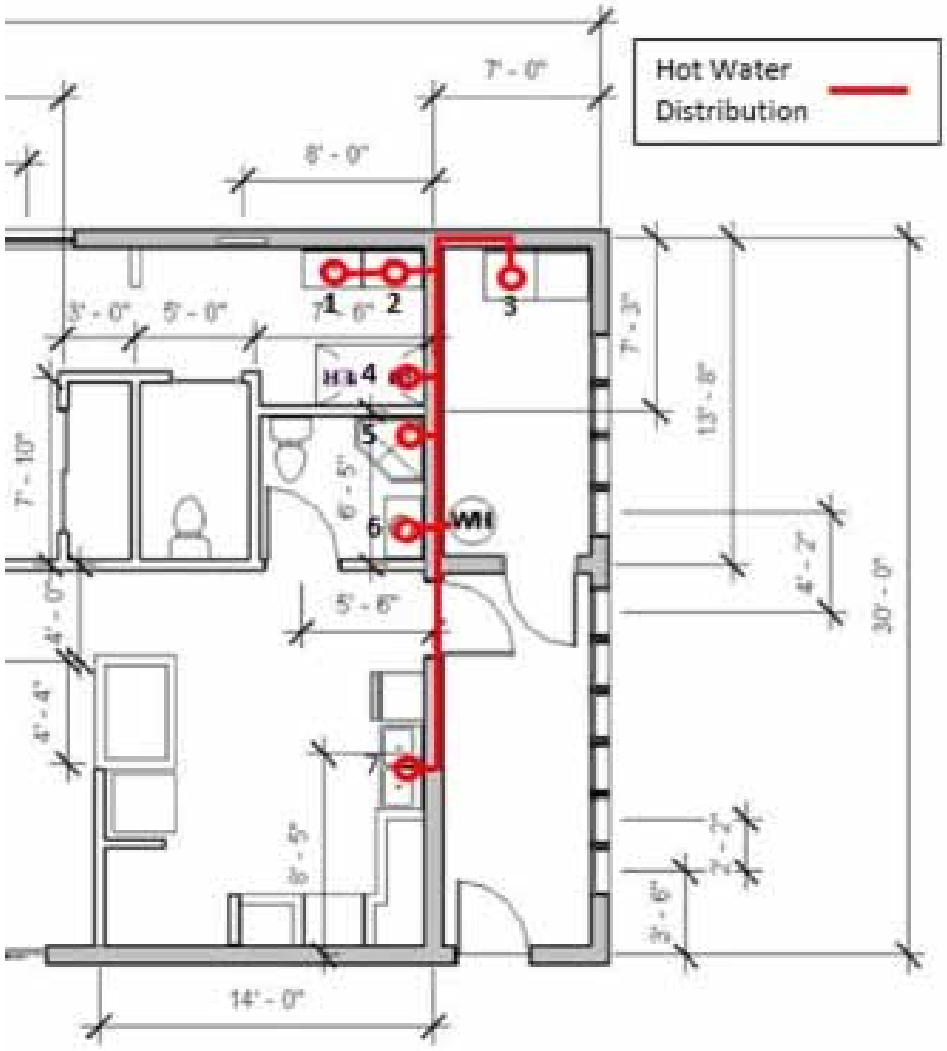
Setting	Time	Setpoint Temperature (Heat)	Setpoint Temperature (Cool)
Wake	6:00 a.m.	< 70° F	> 78° F
Day	8:00 a.m.	Setback at least 8° F	Setup at least 7° F
Evening	6:00 p.m.	< 70° F	> 78° F
Sleep	10:00 p.m.	Setback at least 8° F	Setup at least 4° F

5 PLUMBING

5.1 Code Minimum

5.2 Domestic Hot Water Design

5.3 Efficient Fixtures



5.1 CODE MINIMUM

- Water use and release from homes must work in harmony with the natural flows of the site and its natural environment and 100% of the projects water must come from rainwater catchment or from closed loop water systems, purified without the use of chemicals.
- All stormwater and water discharge, including grey and black water must be treated onsite and managed through re-use, closed loop system, or infiltration.
- All hot water pipes must be 3/8” to reduce wasted hot water with 1” R-4 insulation around the pipes.
- All hot water fixtures must be located near the Water Heater tank (example below) to reduce wasted hot water in transit.

