

Net Zero Ready

New Construction Case Study



Flow of the Show

- NZR Basic Concepts
- My Motivations
- NZR Boundary
- Modeling
- Orientation
- Basic Structure
- Arctic Wall
 - Trusses
 - Fabric
 - Rain Screen
- Window Extensions
- Insulation
- Window Details
- Costs so Far
- Next Steps

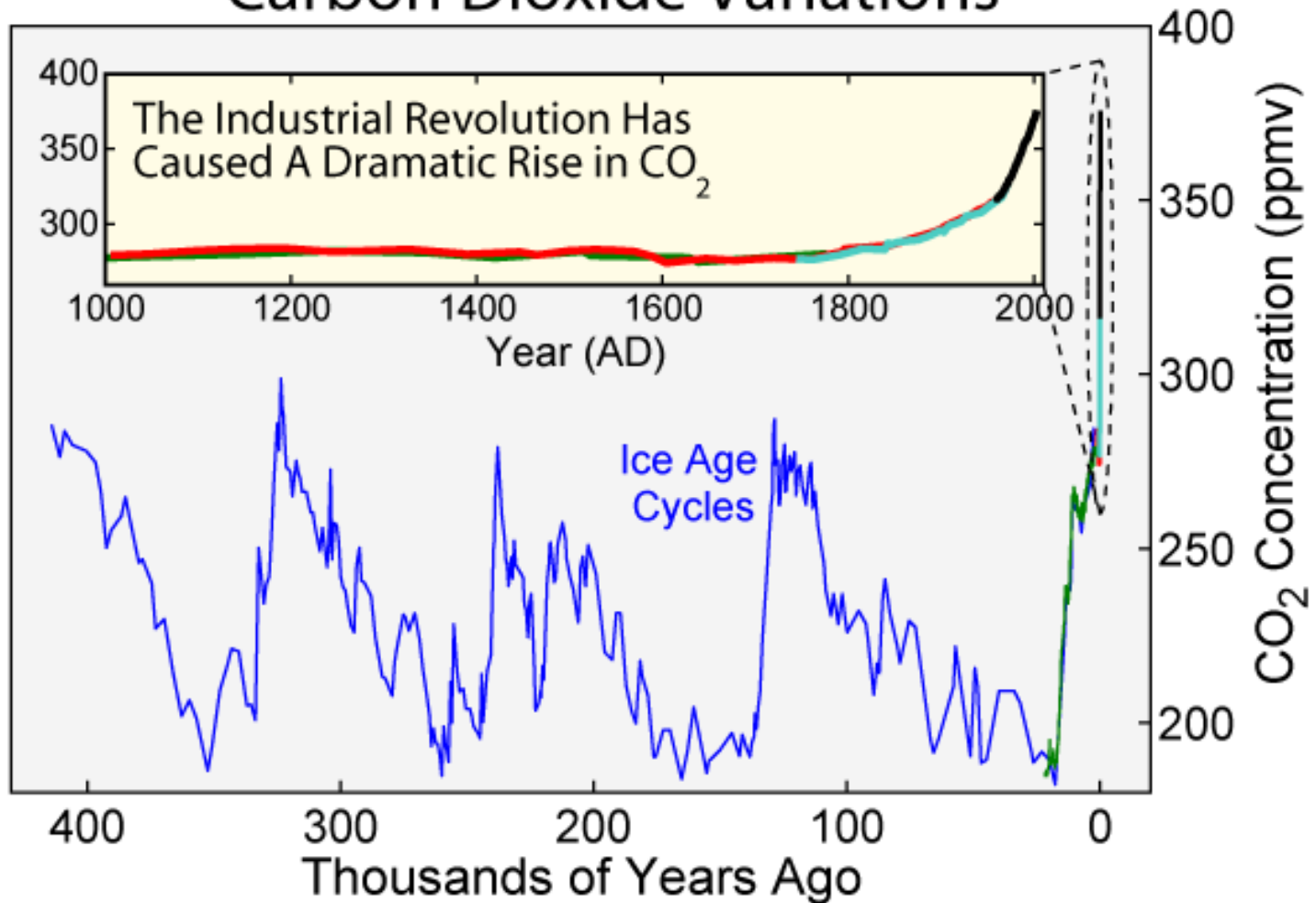
NZE Basic Concepts

- *Efficiency is Job One* – “radical” energy conservation and efficiency measures ***required*** to reduce demand, such that energy supplied can come from clean sources
- Reduce carbon pollution
- Improve individual, local and regional energy security
- Use stably-priced clean fuel – get away from volatile fossil fuel prices that trend up

MY MOTIVATIONS

The “Hockey Stick”

