Net Zero Houses Evolution!

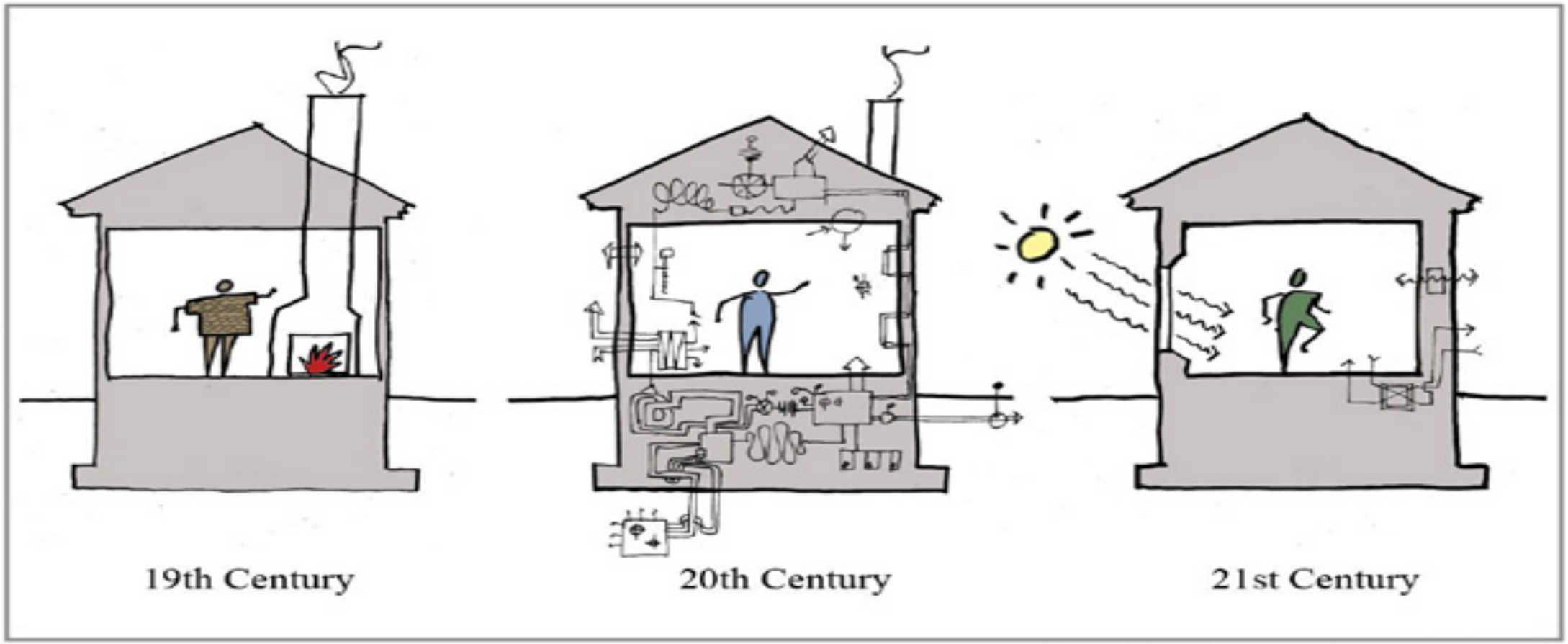


image source: Albert, Righter and Tittmann Architects

Alaska Center for Appropriate Technology

The Path to Net Zero

Heating and Ventilation of Net Zero buildings in Alaska

Special thanks to Graham Wright, John Semmelheck and Chris McTaggert of PHIUS for use of PHIUS slides.

Our Role at ACAT

Educate and connect various “stakeholders”

- Builders
- Homeowners
- Policy-makers

ALASKA CENTER FOR
APPROPRIATE TECHNOLOGY

Mark D. Houston

- AHFC certified Energy Rater.
- First Passive House (PHIUS) Certified Rater in Alaska.
- Founding board member and VP Alaska Association of Energy Professionals (AAEP).
- Board member Alaska Center for Appropriate Technology (ACAT). Guiding Alaska towards Net Zero Construction.
- Adjunct in Construction Management Program UAA.
- Instructor for (ACHP) Alaska Craftsman Home Program.

Introductions

- Name
- Organization
- What brought you here today?

Defining Net Zero

Net Zero Ready

Net Zero

Net Positive

Net Zero Ready

- DOE Zero Energy Ready Homes are verified by a qualified third-party and are at least 40%-50% more energy efficient than a typical new home.
    - This generally corresponds to a **Home Energy Rating System (HERS) Index Score** in the low- to mid-50s, depending on the size of the home and region in which it is built.
- They are designed with plumbing and wiring chases and conduit, installed during new construction.
-
    - This allows for easy installation at a future time.

Net Zero: DOE's Energy Star for Homes

- Comply with **ENERGY STAR for Homes** and the **Inspection Checklists** for Thermal Enclosure, HVAC Quality Installation specifications.
  - Meet 2012 International Energy Conservation Code levels for insulation. Follow the latest proven research recommendations by installing ducts in conditioned space. Conserve water and energy through an efficient hot water distribution system that provides rapid hot water to the homeowner. Provide comprehensive indoor air quality through full certification in EPA's **Indoor airPlus** Program.

- Accomplish savings on the cost of future solar installations by following provisions from the Consolidated Renewable Energy Ready Home (RERH) **checklist** for climates with significant solar insolation.
  - This checklist references EPA's **solar electric guide** and the solar thermal **systems guide**.

Net Positive

- Provides MORE electricity than the building needs and can contribute that back to the grid.

- You can over-size your electrical generating system to make excess electricity as long as you have a Net Metering Policy with your local electric provider to buy it back.
- Alaska?

The reasons for Net Zero

- **The problem:** The average 2400-square-foot house burns around 100 million Btu of fuel per year. $$$$$$$$$$$$
- Health- Poor indoor Air Quality. Mold/Mildew. CO , CO2, Radon.
- Comfort- cold and hot spots through the building.
- Air leakage from the building.$$$$$$$$
- Durability/Life Cycle of the building.$$$$$$$$$$
- Energy independence. Savings $.
- The money you save can be used for anything you want! Financial security for retirement, investing, traveling!!!!!!

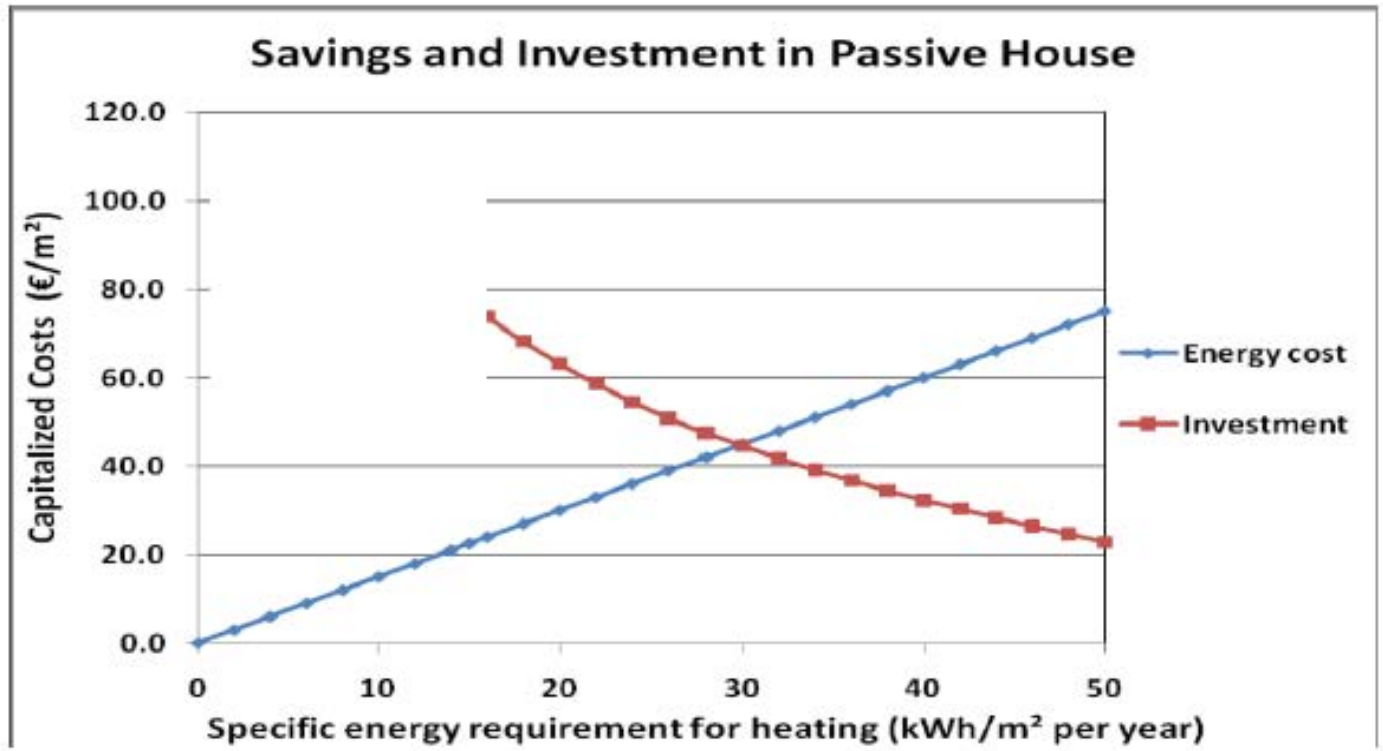
Types of fuel in Alaska

- Oil
- Gas
- Propane
- Coal
- Wood/Biomass
- Electric
- Solar- Thermal and Electric, Passive
- Heat Pumps
- Wind/Tidal/Hydro

Change the complexity!

- Cost of installing heating system and fuel rough-in for a standard building.
- Installation costs for Copper, boiler, side-arm, ect.
- Types of fuels.
- Sizing issues, heat loads.
- Electrical loads of heating/ventilating systems, Ect.

Costs and Estimates
International Energy Agency



Note: Costs are for central Europe (Germany)

(Source: IEA Information Paper: Energy Efficiency requirements in Building Codes, Author Jens Laustsen)

Costs and Estimates
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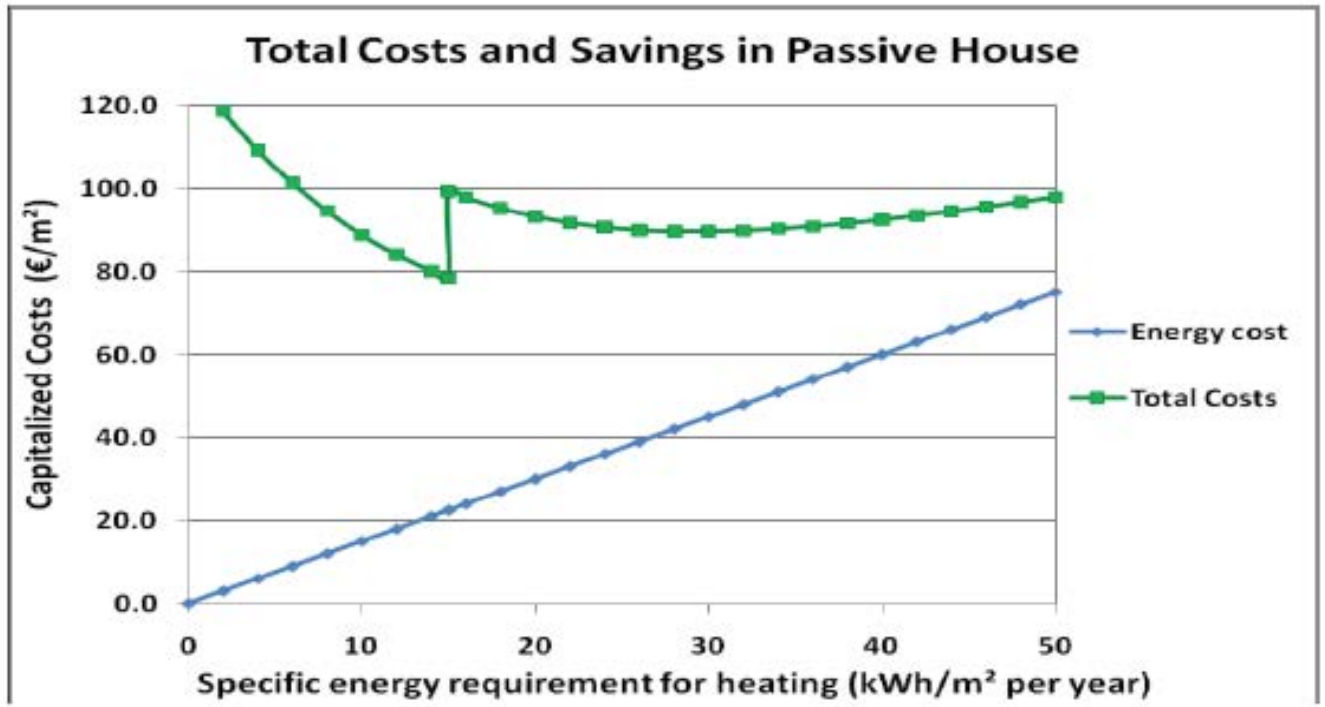

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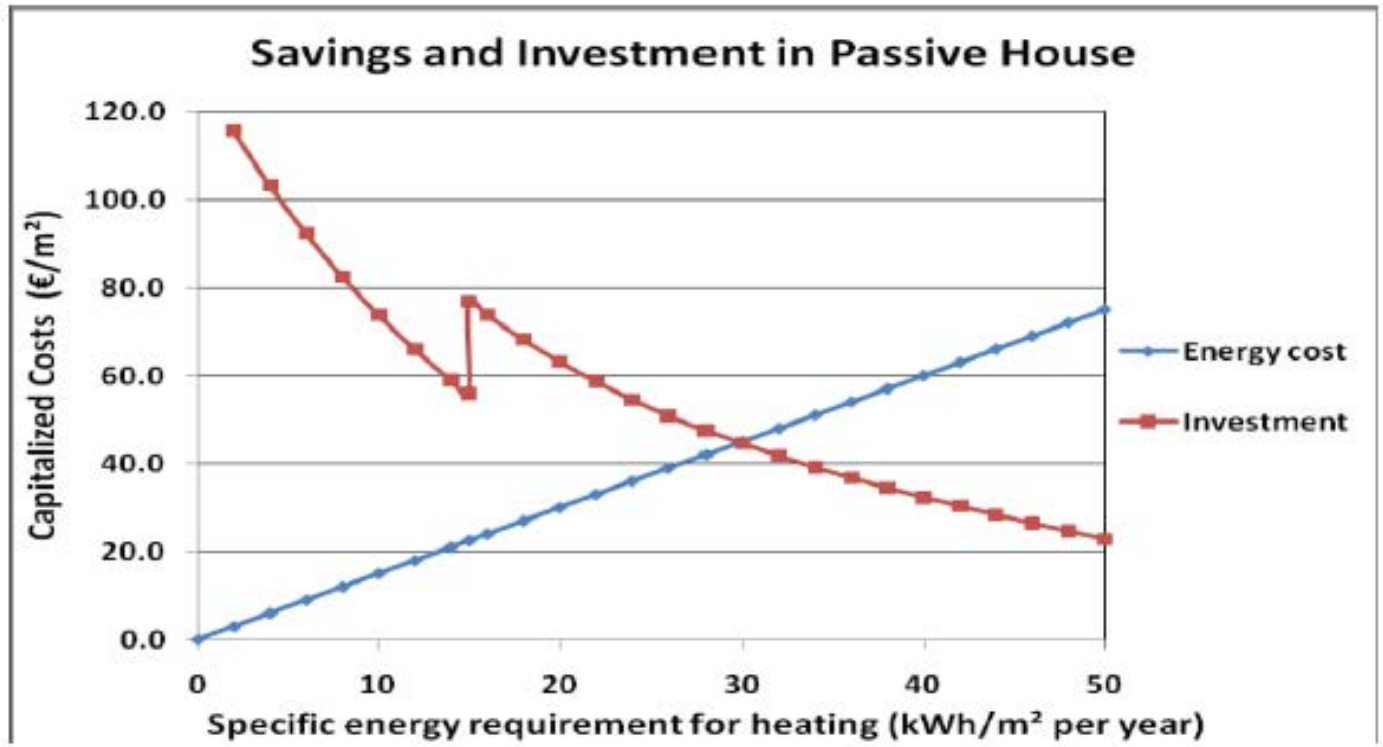


Note: Costs are for central Europe (Germany)

(Source: IEA Information Paper: Energy Efficiency requirements in Building Codes, Author Jens Laustsen)

Do the Math!!!