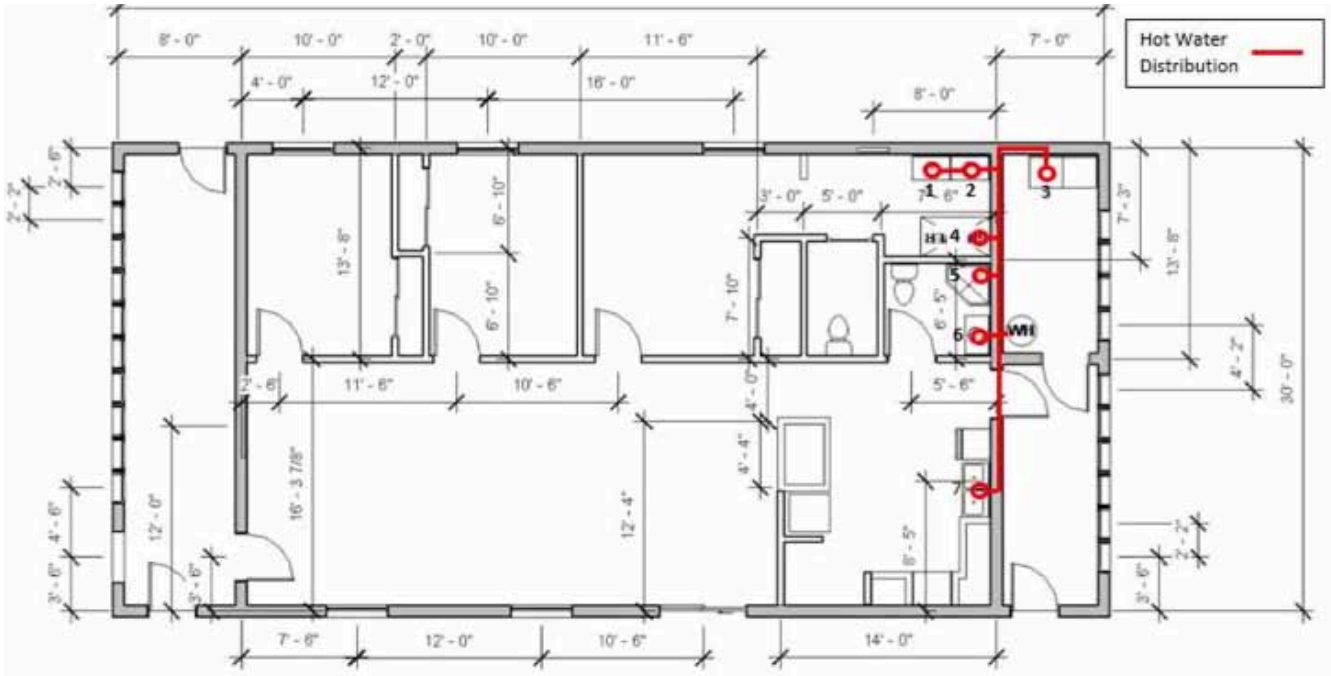


Figure 24. Hot water distribution layout

#1-7: Hot water fixtures

5.2 DOMESTIC HOT WATER DESIGN

Hot Water Distribution

- Use a Trunk and Branch design for hot water distribution.
- Use 3/8” copper pipes for trunks and branches.
- Adjust incoming water pressure to 60 PSI with a pressure regulator prior to entering the water heater to avoid equipment damage.

Pipe Insulation

- Insulate pipes with 1” thick R-4 closed-cell elastomeric insulation.

Closed-cell elastomeric insulation on copper pipes

5.3 EFFICIENT FIXTURES

Bathroom sink faucets

- WaterSense Labeled, Less than 1 gpm.

Kitchen sink faucets

- Swivel aerator with a pause valve.

Shower head fixture

- Evolve 1pgm or less.

Toilets

- ToTo brand 1.28 gpf or less, PVC-free.

Recommended Product		Product Brand and Source
Toilet/Water Fixtures	Eco Drake 1.28 gpf Toilet, PVC-Free	TOTO USA (Georgia)

6 LIGHTING AND APPLIANCES

6.1 Code Minimum

6.2 Built-In Entertainment

6.3 Controls and Energy Monitors

6.1 LIGHTING AND APPLIANCES, CODE MINIMUM

- Replace appliances for only EnergyStar rated lights and appliances such as refrigerators, dishwashers, clothes washers and bathroom fans.
- For Cooking, replace all cooking stoves with Induction Stoves.





