A Path to Green(er) Building

Duluth Energy Design Conference
25 February 2020

Rachel Wagner
through design llc

In accordance with the Department of Labor and Industry's statute 326.0981, Subd. 11,

"This educational offering is recognized by the Minnesota Department of Labor and Industry as satisfying **1.5 hours** of credit toward **Building Officials and Residential Contractors code /1 hour energy** continuing education requirements."

For additional continuing education approvals, please see your credit tracking card.

Learning Objectives

1. Understand the (changing) context, which requires us to build green.
2. Using current context, outline a set of goals for green building.
3. Identify guiding principles relevant to "green building," in alignment with the context and goals set forth.
4. Define priorities – for both thought and action - that will help create the path to green building with the context and goals set forth.
5. Explore completed homes that offer examples of success using this path to green building.

Context

There are a lot of reasons to build green homes, and to adjust and improve our definition of what constitutes a green home.

I'm going to talk about one reason.

The Next Generation Energy Act

- Signed by Governor Pawlenty in 2007
- Requires Minnesota to reduce greenhouse gas emissions “across all sectors producing those emissions” by 80% between 2005 and 2050.
- Supports clean energy, energy efficiency, and supplementing other renewable energy standards in Minnesota.
- Interim goals were also set: a 15% reduction by 2015, and a 30% reduction by 2025.

The Next Generation Energy Act

Interim goals were also set:

A 15% reduction by 2015

A 30% reduction by 2025

Image from pca.state.mn.us

This is a Green Path.

Where are we on the Green Path?