- A home that costs $200,000 would be about $240,000. Extra 20% cost to build.
- Federal Tax Credits NOT included!
- Good until the end of 2016!
- 30% tax credit on a $35,000 Heat Pump/ Solar system would be $10,500.
- $40,000 extra cost-$10,500=$29,500 after Tax Credit.

On Gas

- The annual heating cost for a Net Zero home in Anchorage would be about $120.
- $1200-$120=$1080 Savings per year.

- $1080 x 20yrs = $21,600* savings.

- $29,500 Tax Credit

- $240,000-$29,500*=$210,500 initial investment.

- *This DOES NOT factor the increase of gas over the next 20 years!

- Will the cost of gas over 20 years go down?

On oil

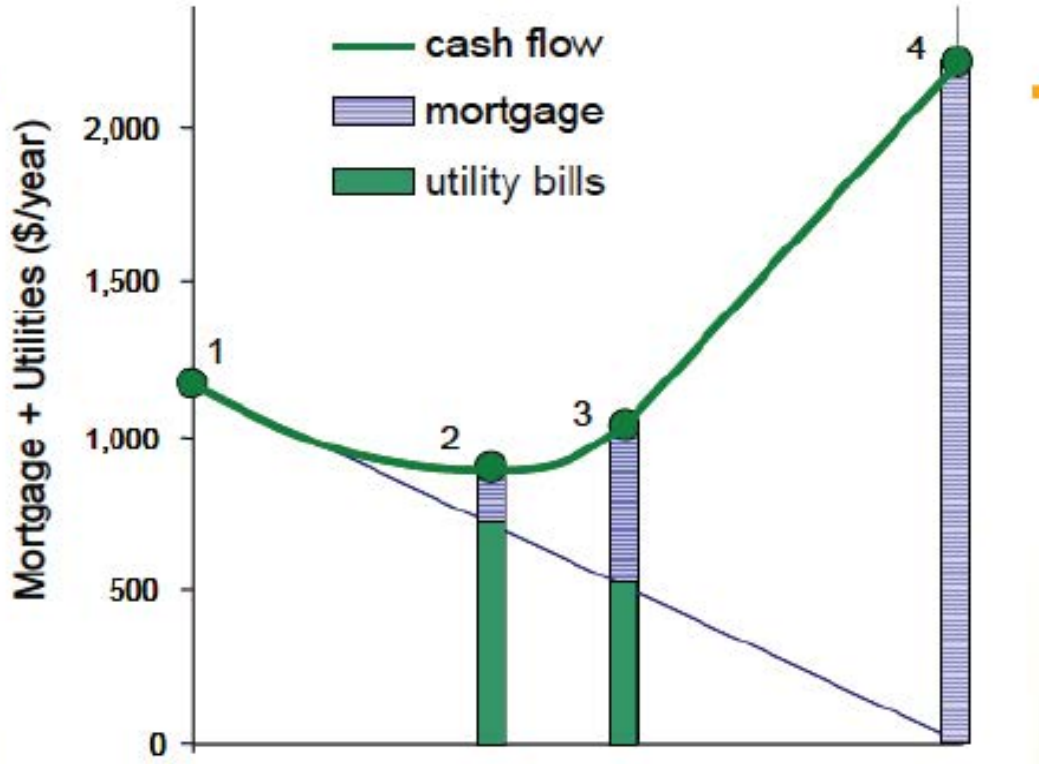
- Same home on oil: Annual Cost $3600

- $3600 - $360 = $3240 savings annually.
- $3240*20years=$64,800 savings over 20 years.

- 20 year life cycle - $40,000 up front - $64,800=(+$24,800)!

- The money you save can be used for anything you want! Financial security for Retirement, Investing, Traveling!!!!!!

PHIUS
Passive House Institute US



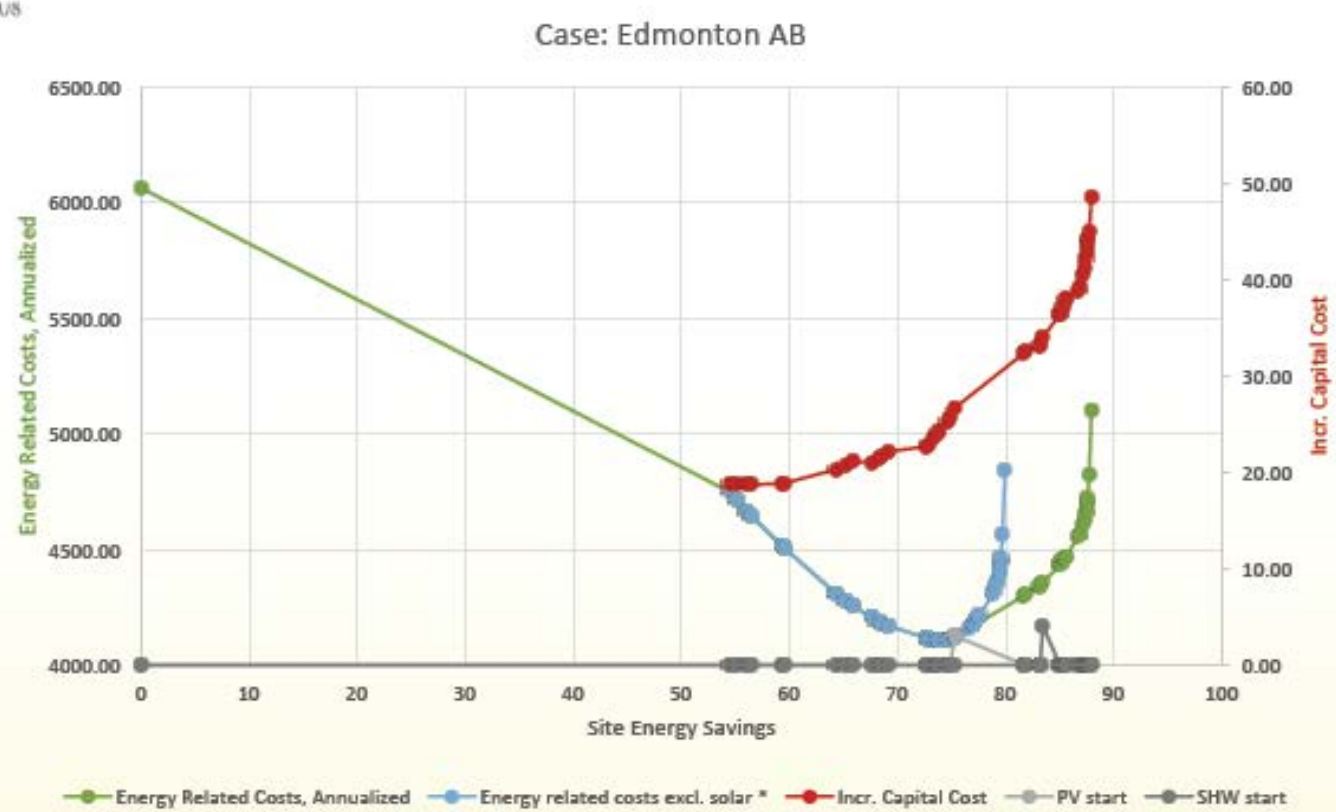
Conceptual plot of the "path to Zero Net Energy"

[NREL/CP-550-37733]

Financial parameters strictly conventional, e.g. 30-year analysis period.

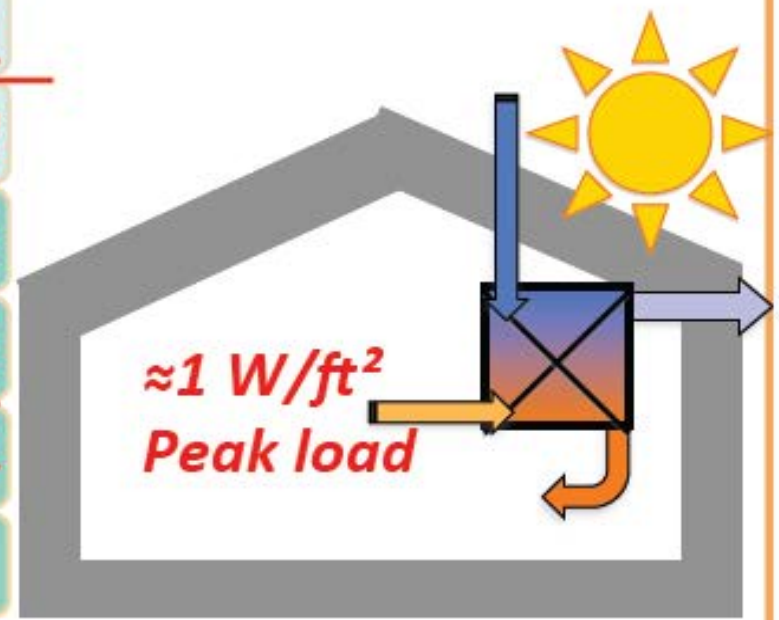
Energy prices vary state-by-state.

PHIUS
Passive House Institute US



PHIUS+ Certificate Requirements: *Current Program (aligned w/ Europe)*

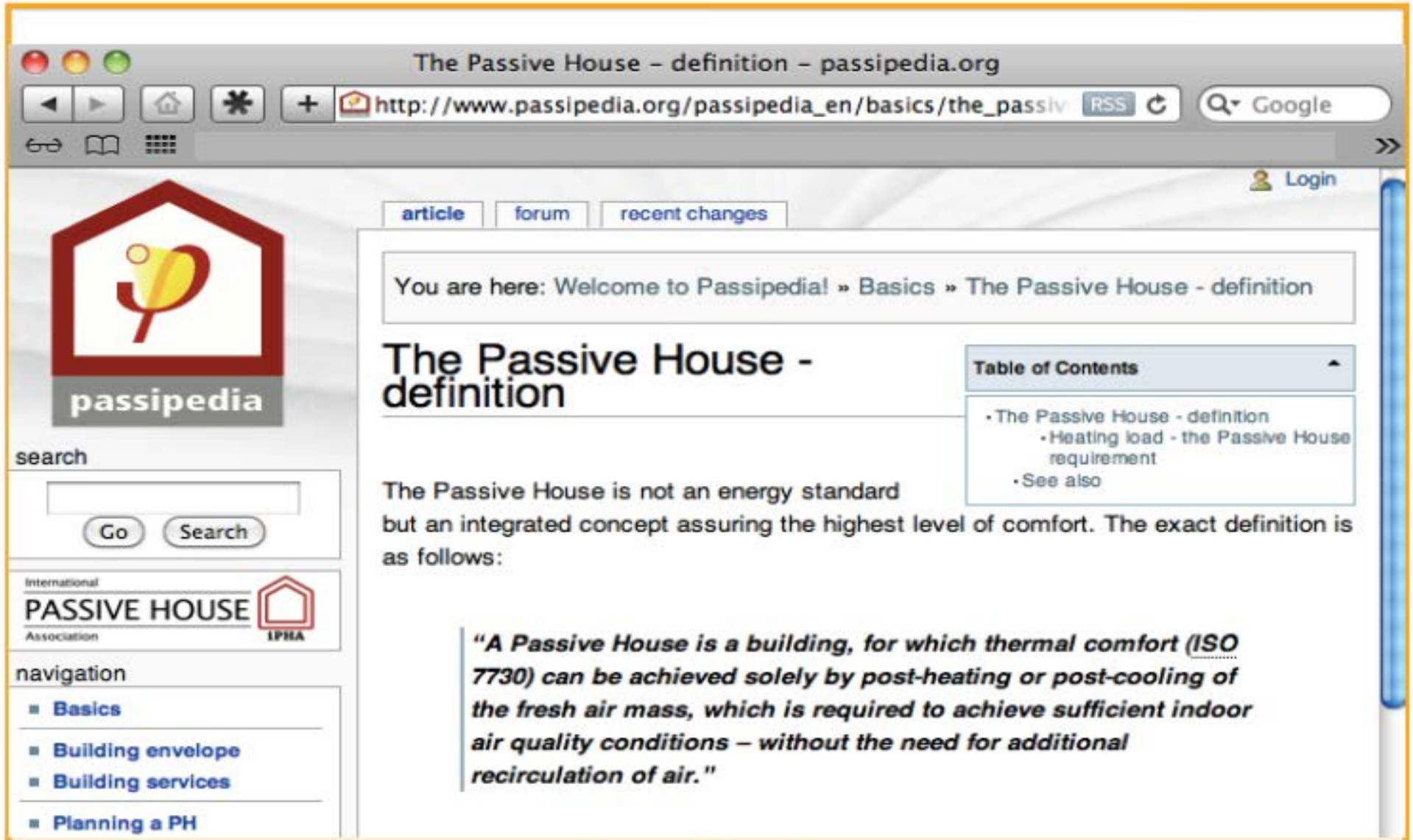
Annual Heat/Cooling Demand	• ≤4.75 kBTU/ft²yr (15 kWh/m²a)	Required
	--OR--	
Peak Loads (heating/ cooling)	• *≤ 3.17 BTU/hr.ft² or 0.93W/ft² (10 W/m²)*	
Primary Energy Demand	• ≤38 kBTU/ft²yr (120 kWh/m²a)	
Airtightness	• ≤ 0.6 ACH_{50}	
Ventilation	• ≥75% Recovery, ≥0.76 W/cfm	Recommended
Thermal Envelope:	• R min ≥ 38.5 hr. ft²°F/BTU, U ≤ 0.026 BTU/hr. ft²°F	
Thermal-bridge Free	• Ψ ≤0 .006 BTU/ hr. ft °F	
Windows installed:	• $U_{w\text{-}install}$ ≤ 0.15 BTU/hr. ft² °F	
SHGC	• SHGC 0.5 – 0.55	



How can we get there?

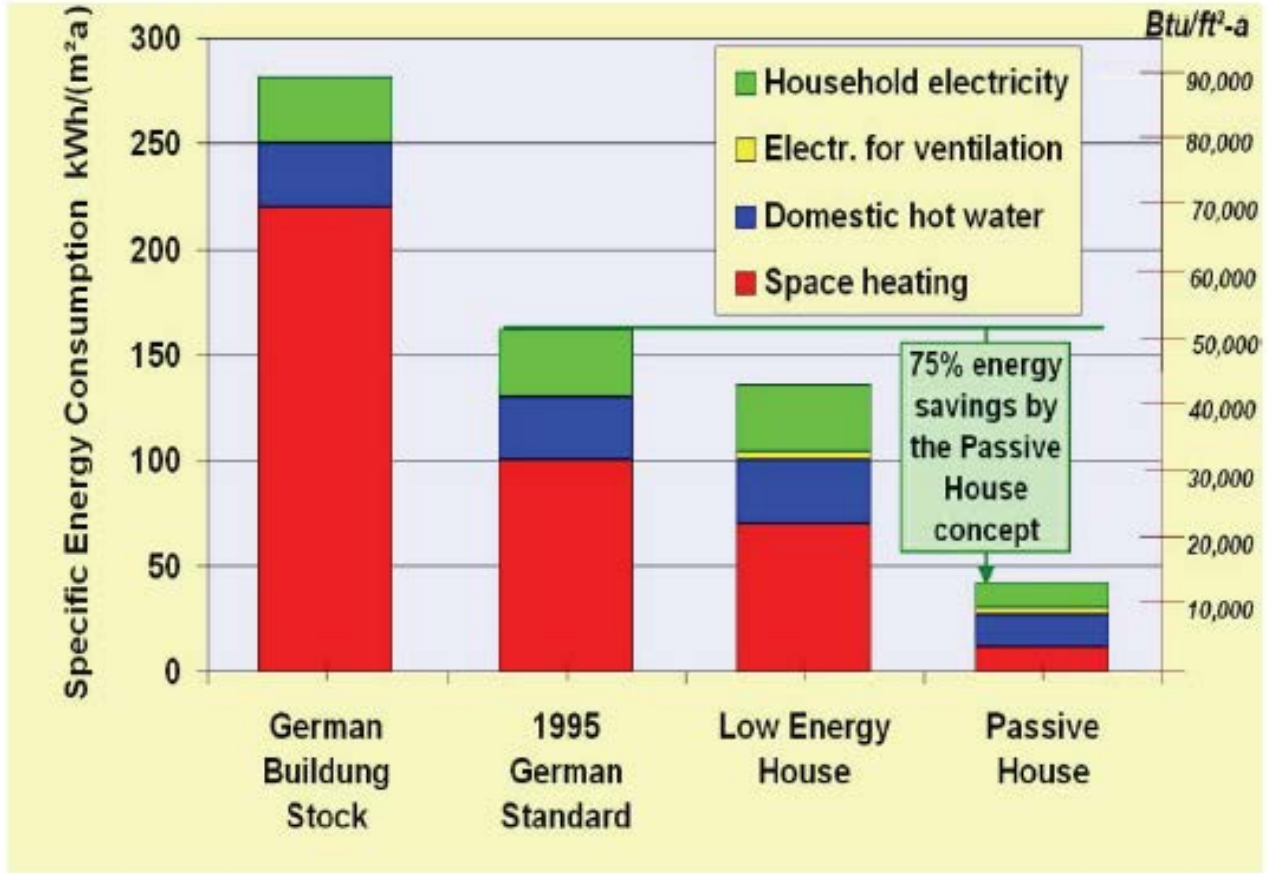
- DOE programs
- Passive house
- Living Building Challenge

- Build Sustainable Buildings!
- Creates good paying jobs worldwide.
- SAVES…….