APPLIANCE	ENERGY STAR MIN. STANDARD (EFS=Exceeds Federal Standard)	BEYOND ENERGY STAR
Refrigerator	EFS by 20%	Frigidaire & Miele models EFS by up to 33%. SunFrost RF-12 (locally manufactured) EFS by 46%
Dishwasher	EFS by 41%	Bosch & Asko models EFS by over 141%
Clothes washer	EFS by 37%	Whirlpool, LG, Samsung models EFS by over 110%

6.2 BUILT-IN ENTERTAINMENT EQUIPMENT

- Built-in entertainment centers shall be installed in the living room of every home to promote the use of Energy Star Televisions and Built-in speakers.

Samsung
UN58H5005AF, UN58H5202AF

MSRP	$799.99
Screen Size	58
Resolution	1920 x 1080
Display Type	LCD
Automatic Brightness Control?	Yes
Annual Energy Use (kWh)*	70
Annual Cost to Operate**	$8

Features:

- Full HD 1080p Reveals a More Stunning TV Experience
- Enjoy the Details in Fast Moving Images with Clear Motion Rate 120
- Experience a Better Color Spectrum with Wide Color Enhancer Plus

Samsung
UN55J6200AF, UN55J6520AF

MSRP	$699.99
Screen Size	54.64
Resolution	1920 x 1080
Display Type	LCD
Automatic Brightness Control?	Yes
Annual Energy Use (kWh)*	69.3
Annual Cost to Operate**	$7.97

Features:

- LED TVs perform well in all lighting conditions
- 1080p resolution for stunning HD images
- Motion Rate 120
- Smart TV delivers a huge world of entertainment
- ConnectShare Movie
- Intelligent energy management

Energy Star Televisions

6.3 CONTROLS AND ENERGY MONITORS

LIGHTING

- Install light switch dimmers on interior lights.
- Install motion sensors on outdoor lights that automatically turn on when people walk by the home and automatically dim to low light levels when no motion is sensed. Connect these lights with photocell sensors that automatically turn on when the sun is setting and turn off when the sun is rising.

ENERGY MONITORING

- Install *Canary Instruments* Energy Monitor, or equivalent, in common area of each home to visualize real-time home energy consumption.

7 HEALTH AND MATERIALS

7.1 Code Minimum

7.2 Red List Materials

7.3 Wood Products

7.4 Entryway Design

7.5 Non-Toxic Paint

7.6 Finishes, Caulks, Sealants

7.7 Thermal and Moisture Control

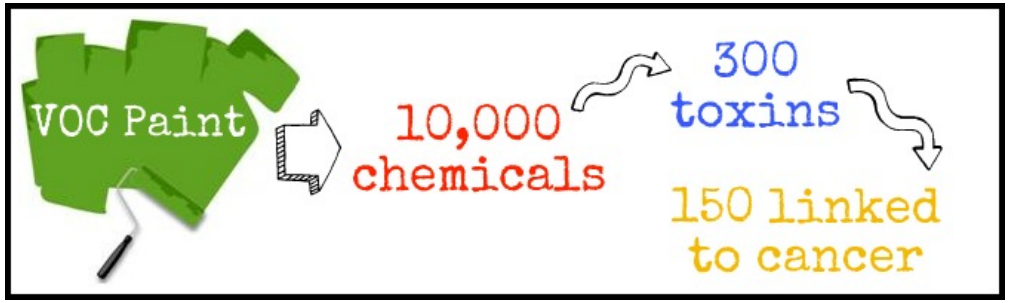
7.8 Flooring

7.9 Pest Control

7.9 Declare Product List

7.1 HEALTH, CODE MINIMUM

- No-VOC Paints to be used in construction.
- No Formaldehyde products to be used in construction.
- Design to comply with ASHRAE 62.2, and Balance air systems within 25% of ASHRAE standards.
- Results from Indoor Air Quality test must pass before occupancy and nine months after occupancy.
- Smoking is prohibited with the project boundary.
- Do not install building materials with visible signs of water damage or mold.
- Do not enclose interior walls when insulation or framing members have high moisture content.
- Install a corrosion-resistant drain pan properly draining to a conspicuous point of disposal.
- Use corrosion resistant fasteners and hardware stainless steel, hot-dipped galvanized, and ceramic-coated products.
- Reference the International Living Futures Institute Declare Products Database for approved products to be used in Construction that include transparent product ingredients, source, and recyclability ratings (***https://living-future.org/declare-products***)



7.2 RED LIST MATERIALS

- Materials will be found on the “Declare Products” Database. This database provides the chemical content of each product provided by the manufacturer to keep harmful toxins out of the home.
- The following “Red List” contains a list of (11) materials, chemicals and elements known to pose serious risks to human health and the natural environment. For this reason, these materials shall not be purchased for the project.