Carbon Dioxide Variations



MY MOTIVATIONS

Climate Change Impacts in Alaska



MY MOTIVATIONS

Chlupp house - Fairbanks

Efficiency First, Solar Water Heating and *Seasonal Storage*



Solar thermal Flat-plate Collectors
5000-gallon thermal storage



MY MOTIVATIONS

CONSERVATION AND EFFICIENCY FIRST

Dillingham Home – “Net Zero Ready”

Outside dimensions: 24'x24' Stories: 1.5

Wall thickness: 28" (with dense-packed cellulose)

Walls R-90; Ceiling R-140; Floor R-35 (+R20 on perimeter)

Airtightness: <0.05 ACH @ 50 pascals

World's
tightest home!



ENVELOPE – NZR BOUNDARY

NZR Envelope – 2nd Floor only



Modeling Energy Demand

- Energy modeling to help in design
- R-60 walls and floor (16" cellulose)
- R-90 ceiling (24 " cellulose)
- Minimize penetrations and thermal bridging
- Triple-pane fiberglass windows
- Best local doors
- "Arctic Wall" construction

Energy Modeling

- Specified parameters and goals (e.g. envelope insulation; window/door size, location and quality, etc.)
- Used AKWarm program
- Design Heat Load approx. 4,600 Btu/hour

Design Energy Modeling - AKWarm

Annual Energy Flows

- Gross loss: 14.9 MMBtu
- Gross Internal: 14.5 MMBtu
- Useable Internal: 10.9 MMBtu (75%)
- Gross Solar: 4.1 MMBtu
- Useable Solar: 1.9 MMBtu (46%)
- **Net Heat Load: 2.1 MMBtu**
- **This is about 3.5 kBtus/SF/yr (Passive House is 4.75)**

MAXIMIZING THE SOLAR RESOURCE

Orientation



End “phase 1” – basic 2x4 structure



Extra tall for a couple reasons....

BASIC STRUCTURE - ENVELOPE

2nd Floor trusses – 16" deep



24" Energy Heel Roof Trusses



Air Diffusion “Arctic Wall” - Concepts

- No separate vapor barrier layer
- Interior layer has higher permeability rating than exterior layer – allows drying to outside
 - Interior layer (OSB) – perm rating about 2
 - Exterior fabric (Mento) – perm rating about 38
- “Rain screen” gap beneath siding, facilitates drying

Air Sealing – Seam Tapes



On 2x4 Structural Wall

Air Sealing – Seam Tapes



On 2x4 Structural Wall

Larsen Vertical Truss

Gusset
16" wide



2x2
Need not
be continuous



2x4



We chose 4-foot
gusset spacing

Mento fabric pinned to
2x4 edge with rain
screen 1x

Larsen truss jig



Gussets at 4-foot spacing – glued and nailed

Larsen Truss – connection at rafter



Larsen Truss – bottom corner



Larsen Truss - Corner “Box”



Thermal Bridging – Window Bays



In case of cellulose settling

Installing Exterior Fabric



Fabric and Rain Screen 1x4s



Rain Screen and Attic Vent at top



Window Extensions



Window Extension



NOTE:
More seam
tape

Big Blower Truck for Cellulose Insulation

HUGE Thanks to Thermo-Kool!