Source: Passipedia

Passive House: Factor-10 Reduction in Space Conditioning Energy



(Source: Krapmeier and Drossler 2001)

Envelope and Thermal Comfort Principles

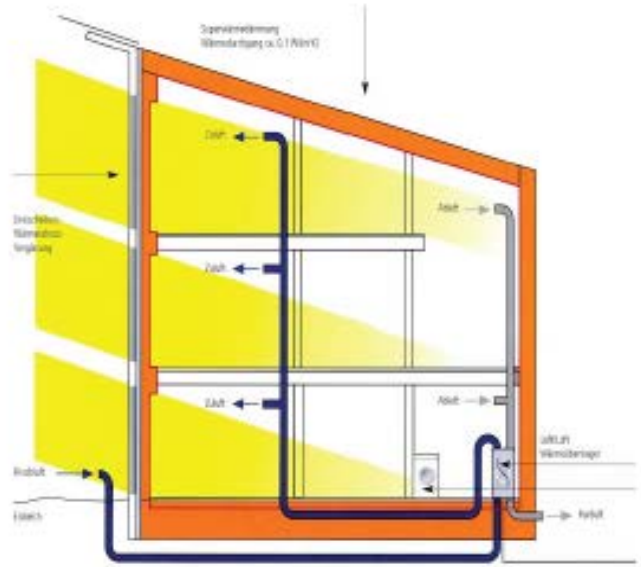
1. **Compact Building Shape** – efficient surface to volume ratio

2. **Continuous Insulation-** creating steady indoor temperatures that won't drop below 50 degrees without heating source – passive survivability

   - **Thermal Bridge Free Construction-** avoids condensation / building deterioration

   - **Air tightness-** minimizes heat losses and moisture diffusion into wall assembly

3. **Balanced Ventilation with Heat Recovery with minimal Space Conditioning System -** exceptional efficiency, indoor air-quality and comfort



4. **Optimal Solar Orientation and Shading** maximizing solar gains for winter, minimizing gains for the summer case

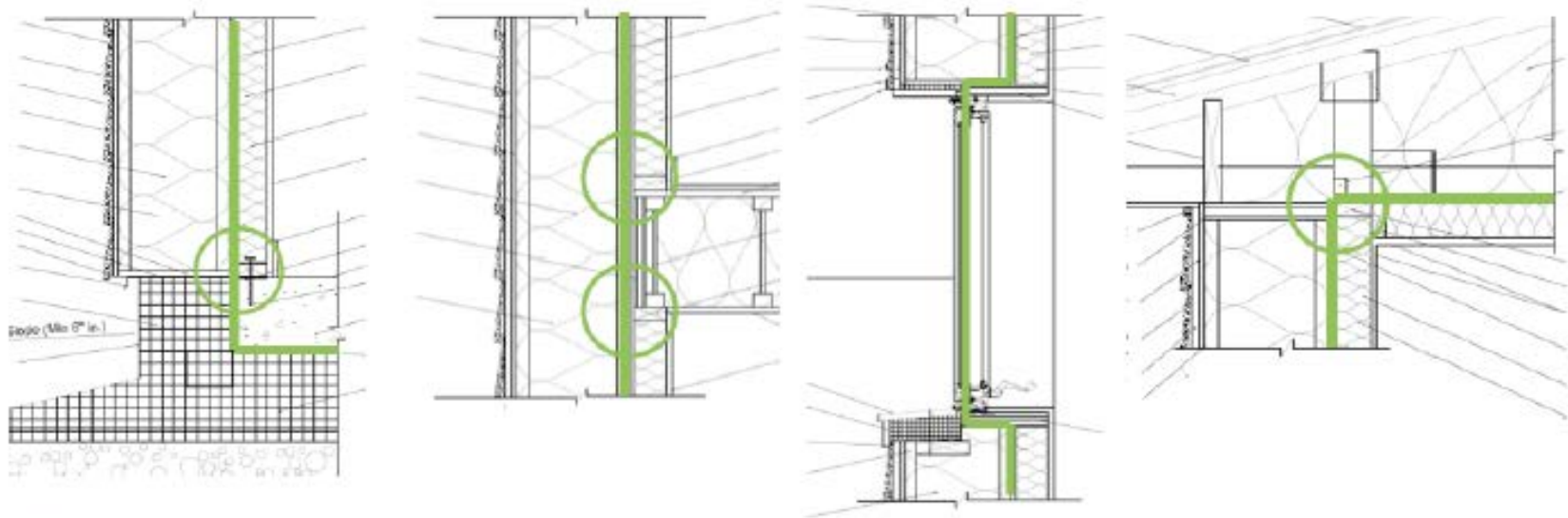
5. **Energy Efficient Appliances and Lighting-** highly efficient use of household electricity

EXAMPLE:

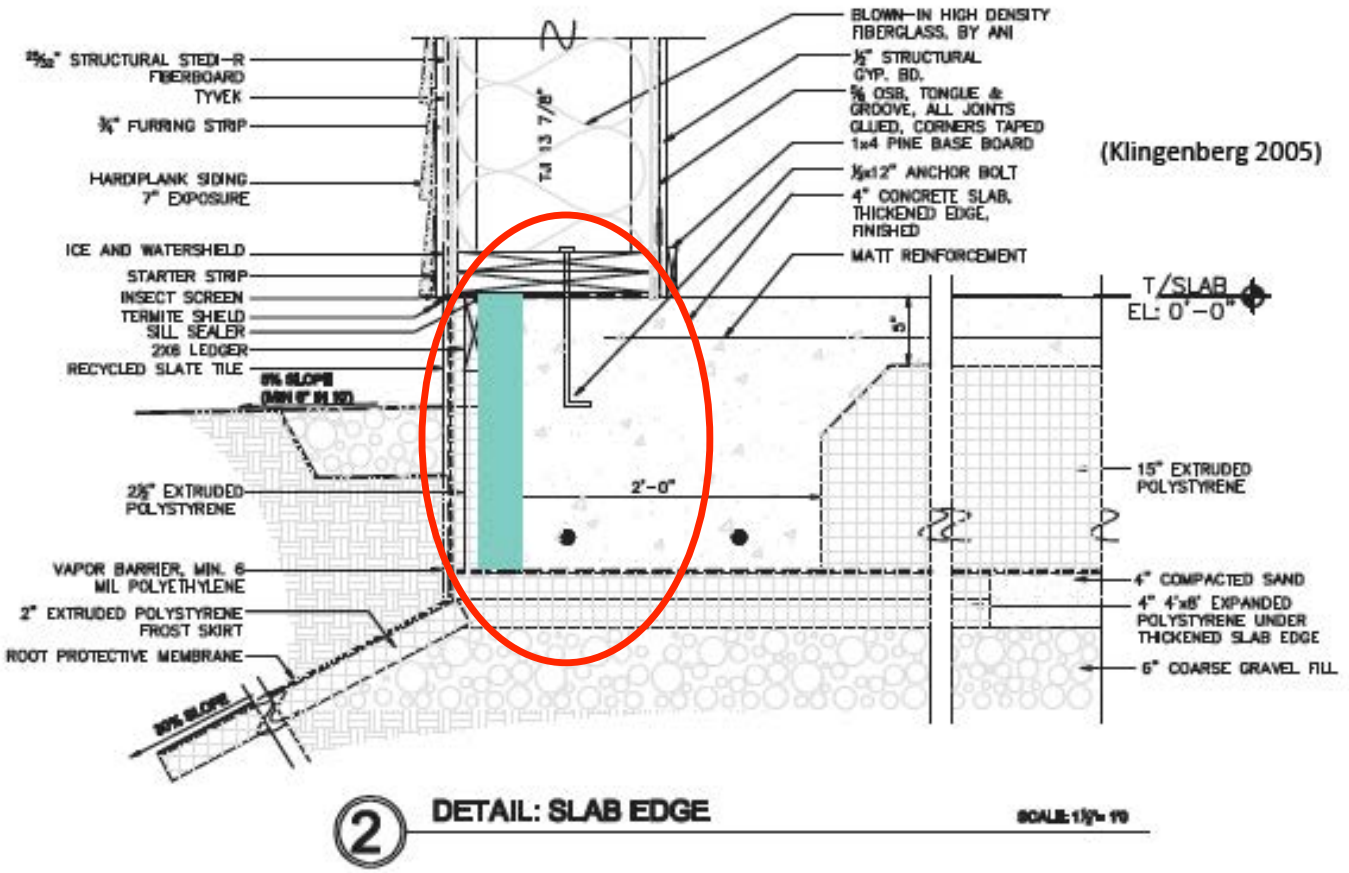
Desired result: Air-tight house (<0.60ACH50)

Technique: Air-tight sheathing method

Process:



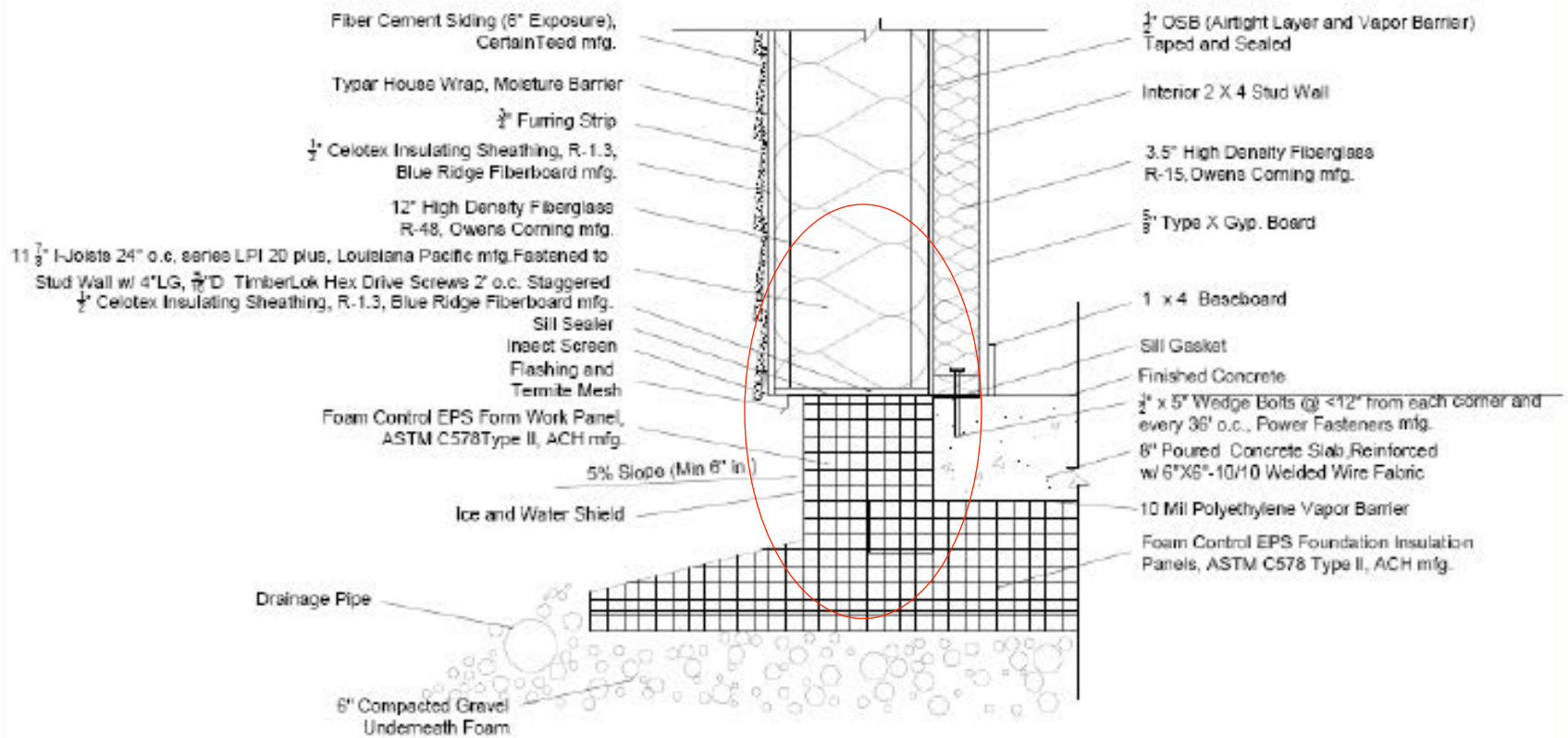
Perimeter Thermal Bridge



(Klingenberg 2005)

Minimized insulation around the perimeter of the slab leads to cold spots on the inside of the wall!

Insulated Foundation Execution



1 DETAIL: FOUNDATION SCALE: 1"= 10

Affordable Dublin House – 2010, Urbana Illinois

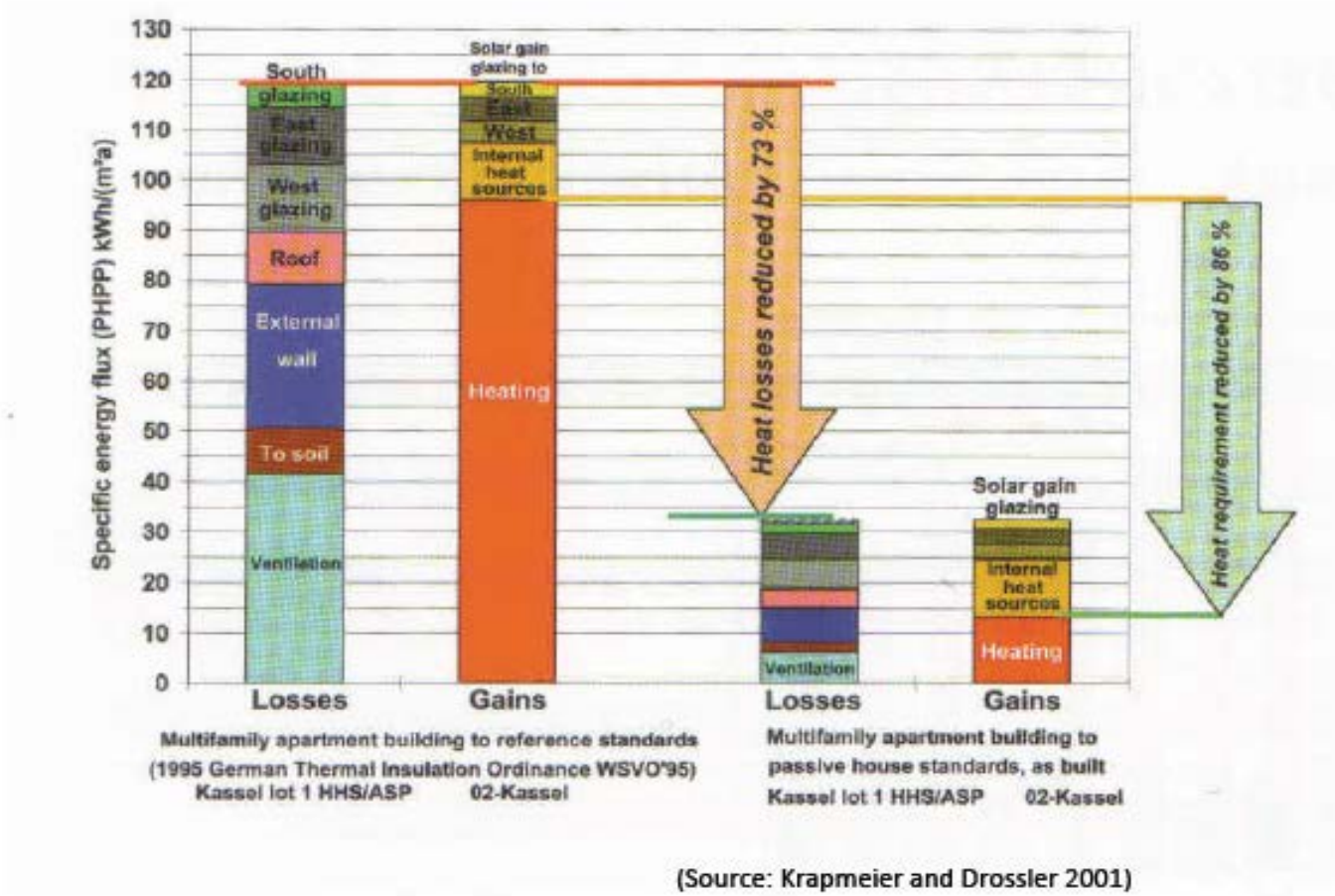
Driving down Heat Loads

- The only ways to reduce heating losses is **air tightness** and **thermal containment**.