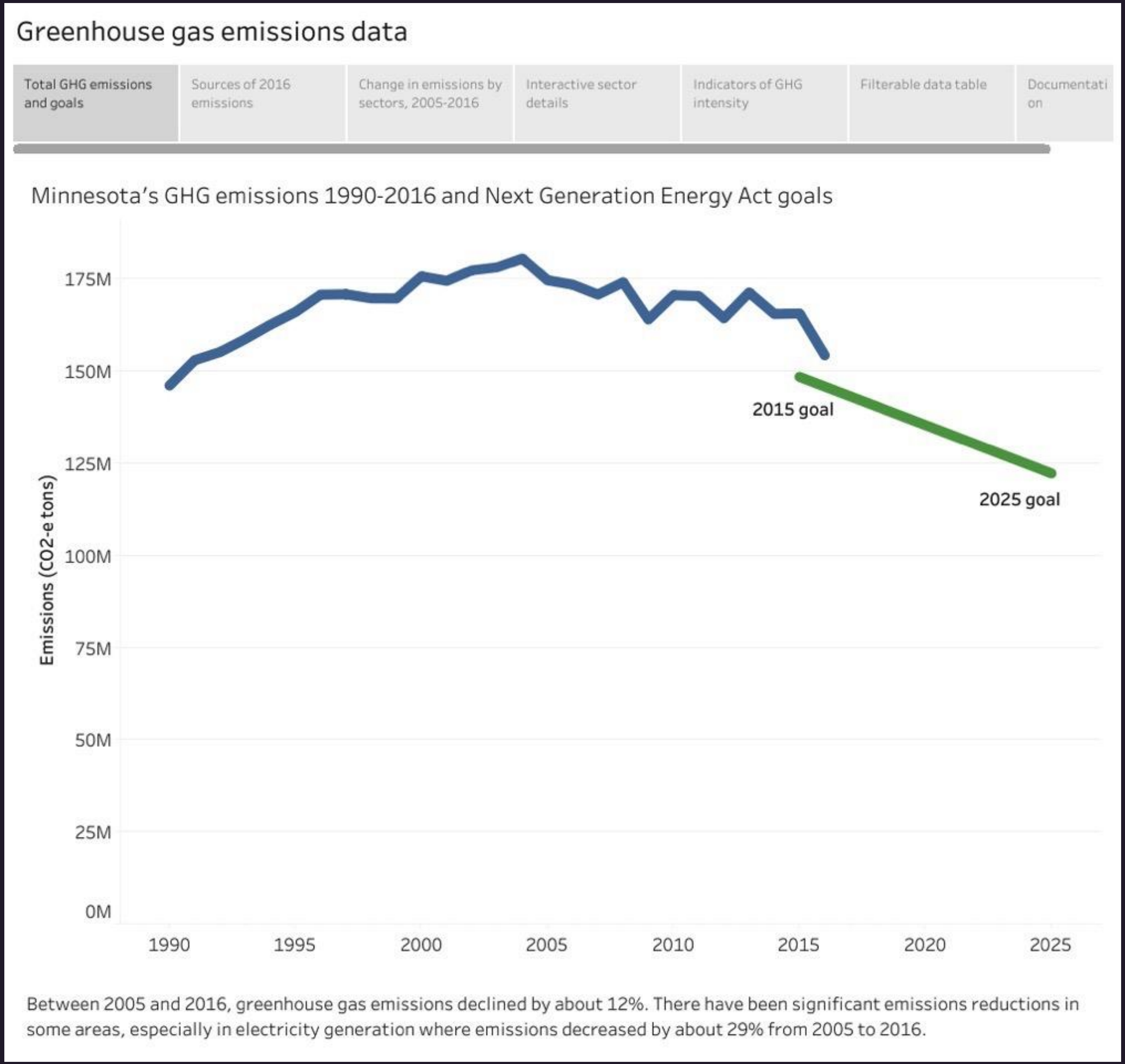


Image from pca.state.mn.us

2016: Residential emissions up 11%

CHANGE IN MN GHG EMISSIONS BY SECTOR: 2005-2016