INSULATION

Dense-Packing Cellulose



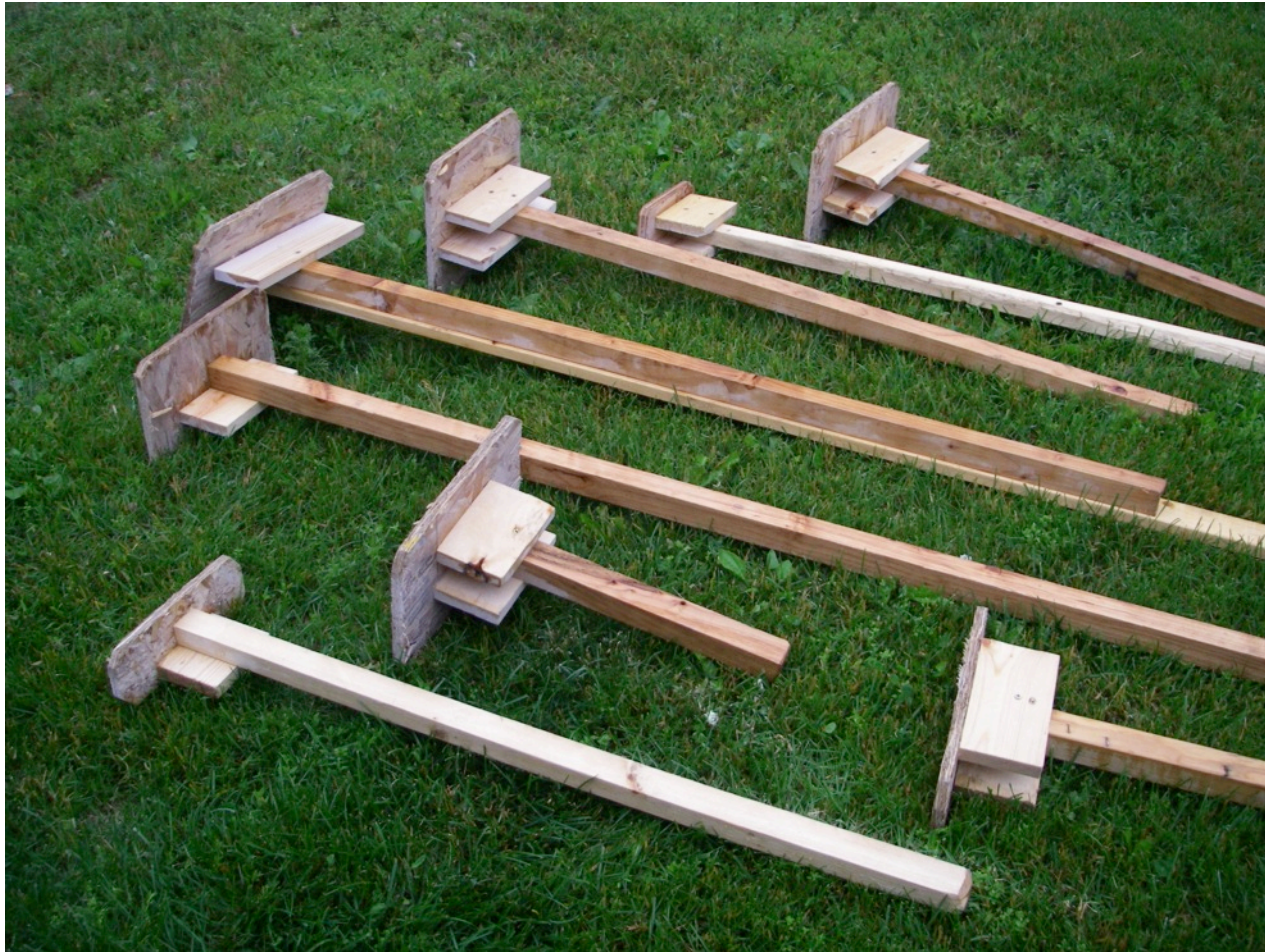
Walls (both stories) took about
9400 lbs cellulose

Dense-packed to 3.5 lbs/CF
- “firm mattress” feel



INSULATION

Sophisticated Dense-packing Tools



Attic Insulation Baffles and final dense-pack access



Windows

- Fiberglass, triple-pane, Low-E Argon
- From Great Land Windows in Fairbanks

	SHGC	Stated U-Value/R-value	Visible Trans
SOUTH	56%	0.13 / 7.7	70%
NORTH	22%	0.11 / 9	56%

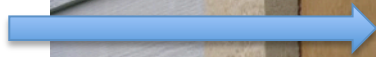
Window Insulation



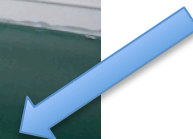
Trying to minimize thermal bridging

Window Exterior Finish

Plywood over
Rigid Insulation



Sloped metal sill
Over Rigid
Insulation



WINDOW DETAIL

More Air Sealing – Seam Tapes on Exterior side of Windows



Costs so Far

- Remember – only 600 square feet, so accepting some economic “penalty”
- Some materials scrounged, etc

Costs so Far

- Costs estimated to simulate 1-story structure
- Basic structural shell – labor and materials
 - Excavation
 - Foundation
 - 2x4 walls
 - Roof trusses with 24" energy heel
 - Metal roofing
- \$63/square foot**

** foundation insulation virtually free



Costs so Far

- Arctic Wall – estimated labor and materials
 - Lumber and fasteners, etc.
 - Insulation
 - Mento fabric and sealing tapes
 - Windows/doors and insulation around them
 - Metal roofing
- \$39/square foot**

** does not include siding (about \$4/SF for cement board, more for fake rock)



Next Steps

- Ceiling plywood
- Insulate ceiling (24" blown) and floor (16" dense-pack)
- Space Heating – air-source heat pump
- Domestic Hot Water – solar thermal and ASHP?
- Plumbing, electric, interior finish

Solar PV and Thermal



DHW is challenge in NZE