- Thermal storage can provide long term control over losses as well. This also helps controls temperature swings.

- Use exhausting air as heat source. You already “own” the heat!

Minimize Losses First – Optimize Gains



(Source: Krapmeier and Drossler 2001)

Good Thermal Boundaries

- R Values will differ depending on climate zones. We have 7 in Alaska alone.
- TOTAL thermal control is mandatory to drive down BTU consumption.
- This includes below the building and Thermal Bridging.

Envelope and Thermal Comfort Principles

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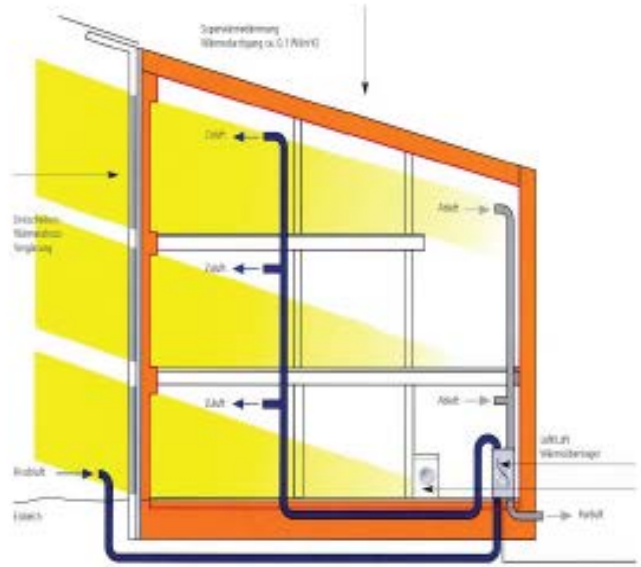

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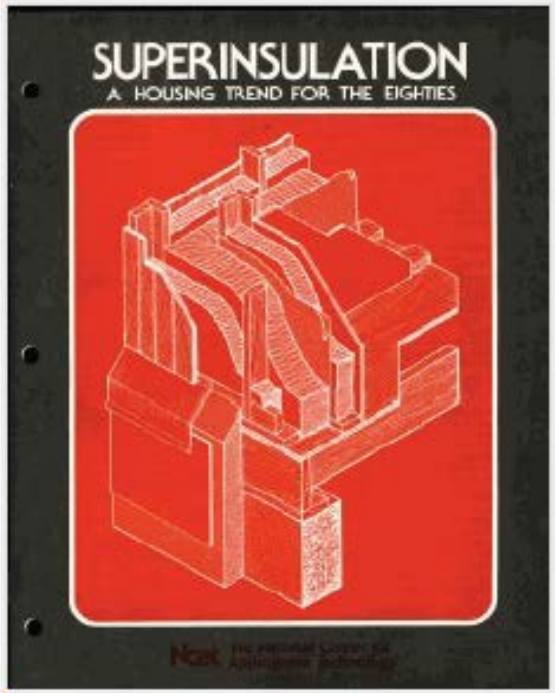
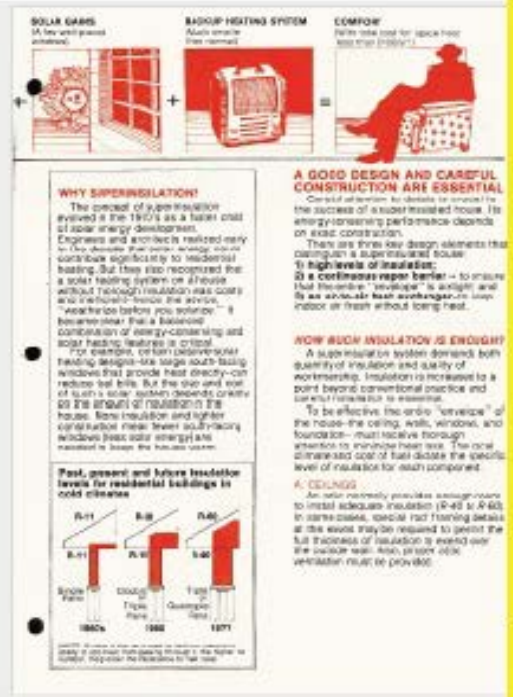
Superinsulation in Montana

National Center for AppropriateTechnology





Source: National Center for Appropriate Technology: Superinsulation - A Housing Trend for the Eighties

Website National Center for Appropriate Technology: http://www.ncat.org/

(Source and ***READING ASSIGNMENT*** : NCAT: Superinsulation)

Old vs. New Concepts?

- R19 walls
- R38 ceilings
- Little insulation in crawlspaces, especially in the middle of floor
- 80% furnaces and boilers
- 54% water heating
- High air leakage!

Passive House Metric

Heating load ≤ 10 W/m2h (1.76 BTU per s.f. per hour).

- This is derived from 3 separate values.
  - First, fresh air supply of 1000 cubic feet per hour per person for good indoor air quality.
  - Second, the specific heat capacity of air.
  - Third, the amount you can increase the temperature of fresh air temperature without burning dust in the air.

From these 3 factors, we know that we can supply 300 W of heat per hour per person by a fresh air heating system.

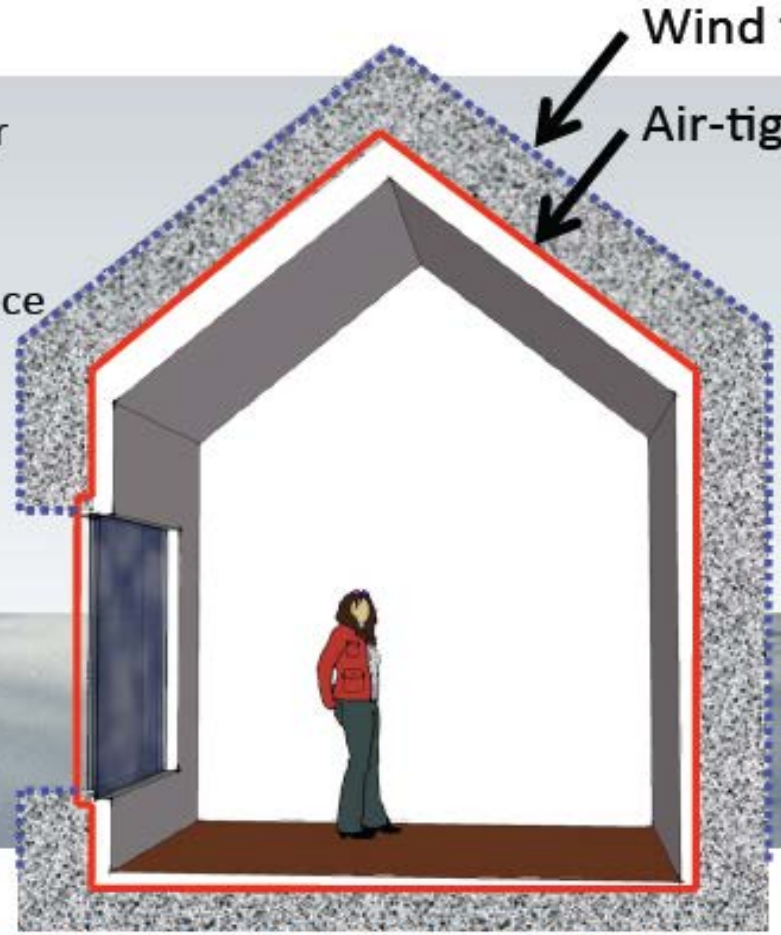
Watts / Sq Ft

- PHI definition: Supply air heating sufficient.
  - Can be done if peak heat load < 10 W per m2 of floor area.
- Expensive hydronic heating system can be eliminated - tunnel through cost barrier.

Tight Air requirements

- Passive House REQUIRES .6ACH blower door or LOWER to meet lower Heat Loads.
- Anchorage average is about 4.20ACH
- Fairbanks average is about 2.4ACH
- This means VENTILATE RIGHT!
- Bath exhaust and fresh intakes won't cut it!
- HRV and ERV is REQUIRED in order to meet **0.6ACH!**

Air Tightness



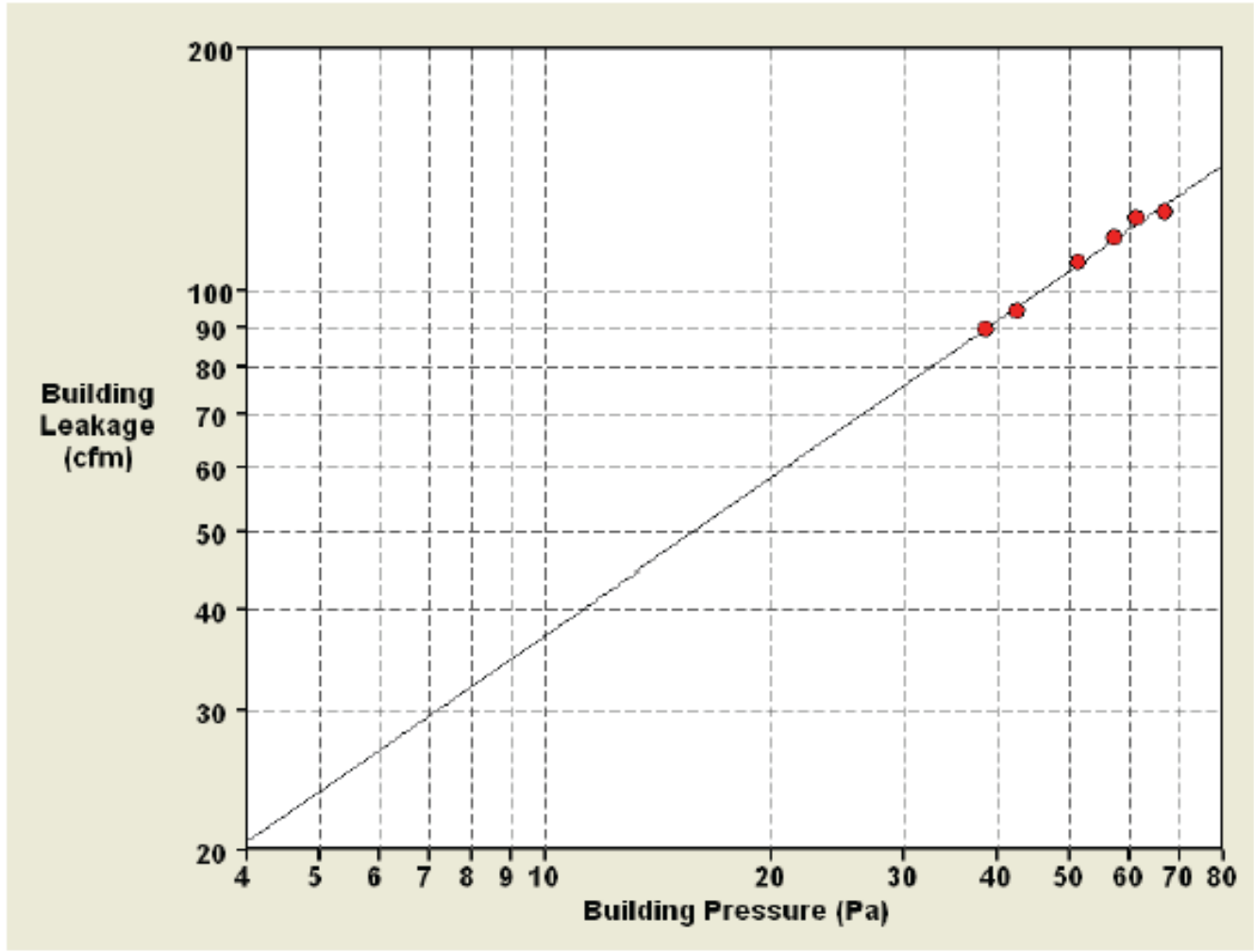
Factors affected by air tightness:

- Moisture Performance of wall
- Heat loss through leaks
- Comfort, no drafts!

RED LINE RULE

- Draw continuous air barrier
- Identify each air barrier component
- Identify connection between them

Blower door testing



PHIUS
Passive House Institute US

PH

Balanced Pressures

- The building needs to have balanced pressure between the inside and outside air.
- With a super insulated, Air tight envelope, how is this accomplished?
- Balanced Ventilation with HRV/ERV’s

Ventilation

- With a blower door test requiring 0.6ACH50, the only way for the home to have acceptable IAQ (Indoor Air Quality) is with complete air change over.

- The EPA has concluded that a healthy level is 5 complete Air Changes per 24 hour period.

Bath fan and fresh intake

- Exhausts 100% of heat when running. No Recovery!
- Brings in cold through leakage in the building or passive vents (fresh 80/100).
- Wastes heat when you need it the most, to prevent mold and mildew issues. WINTER!
- If no intakes, this can bring pollutants into the home: fiberglass from walls, CO down flues, Radon and allergens from crawlspaces, basements and through air inlets.
- Not going to work on a Net Zero Building!

HRV/ERV the best solution

- Balanced Pressure between inside and outside. Prevents moisture from being driven into walls and insulation.
- Heat Exchanger -Brings in fresh outside air, pre-warms it with exhausting air which has high RH, pollutants and odors.
- 75%-95% Heat recovery. This becomes your main source of heating.
- This is heat you have already paid for! (or got it free from passive solar gains and internal gains!)
- The building will keep it in!

GET OVER THE PRICING!

- We have stepped in to a new type of building!
- You have essentially made it air tight!
- IT NEEDS TO BREATHE!
- You have driven the heat load down to 10% of a conventional building. You no longer need conventional heating systems, therefore you have the budget for this product.

A new way of thinking about buildings

- Super Insulated Envelope
- Air tight
- Balanced Pressures
- Air Exchange/Heat Recovery
- Internal recoverable Heat Loads

Super Insulated Envelope

- Attic
- Walls
- Fenestration
- Foundations

Envelope and Thermal Comfort Principles

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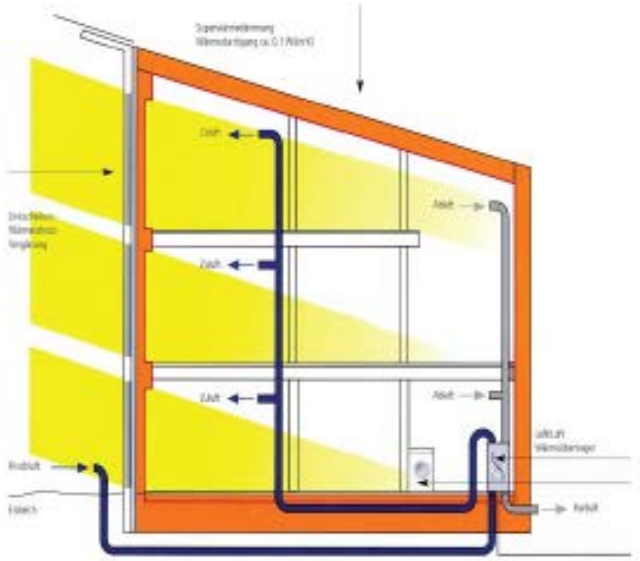


4. **Optimal Solar Orientation and Shading** maximizing solar gains for winter, minimizing gains for the summer case

5. **Energy Efficient Appliances and Lighting-** highly efficient use of household electricity

R-60 walls

R-100 ceilings

R-60 below floors

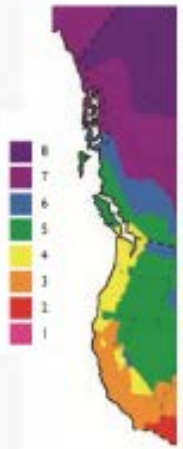
Fenestration

- Openings in Thermal Boundary.
- Windows/Doors.
- Utility, Ventilation, other penetrations.
- Air tight installation requires special details.