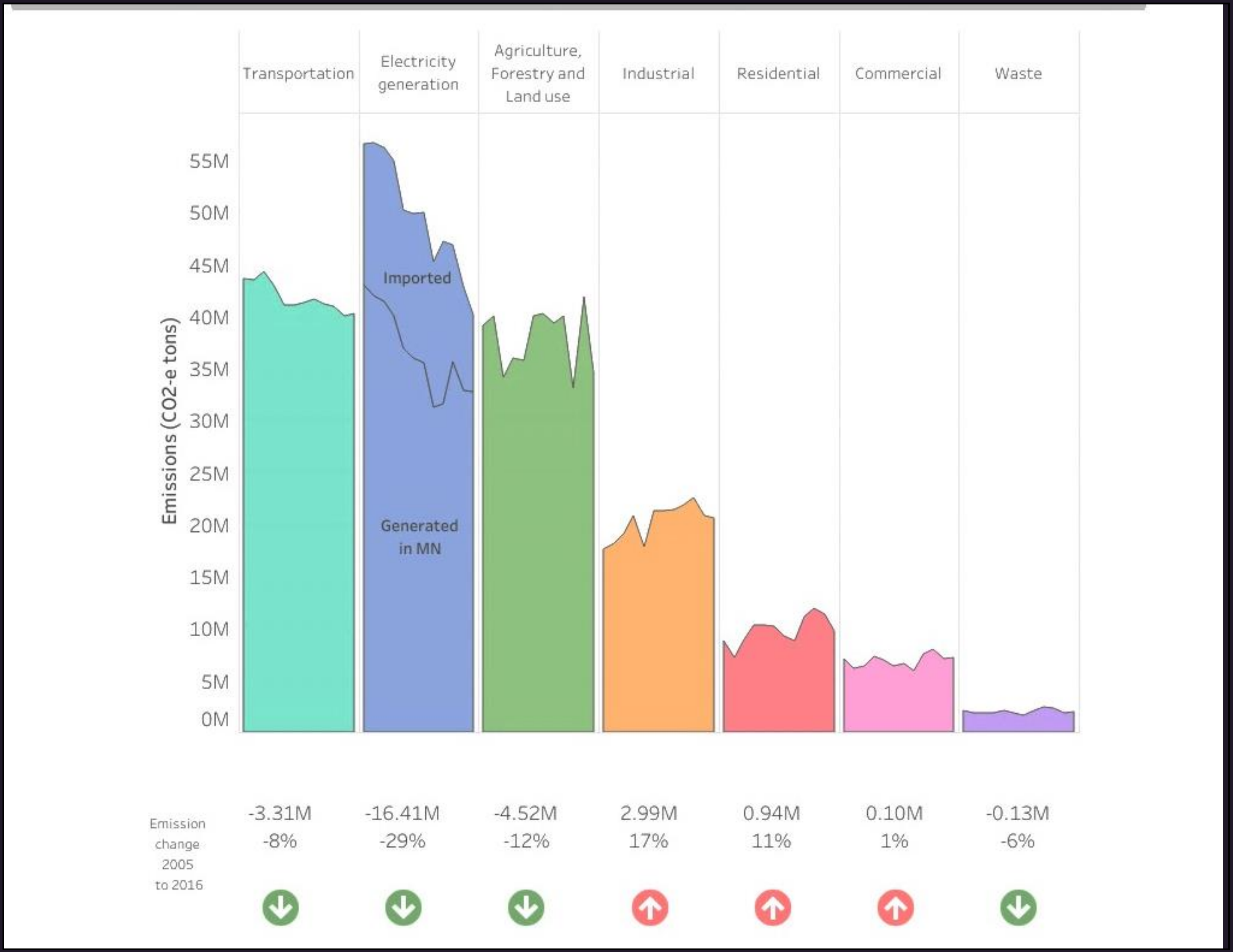


Image from pca.state.mn.us

Context 2018: Emissions from natural gas exceed emissions from electricity!