- Alkylphenols
- Asbestos
- Bisphenol A (BPA)
- Cadmium
- Chlorinated Polyethylene and Chlorosulfonated Polyethlene
- Chlorobenzenes
- Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs)
- Chloroprene (Neoprene)
- Chromium VI
- Chlorinated Polyvinyl Chloride (CPVC)
- Formaldehyde (added)
- Halogenated Flame Retardants (HFRs)
- Lead (added)
- Mercury
- Polychlorinated Biphenyls (PCBs)
- Perfluorinated Compounds (PFCs)
- Phthalates
- Polyvinyl Chloride (PVC)
- Polyvinylidene Chloride (PVDC)
- Short Chain Chlorinated Paraffins
- Wood treatments containing Creosote, Arsenic or Pentachlorophenol
- Volatile Organic Compounds (VOCs) in wet-applied products[22]

7.3 WOOD PRODUCTS

- At least 50% of all structural wood used on each home shall be sustainably harvested from local sources and/or FSC-Certified wood.

Additional Recommended Products		Product Brand and Source
Wood	REII Landscaping Fence	The Reuse Everything Institute (Pennsylvania)
Wood	Nordic Joist, Nordic Lam, Nordic X-Lam	Nordic Engineered Wood (QC, Canada)

7.4 ENTRYWAY DESIGN AND SHOE STORAGE

- At the entryway of each home, design a built-in shoe rack to reduce the likelihood of tracking contaminants into the home. The design on the left can be a simple add-on, where the honeycomb design on the right is a more custom built-in storage option inspired by nature.

7.5 NON-TOXIC PAINT

PAINT:

- Use No-VOC *Milk Paint* throughout Interior and Exterior of the home. The definition “Zero-VOC” still allows products to contain 5 grams of toxic chemicals or every liter of product, but Milk Paint truly contains No-VOC’s.
- Local milk (i.e. Humboldt Creamery) is recommended.

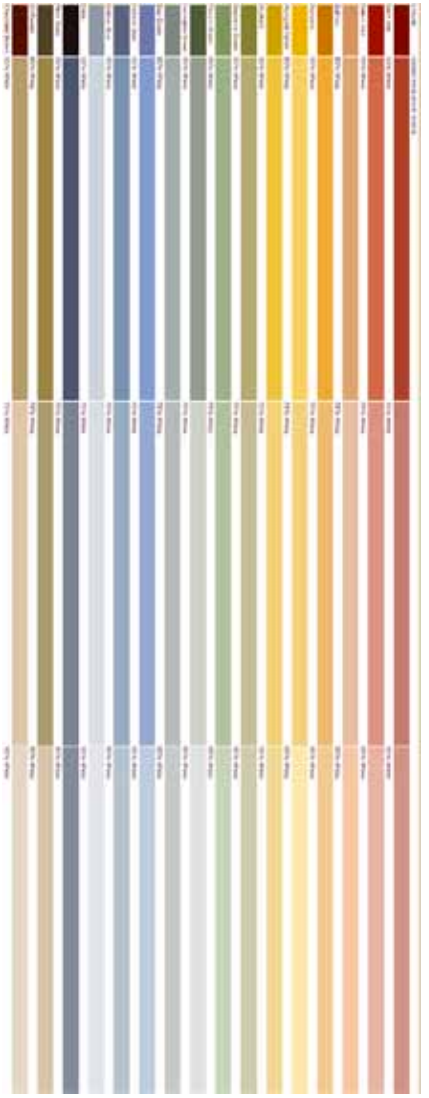
The Genuine Old-Fashioned Home-Made MILK PAINT

*Naturally **safe** Historic Paints since 1974*

ADVANTAGES	
Produces an authentic Colonial or Shaker finish	Adheres to almost all clean, porous surfaces
Environmentally safe, non-toxic and anti-bacterial	Non-flammable
Dead flat finish.	Solvent free
Fast drying	Odorless when dry
Comes in deep rich colors	Longest lasting paint known
Colors can be blended, by the user, to produce many tints and shades.	Permanent colors; will not fade
Easily cleaned up with water	

PHYSICAL CHARACTERISTICS	
Color: Comes in sixteen historical colors. Also available as a translucent base to which pigment can be added for an infinite variety of hues, tones and shades.	**Non-Flammable**
State: Dry Powder	**Non-Combustible**
Mixing Medium: Water	**Environmental Safety**: Biodegradeable and non-toxic
Mixing Temperature: Mixes best with warm water	**Thinner**: Water
VOC's: None - entirely solvent free	**Clean Up**: Soap and Water
Odor: Faint milky odor when wet, odorless when dry	**Drying Time**: Dry to the touch, 30 mins To re-coat, wait two hours. Cures and hardens over time.
Shelf Life: In sealed bag, indefinitely. As liquid, overnight, seal and refrigerate.	