Climate Specific Window Design

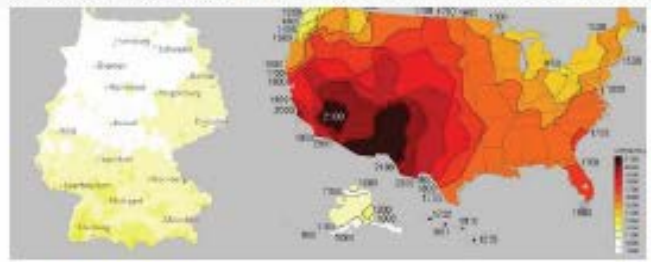
Recommendations by Climate Zone

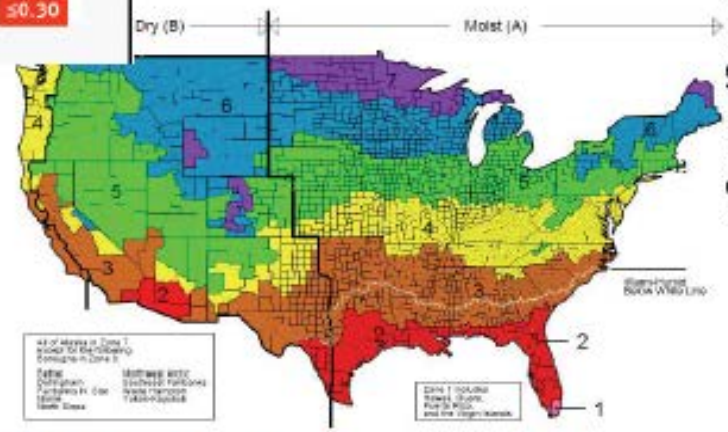
PHIUS – Climate Specific Window Selection Guidelines



ASHRAE/DOE North American Climate Zone	Overall Installed Window U-value - U_w Btu/hr-ft²-°F	Center of Glass U-value - U_g Btu/hr-ft²-°F	SHGC – South	SHGC – North, East, West
8	≤0.11	≤0.10	≥0.50	≤0.40
7	≤0.12	≤0.11	≥0.50	≤0.40
6	≤0.13	≤0.12	≥0.50	≤0.40
5	≤0.14	≤0.13	≥0.50	≤0.40
4	≤0.15	≤0.14	≥0.50	≤0.40
Marine North	≤0.16	≤0.15	≥0.50	≤0.40
Marine South	≤0.22	≤0.20	≤0.50	≤0.30
3 (west)	≤0.18	≤0.16	≤0.50	≤0.30
2 (west)	≤0.18	≤0.16	≤0.30	≤0.30
2 (east)	≤0.20	≤0.18	≤0.30	≤0.30

→ Reference: Table Values PHIUS, Climate Map DOE/ASHRAE/NECB Zones by RDH





Source: www.energycodes.gov

PHIUS Window By Climate Zone

ASHRAE/IECC/DOE North American Climate Zone	Overall installed window U-value Btu/h.ft2.F	Center-of-glass U-value Btu/h.ft2.F	SHGC - South	SHGC - North, East, West
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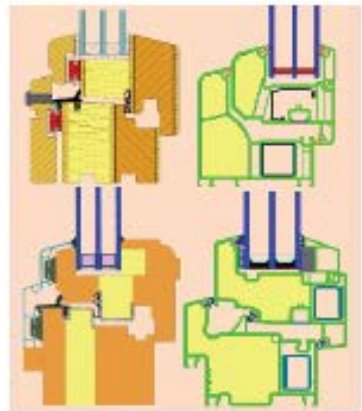
3	≤0.18	≤0.16	≤0.50	≤0.30
2 West	≤0.18	≤0.16	≤0.30	≤0.30
2 East	≤0.20	≤0.18	≤0.30	≤0.30

Insulated Airtight Doors



- Passive house window frames, door frames and doors for cold climates need to be insulated

- Multiple lock systems for operable windows and doors to ensure air-tightness and even wear

- Excellent, multiple seals at sill

Transparent Components

1. **U-value-** glazing and overall U-value, creating warm surface temperatures, avoiding convection, insulated, thermally broken frames

2. **Quality of Spacers -** super spacers

3. **Solar Heat Gain Coefficient**

4. **Air Leakage-** multilock systems, no common sliding glass doors, double hung windows (lift and slide – sliding glass doors are the only sliding option available

5. **Sun light Transmittance VT-** visible transmittance (number between 0 and 1) and light-to-solar gain ratio (ratio between light-to-solar gain and VT

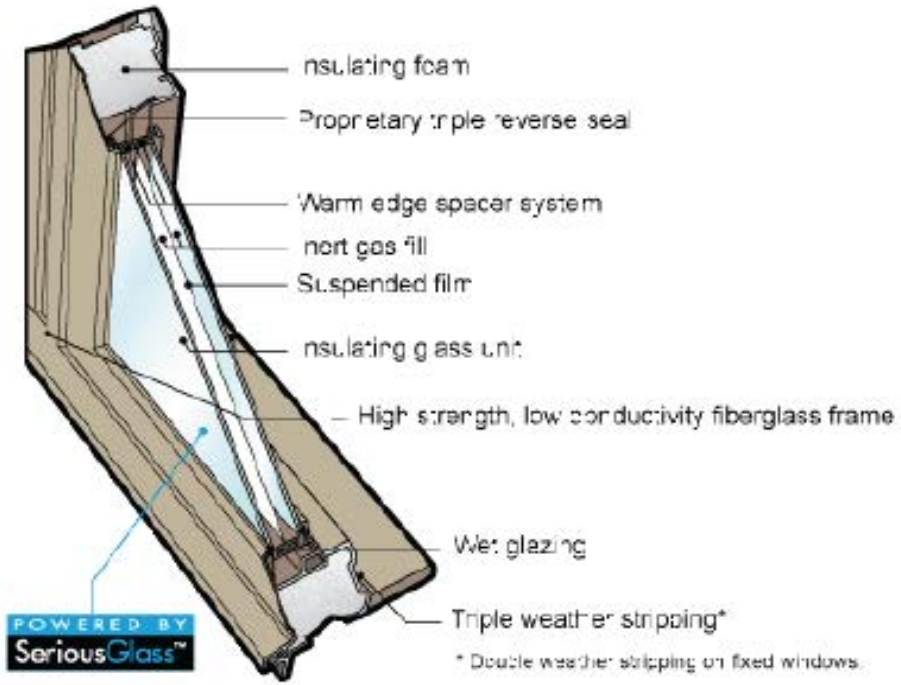
6. **Wind and Water Resistance**

European Window Styles

Tilt-Turn

- Dual action with trickle vent in tilt
- Strong hardware and frames - up to 4’ x 8’ operable
- Most are in-swing
- Easy cleaning
- Unfamiliar action to many
- Screens typically not included

North American Window Styles



www.seriouswindows.com

Mostly Casements / some offer Tilt-Turn

- Insulated Fiberglass and Vinyl frames, sizes are limited for operable
- Most are out-swing
- Familiar action to many
- Screens typically included
- Mounting flange and casing extension for frame and brick installations

OPTIMIZE FOR ASPECT

Penetrations

- Reduce the number of penetrations.
  - Plumbing
  - Electrical-lights, outlets
  - Roof jacks-range hood, bath fan, dryer vent.
- Tapes and foam sealants and caulks.
  - Isocell
  - Siga

Foundations

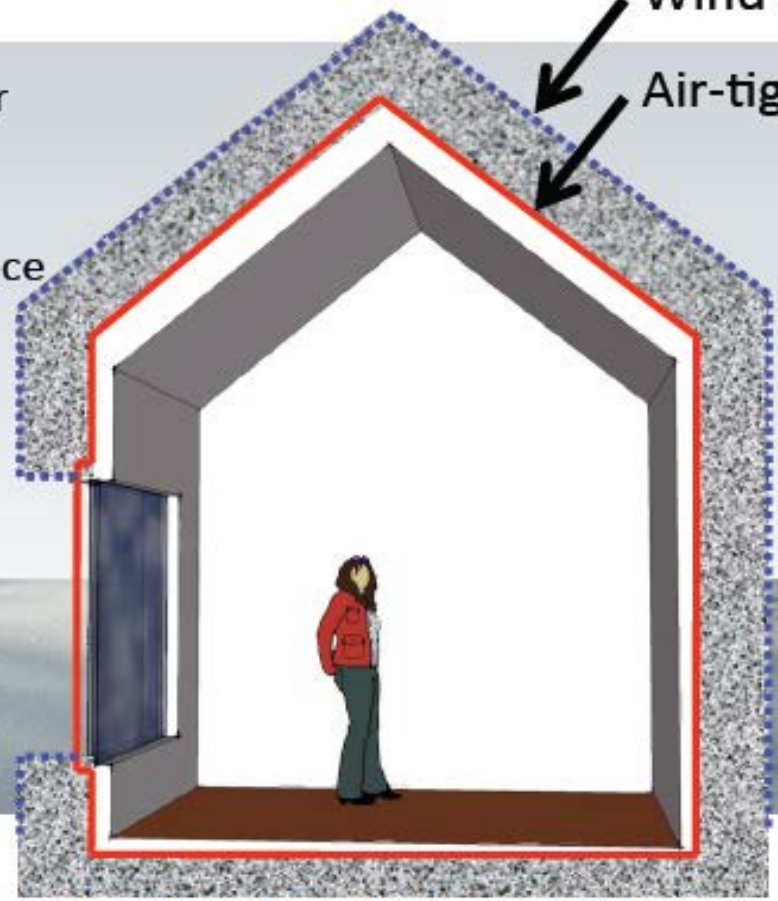
Air tightness/ Balanced Pressures

- .6ACH
- How do you reach this level?
- TEST,TEST,TEST! 3 Stage Testing.
- You WILL need the HRV/ERV system!
- Due to low heating loads you will NOT need conventional oil or gas boilers! You do not want them anyway, They are a liability!

Air Tightness

Factors affected by air tightness:

- Moisture Performance of wall
- Heat loss through leaks
- Comfort, no drafts!



RED LINE RULE

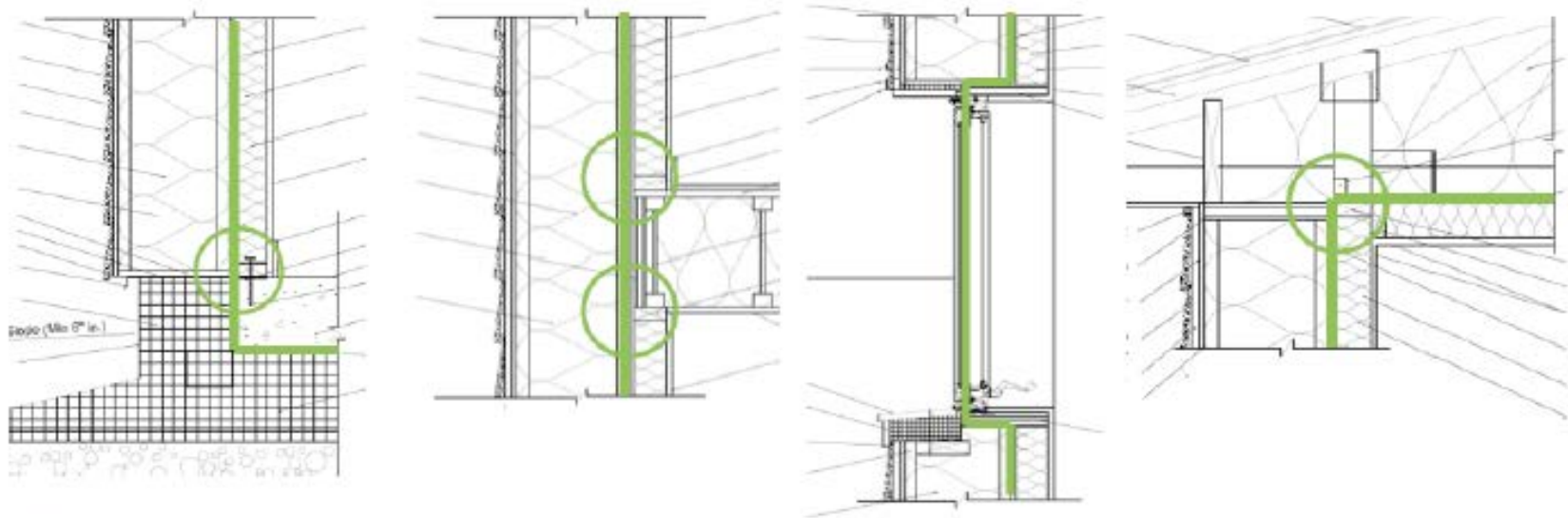
- Draw continuous air barrier
- Identify each air barrier component
- Identify connection between them

EXAMPLE:

Desired result: Air-tight house (<0.60ACH50)

Technique: Air-tight sheathing method

Process:



Air changes

- 5 Complete Air Changes per 24Hrs. (EPA)
- You WILL need the HRV/ERV system!
  - This provides the changes necessary due to the tightness.
- Free heating by over 90% heat recovery!

Heating

- The building is so well insulated and air tight, only supplemental heat is be required.

- The use of Thermal Mass to retain Solar Gains helps keep temperatures stable over long periods of time.

- The BTU load is lower than 90% that of a home the same square footage!
- The building will be heated with the Recovery Unit as the primary heat source!

Air Ventilator/Heat Exchanger

- Brings in fresh outside air, pre-warms it with exhausting air which has high RH, pollutants and odors.

- This unit now becomes your' primary heat source, re-capturing losses of the gains from solar, internal loads and occupants of the building.

Shall we take a break to absorb this?

- We have driven the Heat Load calculations for the building down to about 10% of a typical building.
- It would be impossible and too expensive to get to 0%.
- What we have done is set ourselves up to control the indoor air temperature and quality with an **Air Ventilator/Heat Exchanger**. HRV or ERV.
- We have eliminated the need for fossil fuels for heating and hot water production, thus eliminating the un-predictable, cost of heating.
- We have replaced that with a building that can retain the heat from passive solar gain, the heat from the occupants and other heat from appliances that can be re-captured like refrigerators, freezers, dryers, computers, televisions, exc.
- We can now produce enough extra energy required with other natural no-carbon devices.

Let's Review

Now that we have done all this we can address the supplemental heating needs.

- We have driven the Heat Load calculations for the building down to about 10% of a typical building.
- It would be impossible and too expensive to get to 0%.
- What we have done is set ourselves up to control the indoor air temperature and quality with an Air Ventilator/Heat Exchanger. HRV or ERV.
- We have eliminated the need for fossil fuels for heating and hot water production, thus eliminated the un-predictable, cost of heating.
- We have replaced that with a building that can retain the heat from passive solar gain, the heat from the occupants and other heat from appliances that can be re-captured like refrigerators, freezers, dryers, computers, televisions, cooking ect.

Heat Recovery-Primary Heat Source!

- We have reduced our Heat Load Calculations to the lowest, cost effective levels, and kept the building from being a liability to itself.

- By turning to the Heat Recovery system we are capturing over 90% of the heat that is already in the building AND changing the air in the building at the same time!

- We will use that as our primary heat source!

- We only need to supplement that with other sources for the coldest times of the year.

Let’s look at “Fuels” types in Alaska again.

- Recovered Heat Loss through HRV/ERV systems
- Oil
- Gas
- Propane
- Coal
- Wood/Biomass
- Electric
- Solar- Thermal and Electric, Passive
- Heat Pumps
- Wind/Tidal/Hydro

Throw out Oil, Gas, Propane, as Coal options!

- Recovered Heat Loss through HRV/ERV systems over 90%.
- Wood/Biomass.
- Electric- Wind/Tidal/Hydro .
- Solar - Thermal, Passive and Electric.
- Heat Pumps - Electricity REQUIRED!