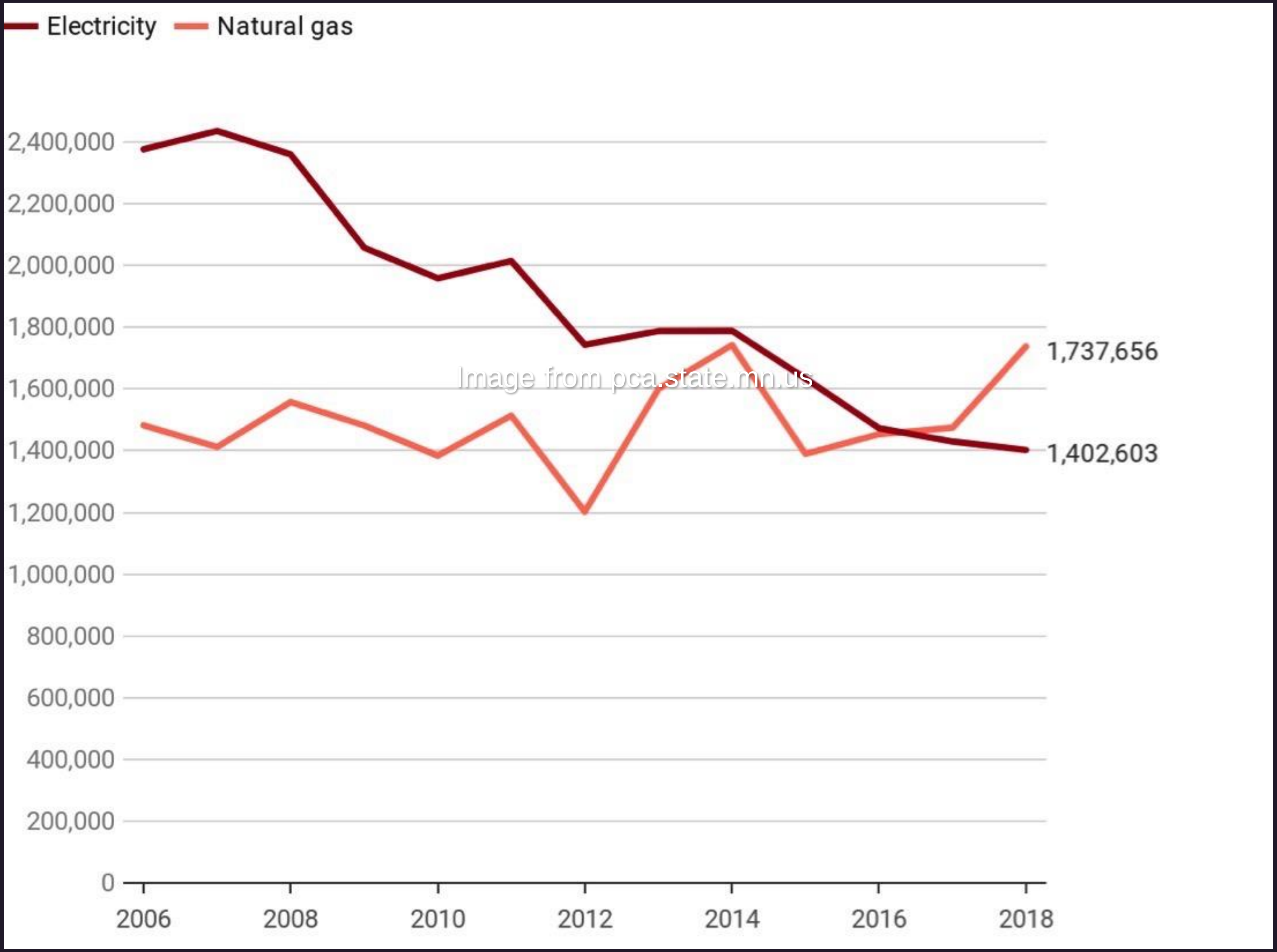


Image from pca.state.mn.us

Goals

Build green homes
for the Next Generation!

Green Homes should align with the targets legislated in the Next Generation Energy Act.

Next Generation Homes

1. Align our building practices to meet the targets of the Next Generation Energy Act.
2. In 2025 all new homes use 30% less energy/30% fewer emissions than in 2005. (HERS$\leq$70)
3. In 2050, all new homes use 80% less energy/have 80% fewer emissions than in 2005. (HERS$\leq$20)

HERS? How much energy?

HERS is based on a “Reference Home”:
Built in our climate, between 2000-2005

In our climate zones

HERS 70:

70 MMbtu/year

HERS 50:

50 MMbtu/year

HERS 20:

20 MMbtu/year

Uses 100 Mbtu/year, or 29,307 kWh/year*

*Energy consumption data aggregated from EIA/ 2005 RECS
www.eia.gov/consumption/residential/data/2005/

If you build a new house in 2020, how should it perform in 2050?

How will homes built today be relevant in 2050?

Even Better Targets for a Greener Path

2030: All new homes HERS < 50

And no fossil fuels burned on site

2050: All new homes zero net-carbon

These targets would fit current context!

Review: Guiding Principles for Green Building

1. Preserve and protect health.
2. Reduce or prevent environmental degradation caused by buildings.
3. Reduce consumption of resources.
4. Conserve energy.
5. Reduce or eliminate use of fossil fuels.

Guiding Principles for the Next Generation of Green Building

1. Building resiliency matters.
2. All electric buildings make sense.
3. Systems should be accessible.
4. PV or PV-Ready is a must.
5. 2050 is sooner than you think.

Priorities of Thought

- Think critically.
- Question the status quo.
- What can you change?
- Look through a different lens.
- Look more closely.
- Look further away.