AVAILABLE SIZES		
one pint	6 oz. powder, plus water	covers approximately 35 square feet
one quart	12 oz. powder, plus water	covers approximately 75 square feet
one gallon	48 oz. powder, plus water	covers approximately 300 square feet



7.6 FINISHES, CAULKS AND SEALANTS

CAULKS AND SEALANTS:

- Use Zero-VOC caulks and sealants throughout.

CABINETS, PARTICLEBOARD, ETC.

- Utilize third-party certified low-emission pressed wood materials that are designed to reduce human exposure indoors to individual VOCs.
    - Beware: Particle board and pressed wood materials commonly use formaldehyde. Purchase No formaldehyde products only.

Recommended Product		Product Brand and Source
Wood	Cabinets	Neil Kelly Cabinets (Portland,OR)
Wood	Collins Pine FreeForm Particleboard	Collins Companies (Oregon)

7.7 THERMAL AND MOISTURE CONTROL

- **Seal all homes with Low-VOC Joint and Seam Filler thoroughly to seal building envelope.**

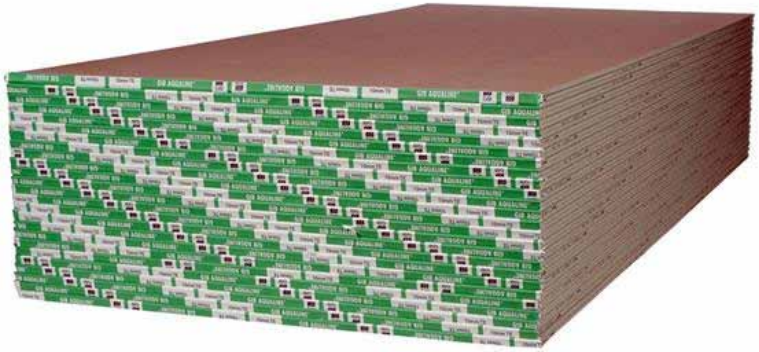
Recommended Product		Product Brand and Source
Thermal and Moisture Protection (Home Exterior)	WrapShield SA Self-Adhered System (A primerless self-adhered water-resistive vapor-permeable air barrier sheet membrane system with liquid flashing, 20 year warranty)	VaproShield (Chicago, USA)
Thermal and Moisture Protection	Prosoco R-Guard Joint & Seam Filler, FastFlash, Cat 5, AirDam, Cat 5 Rain Screen	PROSOCO (Kansas, USA)

7.7 MOISTURE CONTROL

- **BUILDING MATERIALS:**
  Do not install building materials with visual signs of mold.

- **BATHROOMS: Use *GIB Aqualine***
  Plasterboard product, or equivalent, 13mm on the bathroom walls for moisture-resistant backing materials under ceramic tile. If using a single fiberglass shower enclosure, there is no need for extra backing material.

- **BATHROOM TUB:**
  Provide an extra 4” of tile surrounding the shower enclosure to protect walls from future water damage.



Recommended Product		Product Brand and Source
Finishes	10mm, 13mm GIB Aqualine Plasterboard, GIB Braceline/ Noiseline Plasterboard (13 mm GIB Aqualine® is specifically designed for bathrooms, laundries and kitchens. Its water resistant core contains special polymers to help prevent moisture penetration.)	Winstone Wallboards (NZ)

7.8 FLOORING

- Use only resilient flooring throughout the home.
- Entryways shall contain traditional designs chosen by the community by alternating shades of color in the installation (see example of bear River's Hotel hallway below)