It’s all about the Envelope!
Review

- We have a heat load 10% of a typical home.
- Remember: The Reason for Net Zero?
- **The problem:** The average 2400-square-foot house burns around 100 million Btu of fuel per year. $$$$$$$$$$$$
- Health - Poor indoor Air Quality. Mold/Mildew. CO, CO2, Radon.
- Comfort- cold and hot spots through the building.
- Air leakage from the building.$$$$$$$
- Durability/Life Cycle of the building.$$$$$$$$$
- Problem Solved by building a Net Zero Building!

75%-85% Heat recovery OLD Style

- Old style HRV/ERV
- High electrical usage
- Lower energy recovery rates (70-85%)
- Leaky duct work, Rarely balanced!

HRV’s

- Heat Recovery Ventilators.
- Some have web enabled online access.
- Some have the ability to be controlled by Smart Home systems.
- LOW wattage consumption, 36w@60cfm,120w@150.
- Pre-heat through ground loops, Heat pumps.
- Best NOT to use electric resistance or fossil fuels for pre-heat in cold temperatures.
- Tend to Dry Out the building.

PHIUS Level HRV- NEW Style

- Higher Heat Recovery than older styles.
- 90-95%
- Have Ground source pre-heating.
- Tight ducts! Easily balanced
- Some have web enabled online access.
- Some have the ability to be controlled by Smart Home systems.
- LOW wattage consumption PHIUS mandated.

- “Finally you will list the HRV or ERV for your project. If your unit has not been certified by PHI, they will take 12% efficiency off of any accredited score the unit has. They do this because sometimes the reported manufacturing figures are a bit elevated because of ideal test conditions, and not real world conditions.” The Passive House Blog by Linda Whaley

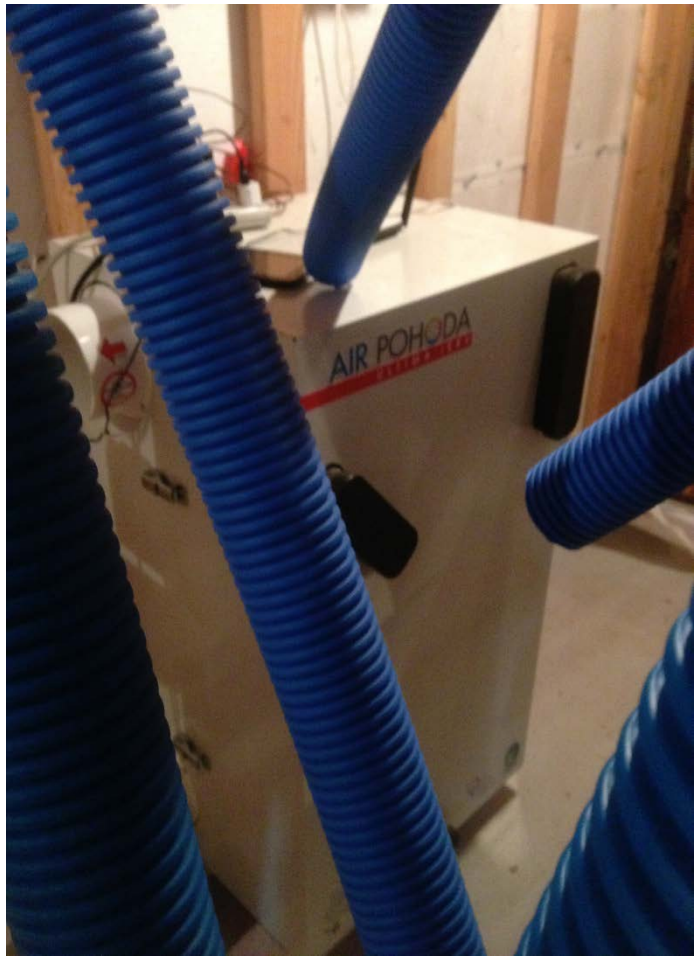
PHIUS Level ERV- New Style90-95%

- NOT just for warm humid climates anymore.
- Some ERV's are capable of reversing flow to de-frost at cold temperatures, down to -20F.
- Can also have ground loops like HRV's for colder areas.
- ERV's have humidity controls which keep the home from drying out.
  - Work best with Triple pane, Low U Value windows.
- Some have web enabled online access.
- Some have the ability to be controlled by Smart Home systems.
- LOW wattage consumption 36w@60cfm,120w@150.
- Control the humidity levels!

FRESH AIR!!!

- These systems change the air in the building 5 times per day!
- They have minimal MERV requirements of 8 but the better ones are 12-15. This is in the range of HEPA filters.
- They filter out dust, pollen, smoke* and other unhealthy air from outside the building.
- CONTROL HUMIDITY
- *In Alaska we have wild fires! Remember last summer?

Balanced Ventilation Systems



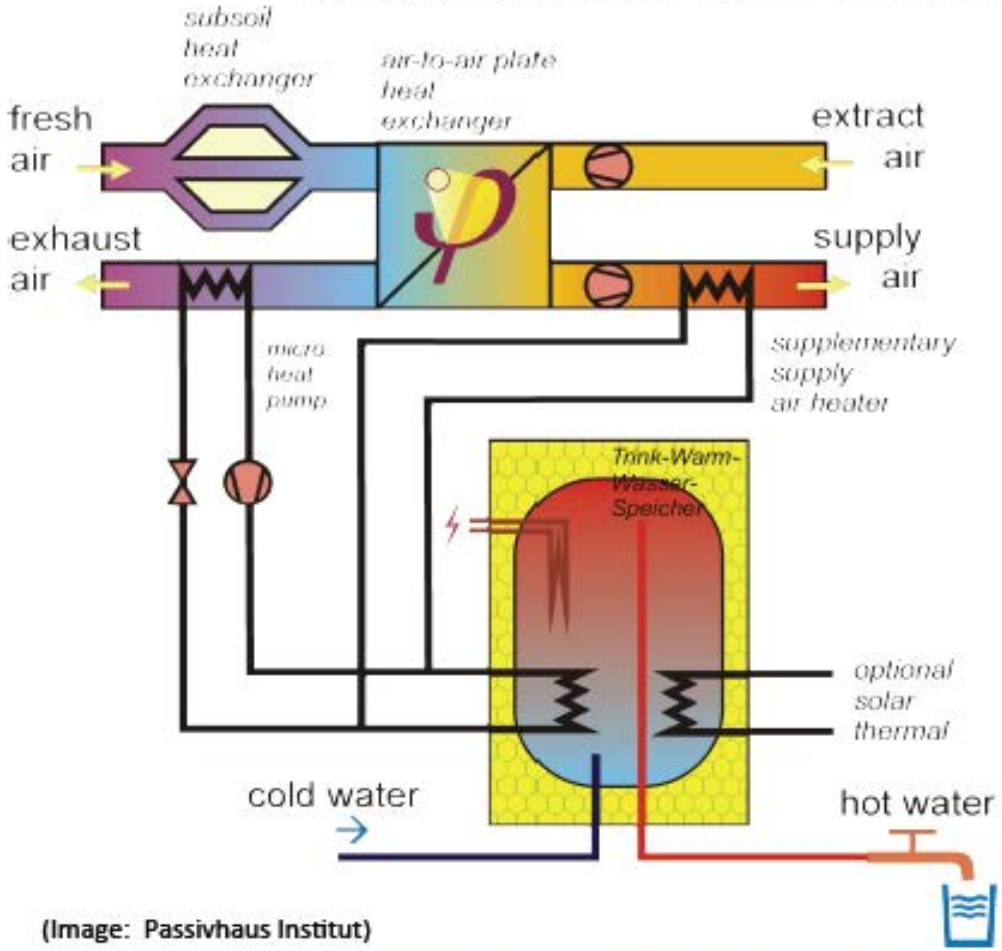
Passive House Level Ventilation Systems

- **Comfort criterion** Minimum supply air temperature of 16.5°C
- **Efficiency criterion** (Heat) The effective dry heat recovery efficiency must be higher than 75 % with balanced mass flows at external temperatures of between – 15 and + 10 °C and dry extract air (ca. 20 °C).
- **Electrical efficiency criterion** At the designed mass flow rate the total electrical power consumption of the ventilation device may not exceed 0.45 W per (m3/h) of transported supply air flow.
- **Balancing and controllability** Outdoor air and exhaust air mass flows must be balanceable for the rated air flow rate, with controllability of at least 3 levels (basic ventilation (70-80%), standard ventilation (100%), increased ventilation (130%)).
- **Sound absorption** Noise level in installation room < 35 dB(A), in living areas < 25 dB(A),
in functional areas < 30 dB(A).
- **Room air hygiene** Outdoor air filter at least F7, extract air filter at least G4
- **Frost protection** Frost protection for heat exchanger without supply air interruption, frost protection for an air heater in case of failure of the extract air fan or frost protection heater coil

Research confirmed systems

- Passive House level systems pass stringent testing.
- Over 90% efficiency.
- Low electrical loads.
- High MERV Ratings. Clean Air!

Individual Component Diagram of Minimized Mechanical System



(Image: Passivhaus Institut)

- **ERV/HRV with integrated hot water coil and/or air to air heat pump for heating/cooling**
- **Insulated Hot Water Tank w/ solar thermal collectors for DHW**

Wood/Biomass

- Wood Stoves
- Masonry fireplaces
- Everyone loves a fire! How do you want yours?

Wood **Stoves**

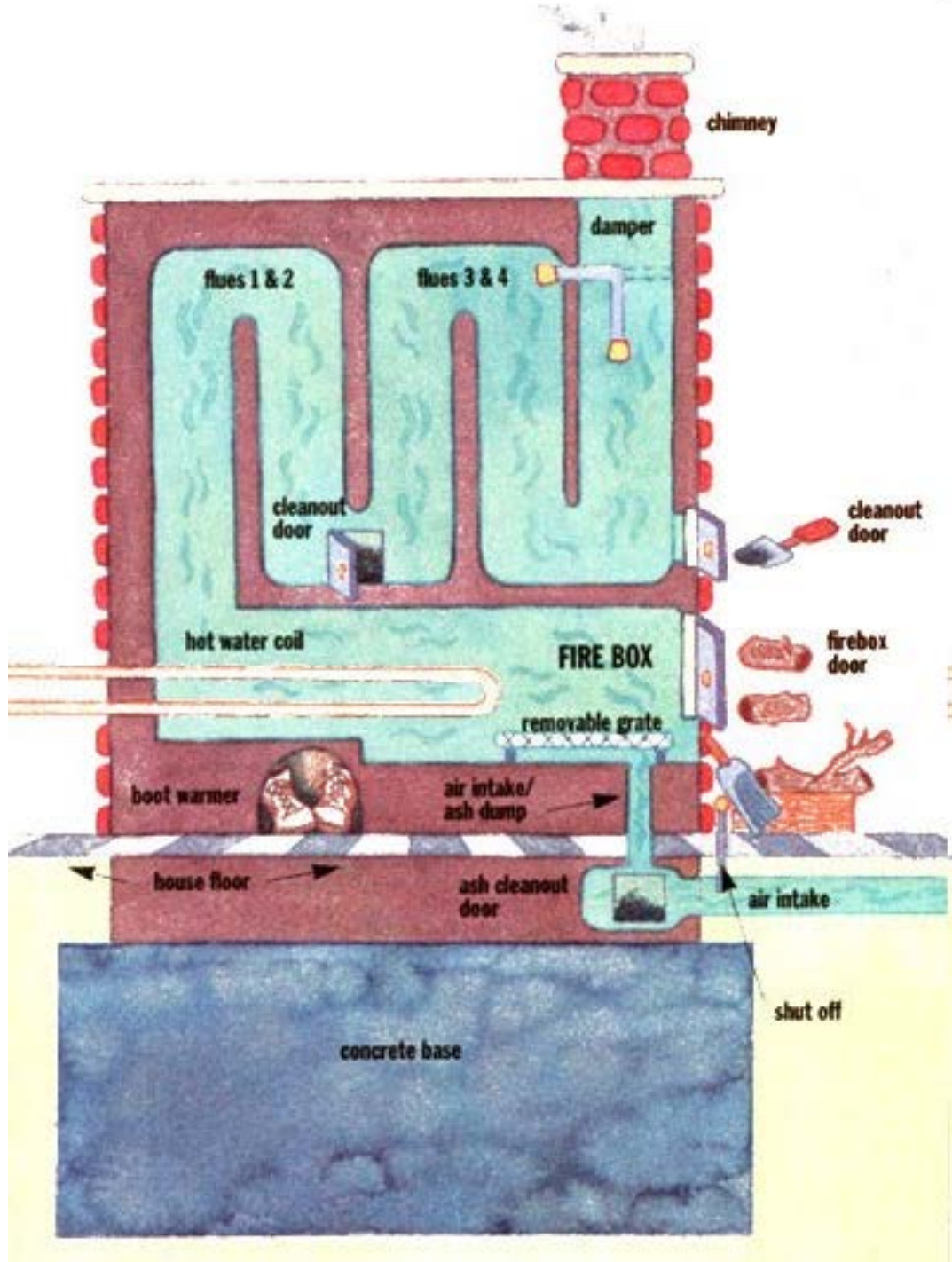
- Free standing Stoves EPA Certified
- Inserts
- Pellet Stoves
- Combustion air from OUTSIDE. The fire does not care if it is 20F or minus 50F! Helps with blower door requirement.

Wood **Stoves**

Masonry Fireplaces

- Wood burns for short periods, at very high temps.

- Can help with Thermal Mass BTU storage systems.


chimney
damper
flues 1 & 2
flues 3 & 4
cleanout door
cleanout door
hot water coil
FIRE BOX
firebox door
removable grate
boot warmer
air intake/ ash dump
house floor
ash cleanout door
air intake
shut off
concrete base

Electric Heat

- We need electricity for the building anyway.
- We can use it for heating.
- We can use it as baseboard or Heat pump.
- Heat Pumps use DC for highest efficiency.

Where do we get it?

- Wind
- Micro Hydro
- Solar
- Co-Generation
- Local Grid
- TEG- Thermal Energy Generator
- All systems are designed for the load. Remember, You have taken that to the lowest level possible!

Thermal Electric Generator

DEVIL WATT™

Wood Burning Stove Water Cooled Thermoelectric Generator DW-WC-70W

Product Overview

The 70 watt water cooled wood stove thermoelectric generator is designed for mounting on a flat hot surface, such as a wood stove to generate the electricity.

Wood Burning Stove Water Cooled Thermoelectric Generator DW-WC-70W

The thermoelectric generator consists of 6 TGMT-19W-4V thermoelectric modules, an aluminum plate and a liquid cooling block. The aluminum plate conducts the heat from the wood stove surface to the hot side of the thermoelectric modules. The heat flowing through the thermoelectric modules is cooled by water. Output power and voltage are proportional to the temperature difference reaches between the hot and cold side.

The generator will produce up to 70 watts if its hot plate reaches 270°C (518°F). The generator is lightweight, produces no noise, and is reliable.

Electric needs

- Household loads- cooking, work, laundry, entertainment, lighting, ect.
- Heating and Ventilation
- Domestic Hot water?
  - With excess Photovoltaic dumping.

Electrical changes for Net Zero

- All Lighting to be LED or better Low Voltage.
- All Appliances Energy Star Certified. These are the top 10% efficiency of their type.
- Install Re-circulating, Charcoal filter kitchen hoods, so you are not loosing heat at 100-300cfm when running.

  Heating circulation and Ventilation are available in DC design!

- These loads can be supplied by Photovoltaic solar collection, even in Alaska!
- The sizing of the systems are based on loads.