Image from
www.ecohomeduluth.com

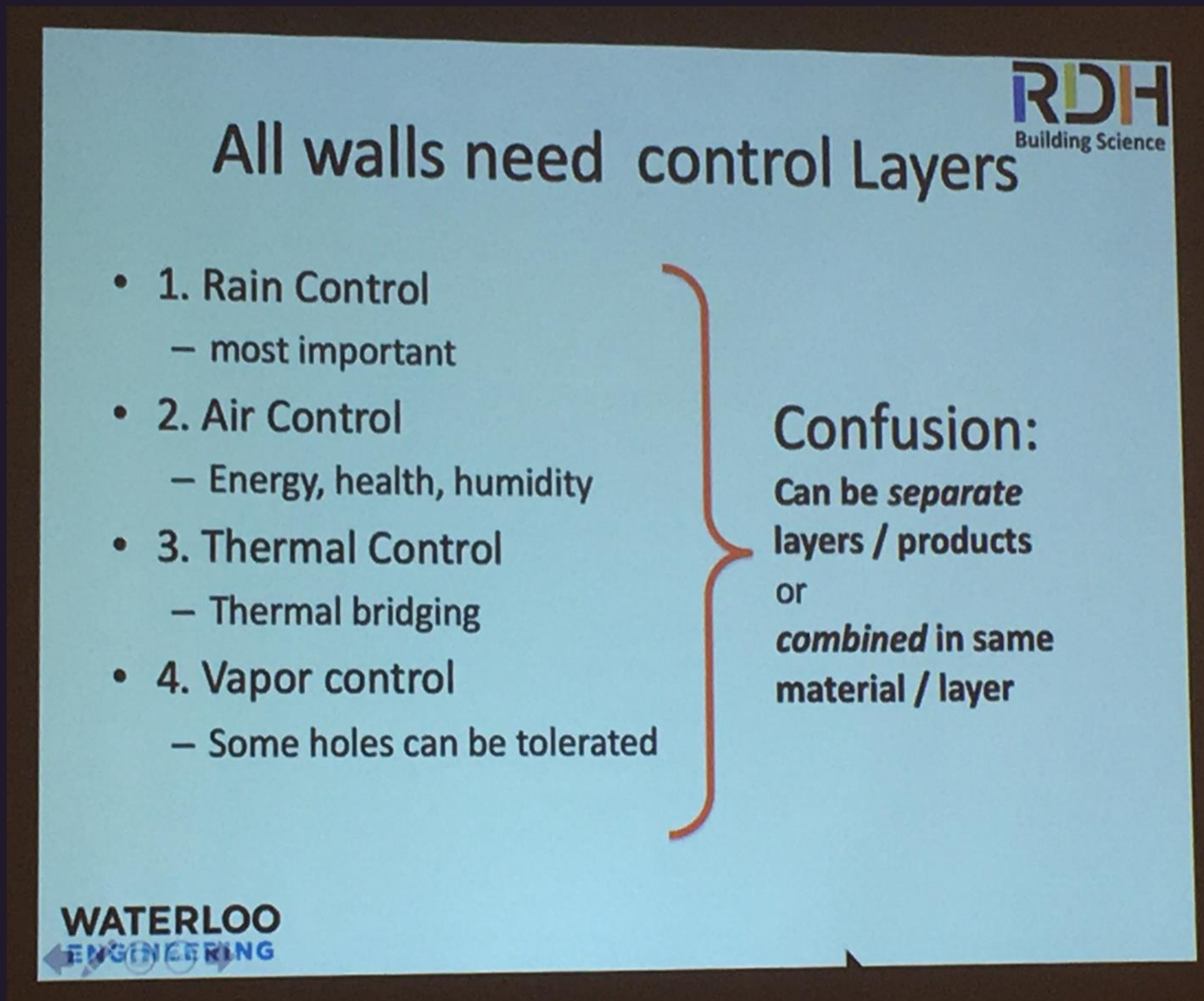
Priorities for Building Resiliency

- Super-efficient
- Uses the sun
- Coasts or adapts in a power outage
- Durable
- Repairable
- Comfortable
- Understandable

Building Science is still a Priority

Reduce thermal bridging, implement careful flashing details and create a robust air barrier for a resilient enclosure.

In Order of Importance



Slide credit: John Straube

What’s the Best (greenest) Wall?

1. Good flashing details.
2. A continuous, durable air barrier.
3. Minimal thermal bridging.
4. Vapor control that still allows drying.
5. Drainage behind the cladding.
6. The assembly can connect to everything else without compromising the above list.