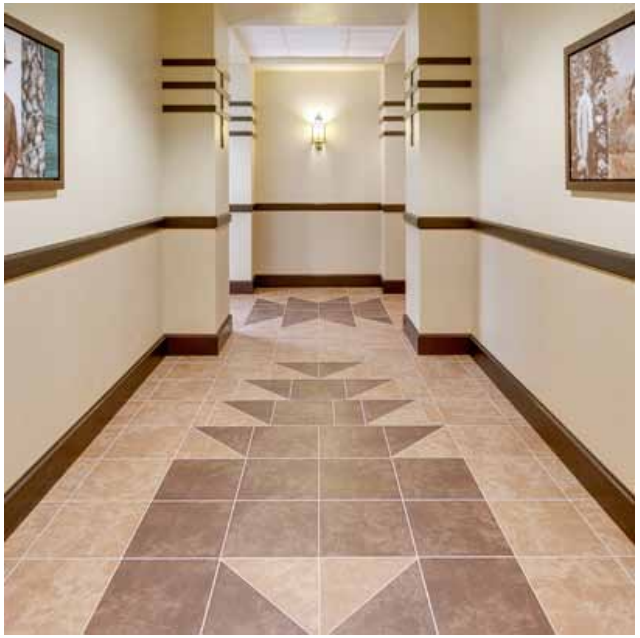
KITCHEN AND BATHROOMS

- Install Ceramic "Green Tile" in Kitchen and Bathrooms with Portland cement-based thin-set mortar and grout OR Marmoleum/ Linoleum sheet floring with Low-VOC adhesive (Recommend Forbo i885m adhesive).

ENTRY, LIVING ROOM, HALLWAYS, BEDROOMS

- Install FSC-Certified locally milled Blue Pine wood with a natural beeswax sealant OR Ceramic Tile for Thermal Mass OR Cork Floors.

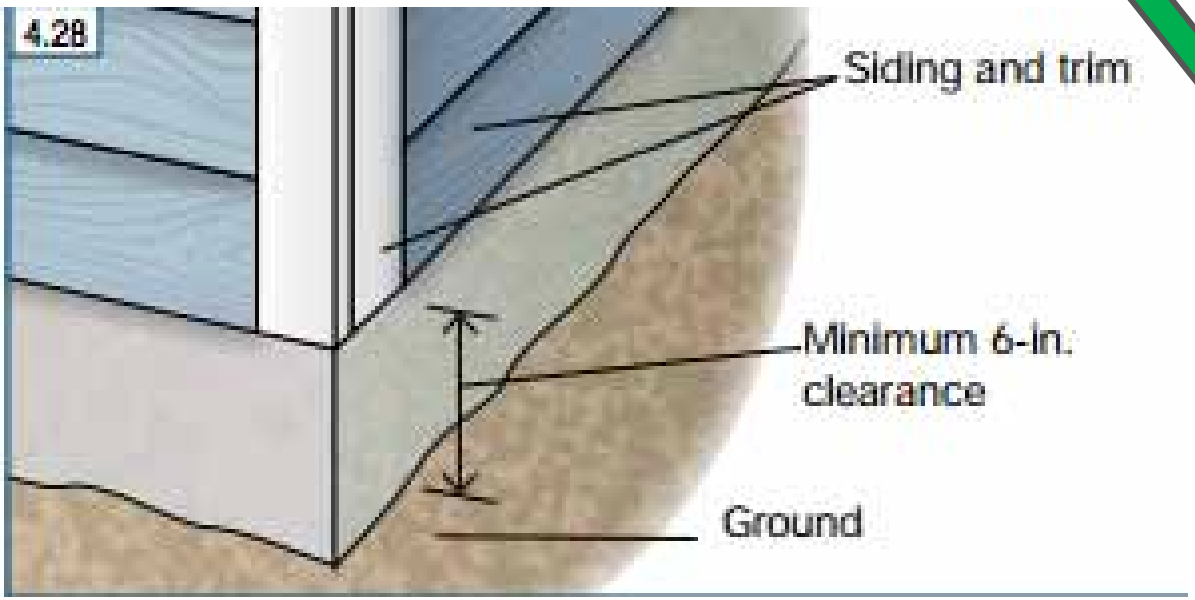
Soft wood Blue Pine Floors



Bear River Rancheria Hotel tile design in hallway

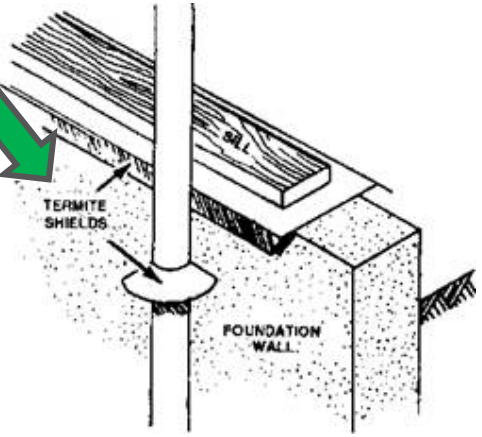
7.9 PEST CONTROL

- Seal all penetrations and joints between the foundation and exterior wall assemblies.
- Install corrosion-proof rodent/bird screens (e.g., copper or stainless steel mesh) for all building openings that cannot be sealed and caulked (e.g., ventilation system intake/exhaust outlets and attic vent openings).
- Add Termite Shield around pipes and penetrations at the foundation level of the home to block termites from crawling up into the home.
- Wall Siding shall be no less than 6” above the ground level to keep wood from rotting and resist pest intrusion.