Ventilating Kitchen- Heat Recovery

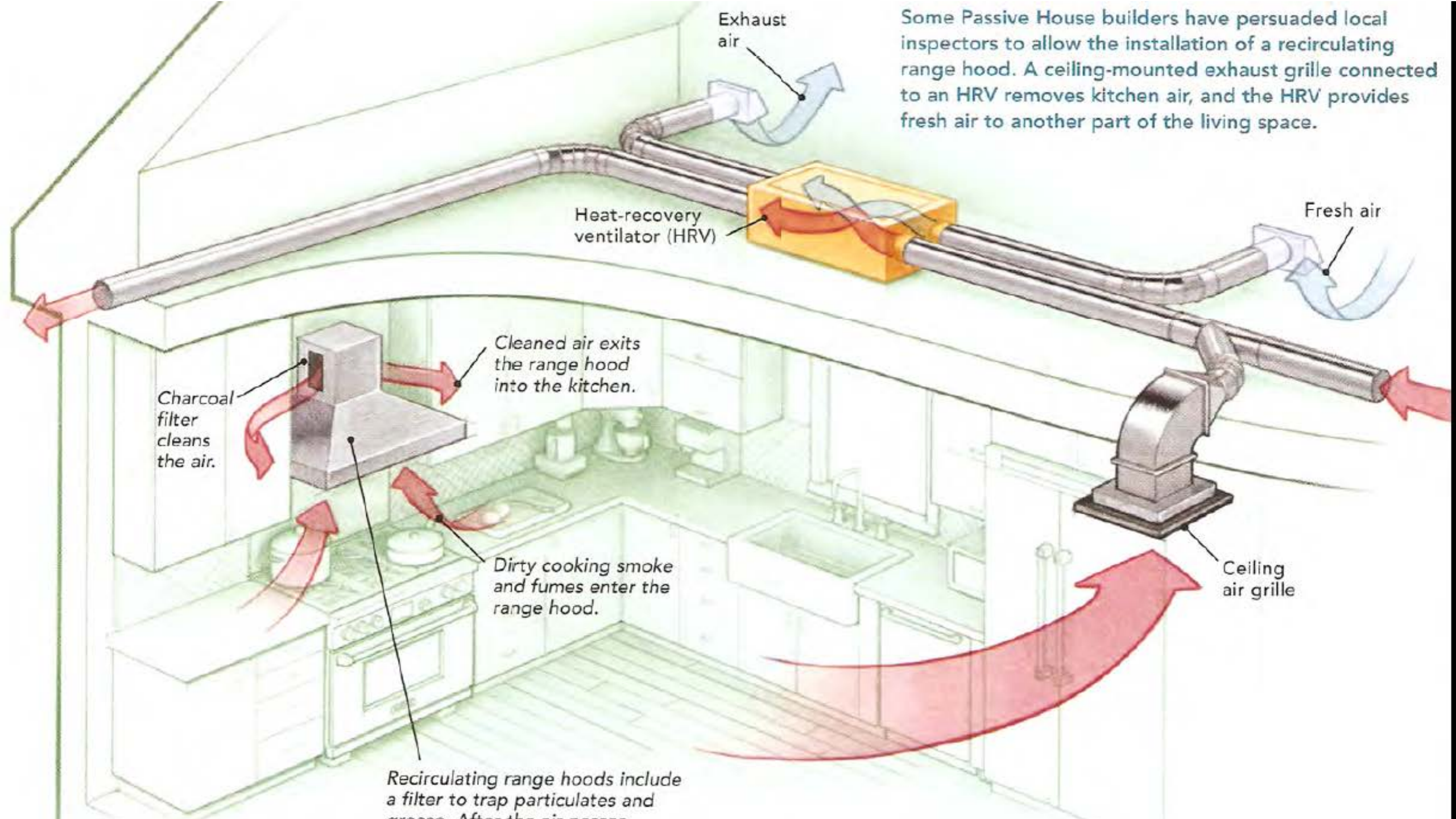
NO GAS RANGES!!!

Direct heat loss during use.

Re-circulating vent hoods ONLY.

Use Carbon or Charcoal filters.

Energy Recovery System return in the zone.



Some Passive House builders have persuaded local inspectors to allow the installation of a recirculating range hood. A ceiling-mounted exhaust grille connected to an HRV removes kitchen air, and the HRV provides fresh air to another part of the living space.

Domestic Hot Water

- Solar Thermal
- Tankless-Electric
- Heat Pump Water Heaters
- Air/Ground source De-Super Heaters

Heat Pump Water Heater

De-Superheaters

- A desuperheater is a secondary heat exchanger, on a Heat Pump, that transfers heat from the earth in the winter, and from your home in the summer, into your domestic hot water tank. The desuperheater is part of the geothermal heat pump's domestic hot water generating system.

Heating Net Zero Buildings

- Heat Pumps- Different types
- Masonry Heaters
- Wood Stoves
- Electric
- Solar-Electric and Hydronic

Mini split systems

- Outside heat pump unit
- Wall mount radiators
- Radiant floor
- Ductless Interior heads
- Ducted- HRV/ERV
- COP 1.5-3.
- Beware of claims of high COP and lowest negative temperature performance in our cold climate.
- Daikon, Mitsubishi, Sanyo.

Mini-split heat pumps

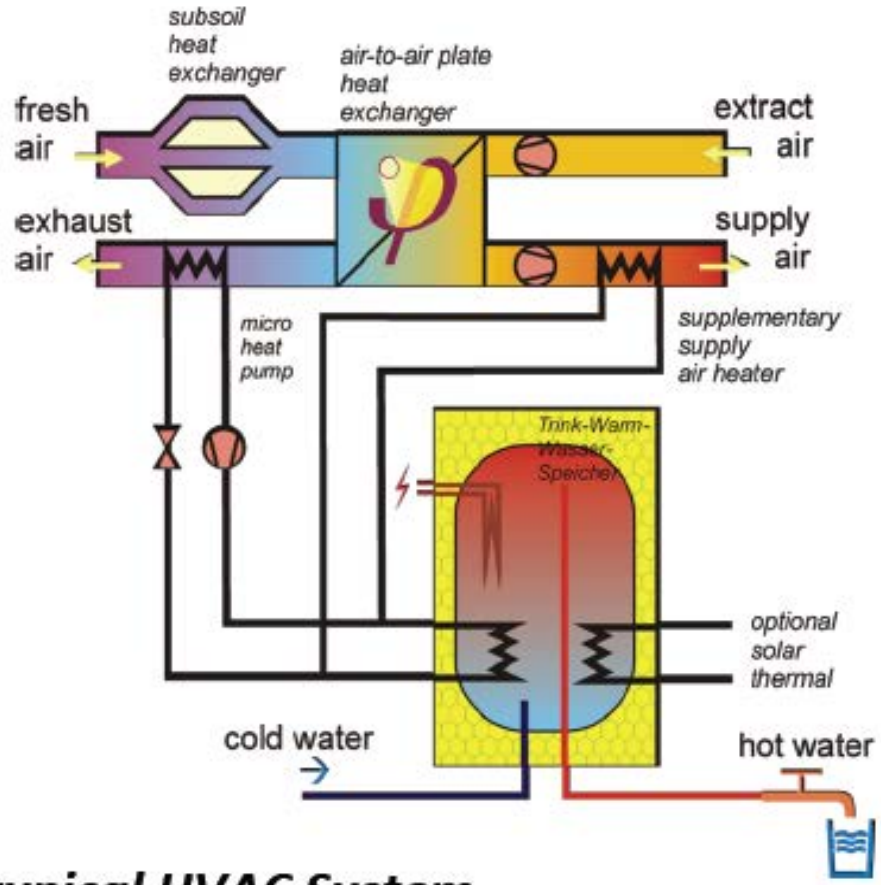
Source: mitsubishicomfort.com

- Operate as low as -13F
- Different indoor unit styles
- Variable capacity – rated outputs as low as 3,000-9,000 Btu/hr
- Need to get expanded performance data to check on capacity at <u>your</u> design conditions

Micro-load Mechanical System

Peak Load Tenet

- **Original Passivhaus Institut (PHI) definition of a passive house:**
- **All space Conditioning Energy deliverable by the minimized ventilation system**



(Image: Passivhaus Institut)

Not your typical HVAC System

Ground and Lake source

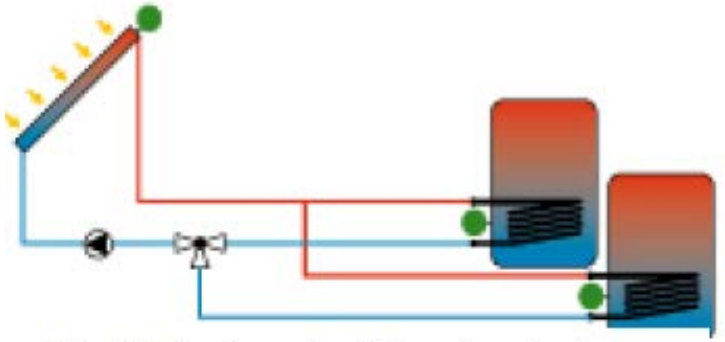
- Consistent temperatures
- COP 2-5
- NO Carbon Monoxide issues!
- Higher cost/Tax Credit

Other sources of heat. Be Inquisitive and Innovative!

- “Waste Heat”
  - Ground source collection from:
    - Storage tanks (solar collection).
    - Septic systems- Consistent heat source

Thermal Storage

- Collect BTU's all Summer in Alaska!
- Can also collect from masonry fireplaces.
- Save for Winter Use.
- Analogous to having a backup Generator.
- Use for heat pumps.



Simplified schematic of the solar circuit

Evacuated Tube Solar

Dryers-Part of the heating strategy

- Dryers need to be Ventless, or heat pump so you are NOT extracting 500cfm every time you run them! As a heat pump, they actually help with the heating of the home!

- Bosch, Electrolux and now Whirlpool, Samsung and LG.

- Can be DC electric for low wattage.

DC POWERED Heat Pumps and Ventilation

- Most manufacturers make DC powered heat pumps.

- Most HRV/ERV manufacturers also make their products DC.
- These help with the electrical load calculations for Passive House certification!

- We have AC/DC converters to make them run in our conventional grid homes. AC consumes more electricity, and there are losses in the conversion!

- Not necessary when we are already are making power from Alternative on the home.

Benefits of Net Zero Buildings

- 90% or lower consumption of energy than conventionally built buildings.
- No Carbon Monoxide or greenhouse gas producing heat systems.
- Balanced heat and controlled humidity with air changes needed for healthy indoor air quality.

Combining Systems

- HRV/ERV + Heat Pump + HPHW
- When all are DC powered by Photovoltaic Electric panels the loads are reduced dramatically due to ECM motors.

- Add Solar Thermal- Evacuated tube or Flat panel- drain back systems. Install Mass Storage systems for Heating and Hot Water.
- Can the Heat Pump work better in Alaska, by taking heat from the Mass Storage?

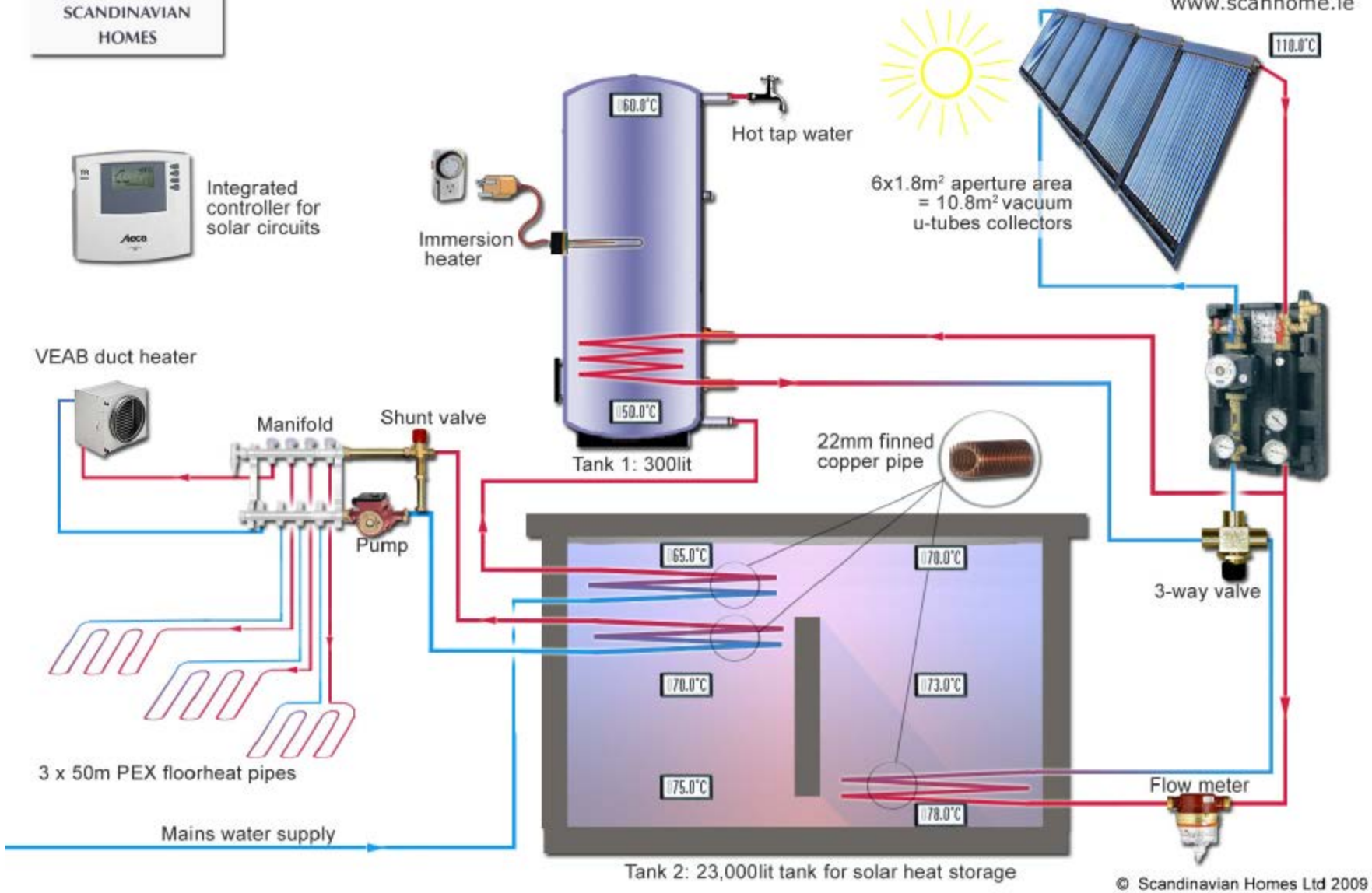
Putting it all together

- Passive house shell.
- Low heat load means small heating system.
- Heat from internal loads of Dryer, Refrigerator, Freezer, Cooking recycled heat all retained!
- High efficiency HRV/ERV. DC Electric.
- Heat Pumps. DC Electric.
- Masonry Heaters.
- Mass Heat Storage.
- Integrate ALL systems when Possible for greatest Energy Recovery!
- Low electric loads means you can install small affordable Electric collector system, sized for your needs. They can always be upgraded!

SCANDINAVIAN HOMES

0-energy passive house with seasonal store of solar heat

www.scanhome.ie



Emerge Alliance

- Focus will be placed on the task of incorporating the use of both AC and DC electricity in a whole house residential hybrid electric power configuration that better facilitates the use of modern electronics-including personal devices to LED Lighting, power saving appliances, hybrid and all electric vehicles, on-site solar, other renewable and emergency back-up energy sources, and local electric energy storage. The EMerge Alliance is reinventing electric power by creating forward thinking standards for the highly efficient use of hybrid AC/DC electric power in residential buildings.

- http://www.emergealliance.org

Emerge Alliance Partners

- An open industry association developing standards leading to the rapid adoption of DC power distribution in buildings.

- These innovative standards integrate interior infrastructures, power, controls and devices in a common microgrid platform to facilitate the hybrid use of AC and DC power throughout buildings for unprecedented design and space flexibility, greater energy efficiency and improved sustainability.

- The Alliance will simplify and accelerate market adoption of EMerge Alliance standards. The Alliance will ensure that its standards deliver:

- Required solutions based on market requirements and ecosystem approval. Buyer assurance with products evaluated against our standards and registered for public view. Increased supply choices in the value chain that spans the needs of different commercial interiors.

- EMerge Alliance is a member of the U.S. Green Building Council. EMerge Alliance is an approved American Institute of Architects (AIA) Continuing Education (CES) Provider.

Closing thoughts

- We can build good, high quality, affordable, Net Zero buildings in Alaska.
- We will not be able to afford NOT to Buid Net Zero buildings as energy costs rise.
- We ALL need to work on the concepts, techniques and application of innovative ideas to make this work.
- We need to share these findings.

Get Involved!

- Join PHIUS Passive House Institute US.
- Join Emerge Alliance.
- Write and talk to your elected officials and get them thinking the same way; Federal, State, Local, City Planning.
- We all win by building healthier, safer buildings as or ready for Net Zero!

Questions?

Thank you for attending ACAT Presentations!