A Robust Enclosure provides resiliency and reduces energy loads.

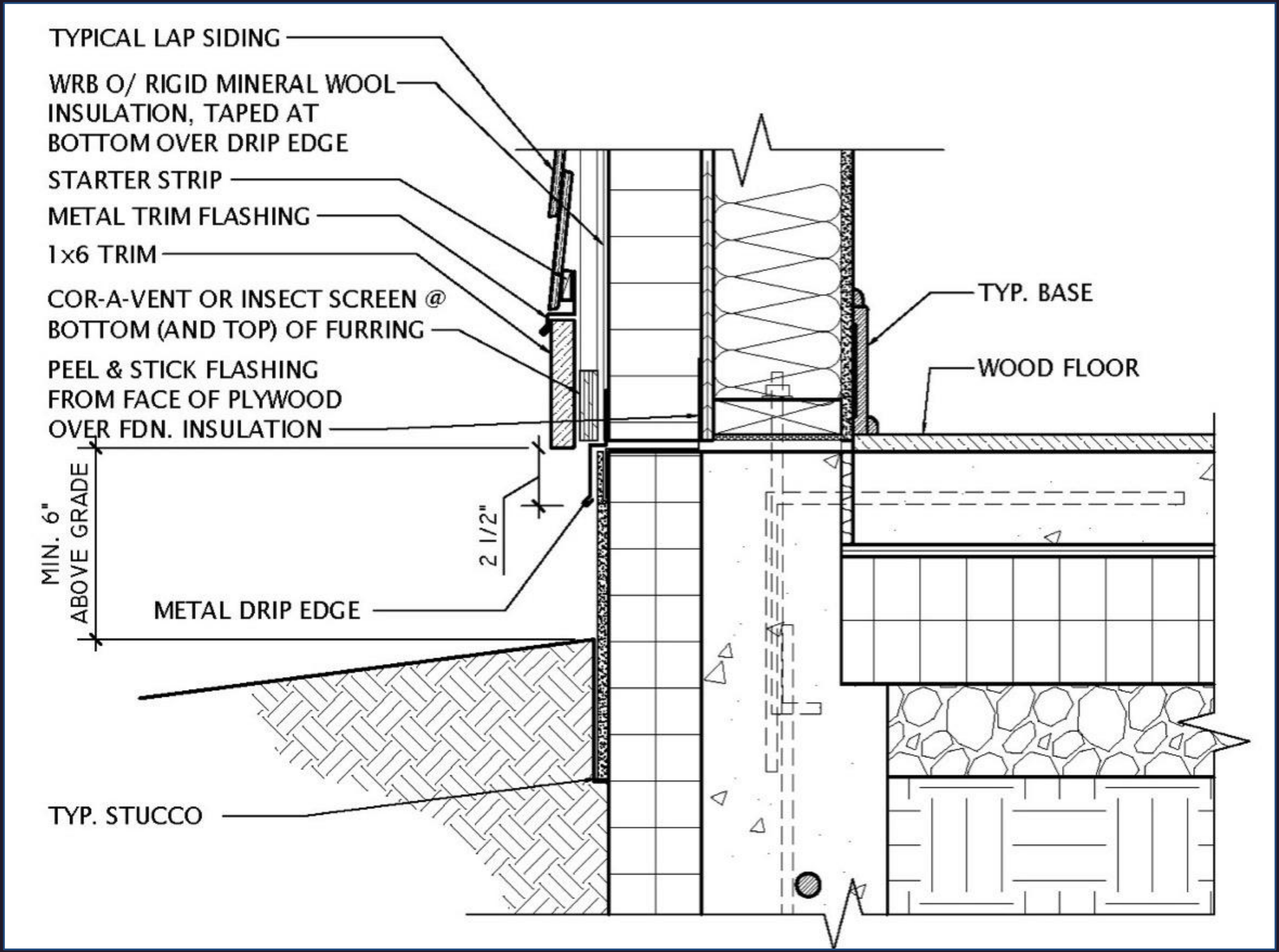


Image credit: Wagner Zaun Architecture

All Electric: Low Loads+High Efficiency

Image from starkappliances.com

Image from subzero-wolf.com

No fossil fuels means no fumes inside a home and no emissions outside a home.