Wall siding 6” above ground

Termite Shields



Termite Shields

7.10 RECOMMENDED PRODUCT LIST

- **The following products are Approved Declare Products, and are recommended to be used in New Construction.**

Section	Product Type	Brand
Finishes	Exterior Oil	Natural House Company (NZ)
Finishes	ethos Modular Flooring, Powerbond ethos Cushion	Tandus Centiva (Georgia)
Finishes	EcoGrille (FSC Pacific Albus) wood ceiling panel, 1100 Cross Piece Grille/2100 Panelized Linear (FSC Hemlock)	9Wood (Oregon)
Finishes	ECOS WoodShield Interior Stain, Zero-VOC, ECOS WoodShield Satin Varnish, ECOS Interior Wall Paints	Imperial Paints (South Carolina)
Finishes	Linoleum Harmonium xf^2	Tarkett (Italy)

7.10 RECOMMENDED PRODUCT LIST

- **The following products are Approved Declare Products, and are recommended to be used in New Construction.**

Section	Product Type	Brand
Insulation (New construction, use unfaced)	EcoBatt Unfaced, Knauf Insulation IB Board	Knauf Insulation (USA)
Insulation (Attic for new construction)Finishes	GreenFiber Cellulose Insulation	US GreenFiber (USA)
Thermal and Moisture Protection	Havelock Wool Insulation	Havelock Wool (Nevada, USA)
Thermal and Moisture Protection	ENRGY 3 .E- Johns Manville Roofing Insulation Board	Johns Manville (Indiana, USA)

8 PERFORMANCE

8.1 Quality of Installation

8.2 Building Performance Verification

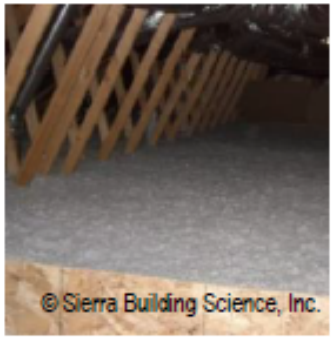
8.1 QUALITY INSULATION INSTALLATION

- **Verification of *Sealed building envelope* prior to exterior walls being enclosed.**
- **Verification of *quality of insulation installation* prior to interior walls being enclosed.**

Some components of QII to highlight include:

Sealing the Air Barrier: Seal all gaps around windows, doors, behind tubs and showers, etc. Caulk or seal all gaps in the air barrier greater than 1/8" with foam.

Correctly Sized Batts: Batt insulation should be cut to fit snugly at the sides and ends without gaps or buckling. It should not double over or be compressed and should be friction fit to cavities, or otherwise supported. Batt insulation should be split to fit around wiring or plumbing, and trimmed to fit around junction boxes.



Required U-factors (& associated R-Values equivalents) for Envelope Systems: Designers shall specify U-factors for assemblies shown in the Residential Appendix. Installers must follow specifications in order to meet QII requirements.

8.2 BUILDING PERFORMANCE VERIFICATION, PRIOR TO OCCUPANCY

- **Verification of *Sealed building envelope* prior to exterior walls being enclosed.**
- **Building Envelope HERS testing to verify no more than *2.5 air changes per hour @50 psi* through the building envelope.**
- **HERS Blower Door Test to verify *duct leakage less than 6%.***
- **Supply and Return air flow HERS testing with *Duct Blaster Test.***
- **Mechanical Ventilation HERS testing for *refrigerant charge.***
- **Third party verification for rooftop *flashing.***