Please join ACAT or renew your memberships!

Some Net Zero Houses Yes, we are evolving!

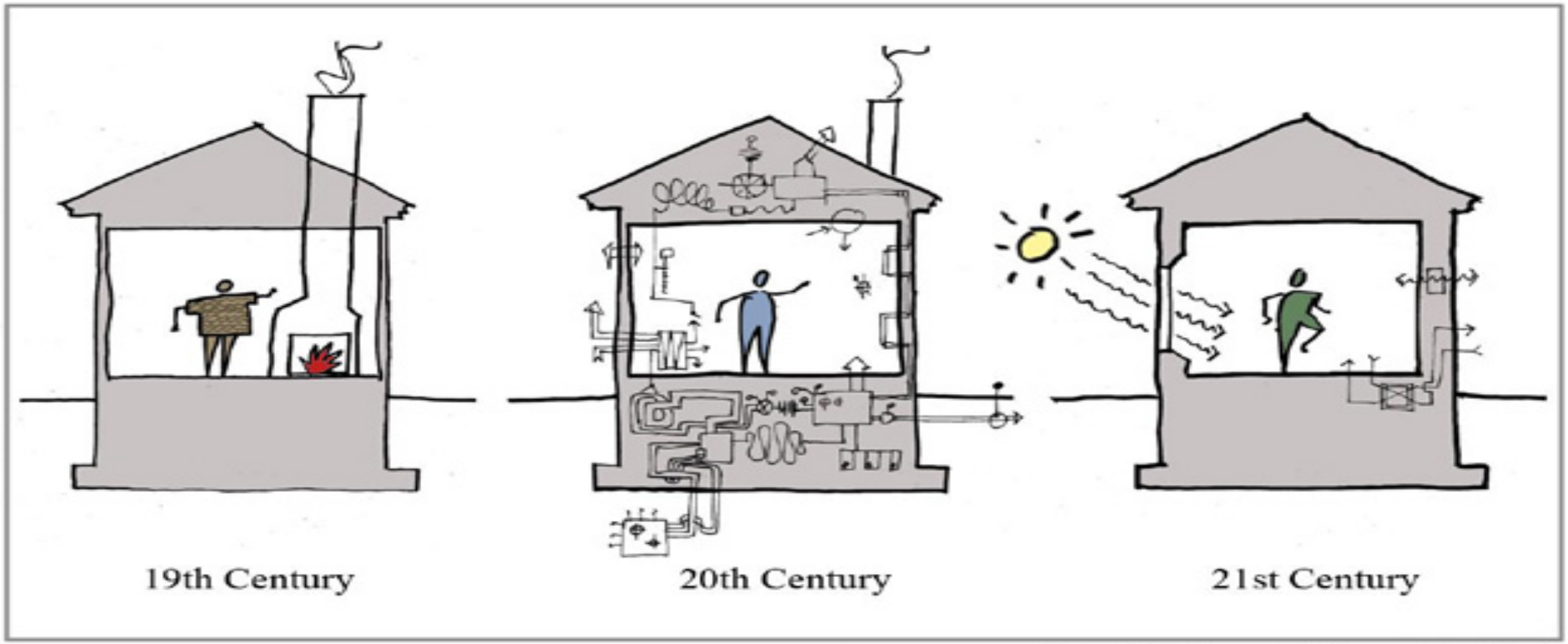


image source: Albert, Righter and Tittmann Architects

CABIN FEVER

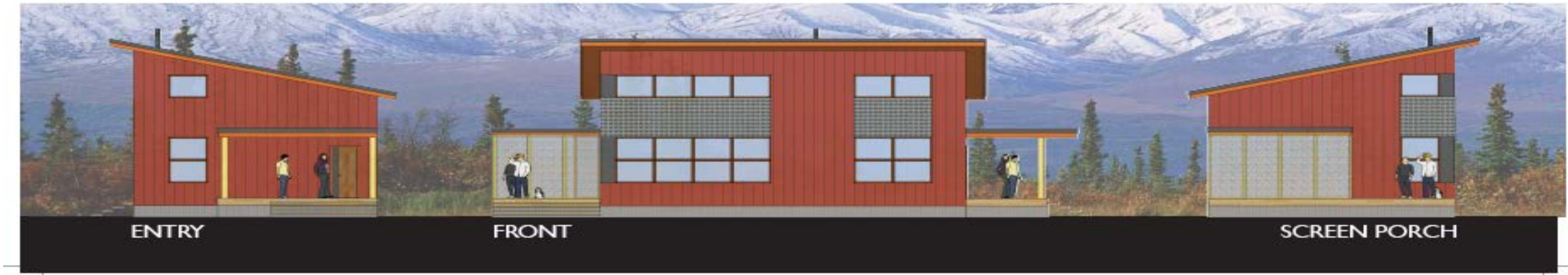
TEAM NET Ø
MARK HOUSTON
JASON SWIFT

ENERGY DESIGN GOALS

- THE GOAL WAS TO REDUCE OUR HEAT LOSS TO SUCH A LOW LEVEL SO A SMALL AND SIMPLE HEAT SOURCE WOULD BE NEEDED ONLY ON THE COLDEST OF DAYS.
- DESIGN HEAT LOAD OF THE BUILDING AS MODELED IN AKWARM, FOR TALKEETNA, ALASKA IS ABOUT 7200 BTU AT THE ANNUAL LOW OF -20F. TIGHTNESS WILL BE BLOWER DOOR TESTED AT .50 ACH OR LOWER.

BUILDING SYSTEMS

- THERE IS A LOW BTU WOOD STOVE FOR BRINGING THE PLACE UP TO TEMPERATURE IN THE DEEP OF WINTER. IT BRINGS AIR FROM THE OUTSIDE DIRECTLY INTO THE FIREBOX, TO PREVENT INDOOR AIR QUALITY ISSUES.
- AN DC AIR SOURCE HEAT PUMP HELPS TO MAINTAIN CABIN TEMPERATURE DURING TIMES THAT IT IS UNOCCUPIED.
- PHOTOVOLTAIC PANELS AND A THERMO ELECTRIC GENERATOR (TEG) CONNECTED TO A SMALL BATTERY BANK WILL PRODUCE DC ELECTRICITY.
- THE PHOTOVOLTAIC PANELS ARE HINGED TO CREATE SHADING FROM OVER HEATING IN SUMMER.
- HUMIDITY CONTROL AND REQUIRED FRESH AIR WILL BE PROVIDED BY A DC POWERED ERV. THE UNIT HAS A MAXIMUM DRAW OF 120 WATTS AT 240 CFM.
- DC LIGHTING IS CAREFULLY PLACED FOR KEEPING THE SKY DARK AT NIGHT.
- THE ENTIRE BUILDING WILL BE CONTROLLED BY Z-WAVE COMPATIBLE REMOTE SATELLITE PHONE MONITORING WITH ALL LOCKS, MOISTURE SENSING FOR WATER LEAKS, TEMPERATURE, ERV CONTROLS, LIGHTING, CAMERAS AND PV SYSTEM. ALLOWS FOR REMOTE DIAGNOSTICS / FIXING.



ROOF ASSEMBLY :: R-93.5
METAL ROOFING TO KEEP FIRES AT BAY
ICE AND WATER SHIELD
PLYWOOD
VENTILATION CAVITY
PLYWOOD
24" DENSE PACKED CELLULOSE
INTERIOR OSB PANELS
LOCALLY SOURCED BLEACHED WOOD PANELING

WALL ASSEMBLY :: R-52
METAL SIDING TO KEEP THE FIRES AT BAY
VENTILATION CAVITY - EVEN A CABIN HAS TO BREATH
DOUBLE STUD WALL
18" DENSE PACKED CELLULOSE
ALASKA ASSEMBLED FIBERGLASS, QUAD PANE, XENON. LOW-E, U.09 WINDOWS
WINDOW COATING ADJUSTED PER DIRECTION
INTERIOR OSB PANELS
LOCALLY SOURCED BLEACHED WOOD PANELING

FLOOR ASSEMBLY :: R-61.5
POLYURETHANE SEALER
ALASKA CURED GLACIAL MUD, 6" THICK (THERMAL MASS)
12" OF ALASKA MADE R-TEC TYPE IX RIGID INSULATION
PRESSURE TREATED PLYWOOD
ALASKA APPROPRIATE METAL SPACE FRAME FOUNDATION

INTERIOR PERSPECTIVE

SECTION @ CATWALK

AS ALASKA GROWS INTO THE 21ST CENTURY, WITH FEWER AND MORE EXPENSIVE FUEL SOURCES, NOT TO MENTION CONCERNS ABOUT CARBON FOOTPRINTS, NET-ZERO BUILDINGS BECOME THE OBVIOUS ANSWER. THESE BUILDINGS NEED NO ENERGY FROM THE GRID, COMPLETE HEALTHY INDOOR ENVIRONMENT, AND LOW MAINTENANCE ISSUES. THE END RESULT IS READY FOR NET-ZERO OR PASSIVE HOUSE CERTIFICATION.

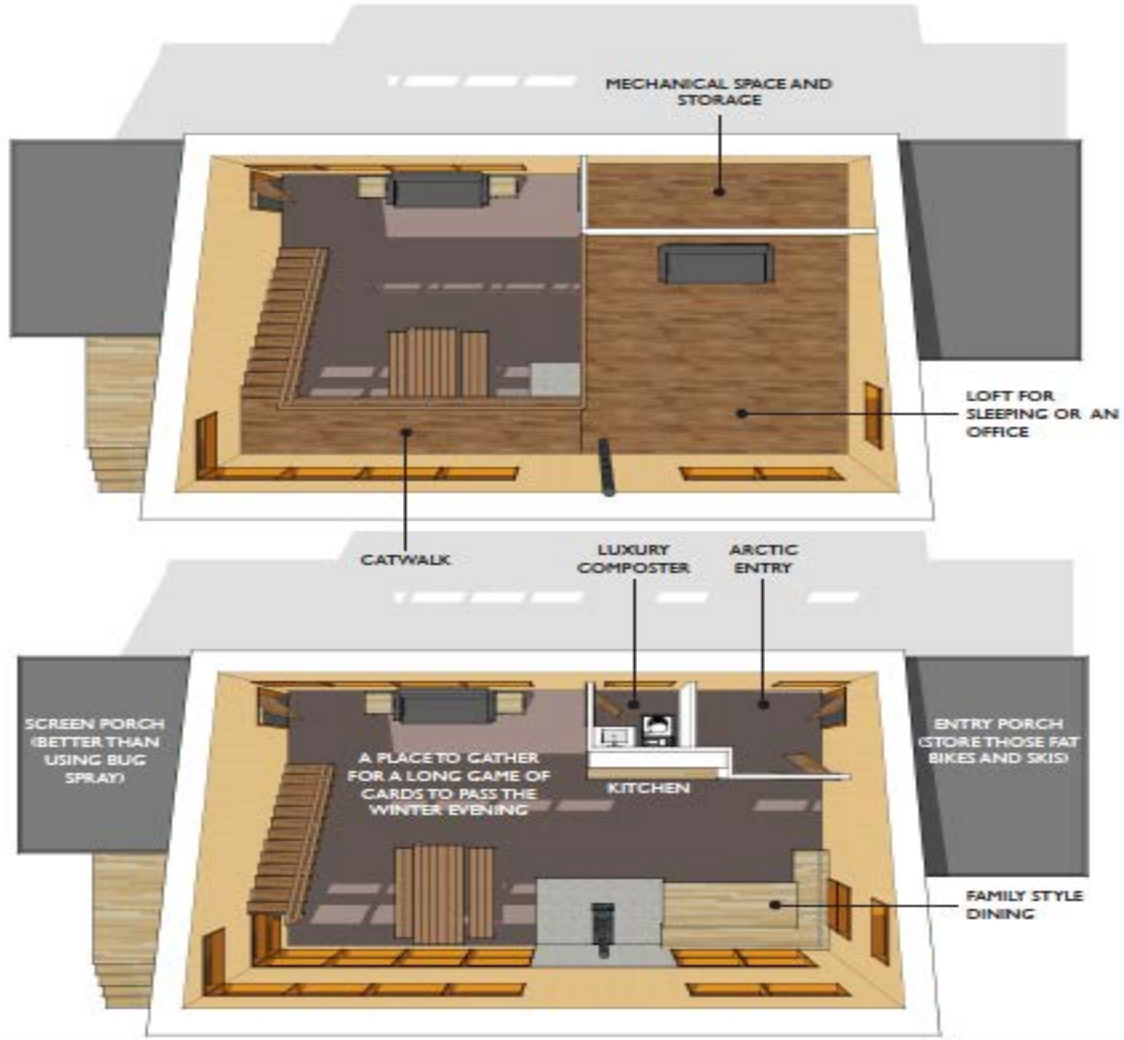
AS AN ARCHITECT, JASON SWIFT, AND PASSIVE HOUSE ENERGY RATER, MARK HOUSTON, OUR OBVIOUS DIRECTION WAS TOWARD NET-ZERO, BUT WE ALSO HAD A FEW OTHER REQUIREMENTS. WE WANT AS MANY MATERIALS AS POSSIBLE TO BE LOCALLY SOURCED, AND DURABLE. THE BUILDING WILL BE BUILT FOR A 100 YEAR LIFE-CYCLE. IT WILL MOST LIKELY FAR EXCEED THAT!

THE DESIGN

- THIS CABIN DESIGN IS ON 4' MODULAR SIZING, IS SCALE-ABLE AND PRE-CUT FOR ASSEMBLY IN ANY REGION IN ALASKA, BY LOCAL RESIDENTS WITH SOME SKILLS, WHO ARE WILLING TO LEARN. WE WANT THIS TO BE BUILDABLE BY ANYONE, ANYWHERE IN ALASKA.
- WE HAVE PROVIDED A SCREENED PORCH ON THE WEST FOR SUNNY SUMMER EVENINGS FREE FROM MOSQUITOES! AND OF COURSE THERE IS A FIRE-PIT FOR YEAR-ROUND ENJOYMENT. THE ARCTIC ENTRY HAS PLENTY OF ROOM FOR BOOTS, COATS AND PEOPLE AT THE SAME TIME.
- THERE IS A READING NOOK UNDER THE STAIRCASE, A SLEEPING LOFT ABOVE, AND THE ABILITY TO CURTAIN OFF THE AREA BELOW THE LOFT FOR AN ADDITIONAL ROOM. A COMPOSTING TOILET AND DRY KITCHEN COMPLETE THE PICTURE. ANYTHING IN THIS CABIN CAN BE UPGRADED BY THE OWNERS.

CONSTRUCTION

- THE BUILDING IS ON A "SPACE FRAME" FOUNDATION. THE FRAME CAN BE ADJUSTED WHEN SOILS SHIFT, TO CORRECT ANY LEVELING ISSUES. IT CAN ALSO BE BUILT ON ANY COMMON TYPE OF FOUNDATIONS SHOULD YOU CHOOSE.
- THE CABIN HAS A MAIN FLOOR OF 4-6" LOCALLY SOURCED CLAY WITH A NATURAL SEALER. CLAY HAS A LOW EMBODIED ENERGY AND A HIGH THERMAL MASS, PERFECT FOR BEING HEATED BY THE SUN.
- THE EXTERIOR WILL BE METAL ROOFING AND SIDING, FOR FIRE PROTECTION AND LONG TERM DURABILITY.
- THE INTERIOR WILL BE OF LOCALLY HARVESTED WOOD PRODUCTS. THE PANELING WILL BE SPRUCE, WITH A WHITEWASH STAIN FOR A BRIGHT INTERIOR. INTERIOR DOORS WILL BE T&G BIRCH WITH A CLEAR FINISH. WINDOW JAMBS, BASE, AND CASING THROUGH OUT WILL BE LOCALLY HARVESTED BIRCH.
- THE STAIRCASE WILL BE BIRCH STAIR TREADS OF HALF SAWN LOGS OPEN SPACED. THERE WILL BE A SINGLE LOG RUNNER UNDERNEATH FOR REDUCED LIGHT BLOCKAGE. THE CAT WALK AND BALCONY WILL BE LOCAL SPRUCE FRAMING WITH SPRUCE T&G CAR DECKING.
- THE CELLULOSE INSULATION IS LOCALLY RECYCLED NEWSPAPER AND CARDBOARD WITH A VERY LOW COST FOR THE R VALUE. IT KEEPS THE WINTER CHILL AT BAY.



FLOOR PLANS