Super-Efficient Electric Heat Systems

Cold climate air source heat pumps can operate below -15F.

Small electric back-up heat and passive solar offer resiliency.

Super-Efficient and Accessible Systems

Systems will be replaced or upgraded more frequently than structure. Make the house ready.

Heat pump water heaters have energy factors above 3; more than 5x as efficient as gas!

Energy Monitoring

Image from sense.com

Image from mitchellinstrument.com

Many options to measure, track, learn, adjust

Priority for PV now or PV Ready

Panels continue to drop in cost.

Home battery storage options are increasing.

Solar Data Explorer: Minnesota

	2019 cost for a 5 kW system
Out-of-pocket cost	$13,855 – $18,745
Net 20-year savings	$25,015 – $33,844
Payback period	7.9 – 10.7 years
Electricity bill offset	75 – 101 %

Solar installation costs do not include the 26% Federal Investment Tax Credit or local incentives.

Image and data from energysage.com

Examples on the Greener Path

What these homes have in common

- Building design to take advantage of the sun
- Building form to aid enclosure efficiency
- Energy modeling to refine the insulation levels
- Thermal bridging addressed in assembly details
- R-20+ foundations
- R-30+ walls
- R-60+ attics
- U-0.20 or better windows
- Air tightness < 1.0 ACH50
- ALL CONSUME LESS THAN 50 MMBtu/YEAR

Skyline House

Completed 2008/Added PV June, 2016

Typical annual energy consumption: 32 MMBtu

Details: Skyline House

3000 ft2
1 story + walk-out basement

ENCLOSURE

Foundation Walls	R-42
Framed Walls	R-51
Attic/ceiling	R-100
Windows	R-5.5 (U.18)
Air tightness	.7 ACH50

SYSTEMS

- Integrated solar space-water heating
- Thermal mass wall
- Wood stove
- Fully ducted HRV w/additional heat
- 48 tube solar thermal array
- 7 kW PV

Ecologists' Net Zero House

Completed 2015

2016 Energy Use & Production

Electricity:

Produced	7,534 kWh
Purchased	4,807 kWh
Sold	5,754 kWh
Consumed	6,587 kWh (549 kWh/month)
	22.46 MMBtu

Also Firewood	39 MMbtu
Electric surplus	-3.23 MMbtu

Total net energy use: 35.77 MMbtu

Details: Ecologists' House

2832 ft2
2 stories + finished attic

ENCLOSURE

Slab Foundation	R-20
Framed Walls	R-36
Attic/ceiling	R-71
Windows	R-5.5 (U.18)
Air tightness	.3 ACH50

SYSTEMS

- Marathon electric water heater
- 6 kW electric boiler w/radiant slab
- Wood stove
- Mini-split ASHP heating/cooling
- Fully ducted HRV
- 6.6 kW PV

Net Zero Project Construction Costs

Item	Cost
House	$416,350
Utilities (not including PV)	27,700
6.6 kW PV system, designed and installed	38,060
Federal PV Tax Credit	-11,253
Net PV ($4 per watt)	26,807
Utility Program House Efficiency Rebate	-2,800
Design Fees	27,000
Total Project Construction Cost	$495,057
Cost Per Square Foot (2950 ft2)	$168/ft2
House completed summer 2014 (minimal owner sweat equity)	