HERS Duct Blaster Test

HERS Blower Door Test

9 RENEWABLE ENERGY

9.1 Code Minimum for Homes

9.2 Energy Storage

Southern View of 25 MW Solar Farm

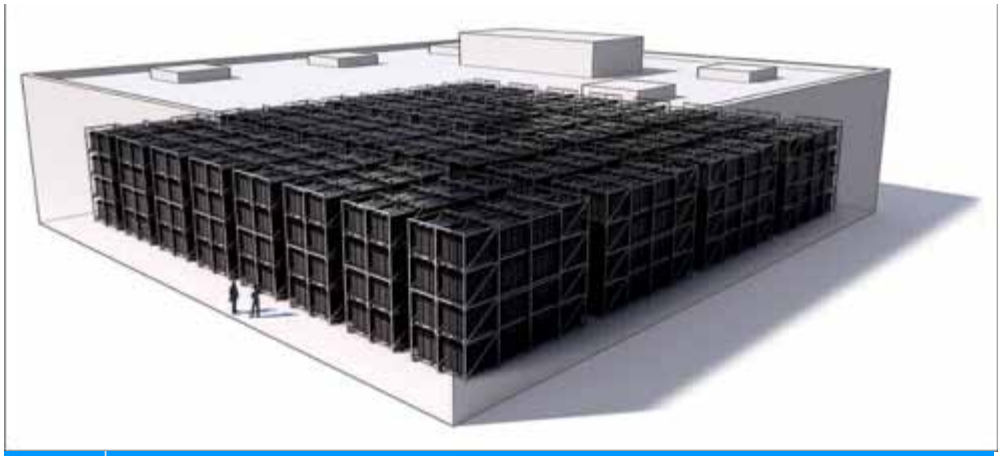
9.1 CODE MINIMUM

- A 1,500 square foot house requires 12 kW's of PV to supply energy throughout the winter.
- The combined Aquion saltwater battery for each home must be sized to 11.5 kWh's.
- All Solar Panel and Roof Rack Installations shall be completed by Tribal Members after receiving proper training and certification through GRID Alternatives or a similar training and certification program.
- Install solar panels in a basket weave pattern along the hillside, much like the Wiyot baskets and basket cap designs. Is this a suggestion? Is this mandatory? Feels weird…

Elizabeth Conrad Hickox, Karuk (Karok) / Wiyot, 1872-1947, or Louise Hickox, Karuk (Karok), 1896-1967 Basket
About 1925
Wild grape root, myrtle sticks, hazel, maidenhair fern, yellow-dyed porcupine quills, and stag horn lichen

9.2 BATTERY STORAGE

The energy sovereignty Micro-Grid will work in conjunction with Aquion brand deep-cycle batteries for energy storage. The Aquion batteries are non-toxic, saltwater batteries, adaptable to commercial and utility-scale systems that could consistently carry the energy loads of Tribal Nations and communities.



Step 4	Determine Lifecycle cost of ownership				
Type	# Cycles	Wh Storage	Total Wh life of battery bank	Cost of Bank	Cost per kWh
Lead Acid	1500 x	27,789Wh	= 41.6MWh	$8,000	$0.19
Aquion AHI	3500 x	14,033Wh	= 49.1MWh	$8,400	$0.17

Aspen 48M Battery

The Aspen 48M is a parallel string of twelve Aspen 48S batteries configured as a single, palletized battery unit.
They can be connected in series up to 1,000 volts DC.

OPERATION & PERFORMANCE

Chemistry: Aqueous Hybrid Ion (AHI™)
Energy: 25.9 kWh (at a 20 hr discharge)
Cycle Life: 3,000 cycles (to 70% retained capacity)
Operating Temperature: -5 to 40°C ambient Certifications
Nominal Voltage: 48 V
Usable Depth of Discharge: 100%
Round Trip Efficiency: >90%

PHYSICAL CHARACTERISTICS

Dimensions: 1,159 x 1,321 x 1,504 mm (45.6 x 52.0 x 40.0″)
Weight: 1,504 kg (3,309 lbs)

CERTIFICATIONS

Cradle to Cradle Certified™ Bronze
UL recognition in process
CE marked

WARRANTY

Limited Warranty: 5-year full plus 3-year prorated

10 EDUCATION

10.1 Resident Education

10.1 RESIDENT EDUCATION

- **Install Energy Monitors in each home that will provide real-time energy information with immediate feedback to Residents on their energy use. We recommend the Canary Instruments/Nexi device that plugs into the wall outlet and changes colors to indicate High energy use (red), average (yellow) and conservative energy use (green).**
- **The Tribal Council shall provide Community Meetings for Tribal Members twice every month for the first 3-months of occupancy to educate home owners and renters on their new homes. Additionally, provide home owners and renters with a brief packet highlighting the same topics discussed in-person.**
    - Education and Training should include a brief presentation touching on the following topics:
        - Renewable energy, energy storage, HVAC and DHW equipment and how it is linked to energy storage and demand, HVAC controls, indoor air quality, and how to maintain the homes.