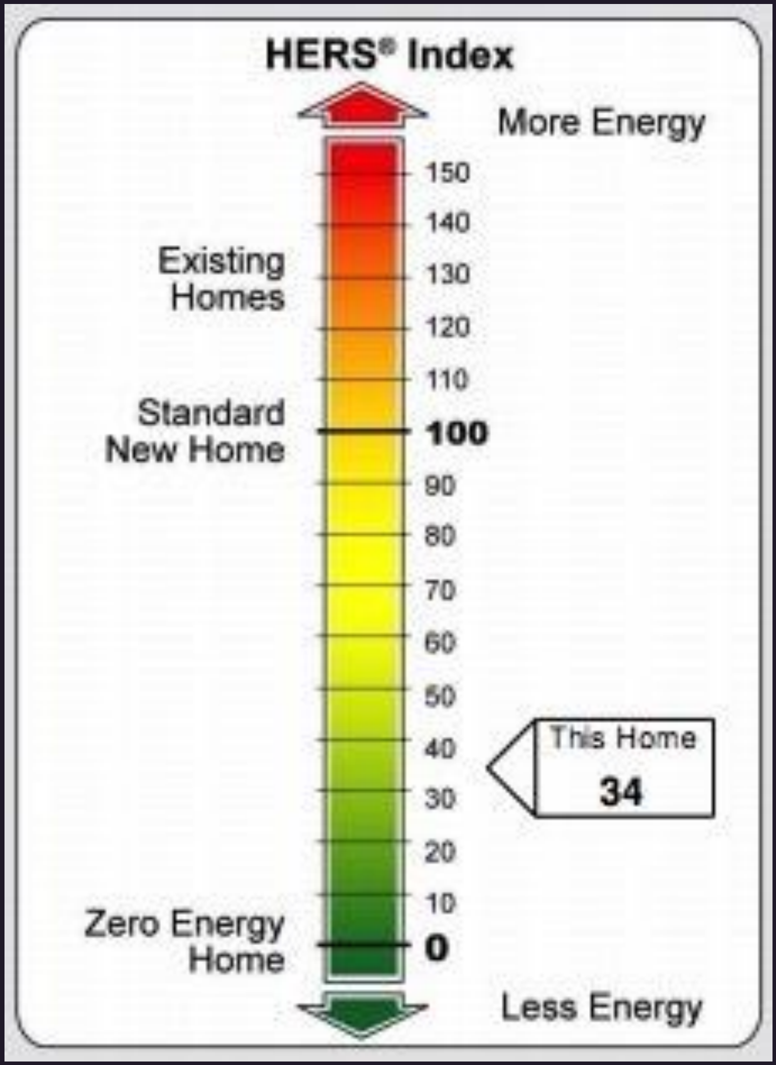
Lagom Farmhouse

Completed 2017
HERS 34 without PV

2018 Energy consumption (no PV): 12,203 kWh = 41.6 MMbtu
=12.2 kBtu/ft2

Details: Lagom Farmhouse

3400 ft2
2 stories + basement



ENCLOSURE

- Basement walls R-20
- Basement slab R-24
- Framed Walls R-36
- Attic/ceiling R-71
- Windows R-5.5 (U.18)
- Air tightness 280 CFM50

SYSTEMS

- Heat Pump Water Heater
- Mini-split ASHP heating/cooling
- Fully ducted ERV
- 7.1 kW PV added a year later

A Plum Home

Completed 2019 - Aiming for zero net energy

Details: A Plum Home

3400 ft2
1 story + walk-out basement

ENCLOSURE

- Foundation walls — R-36
- Basement slab — R-32
- Framed Walls — R-43
- Attic/ceiling — R-100
- Windows (U.18) — R-5.5
- Air tightness — .28 ACH50

SYSTEMS

- Heat Pump Water Heater
- Mini-split ASHP heating/cooling
- Fully ducted HRV
- 10.1 kW PV

If Habitat can do it, we all can do it.

Image from St. Croix Valley Habitat for Humanity

Let’s all build for

The Next Generation

Thank you.

Rachel Wagner, through design LLC

throughdesign.net

rachel@throughdesign.net

A Few of My Favorite Things: Resources

- The Next Generation Energy Act

  https://www.pca.state.mn.us/air/state-and-regional-initiatives

- Building Science Corporation

  buildingscience.com

- Green Building Advisor

  greenbuildingadvisor.com