How Much and How Much Better?

A Case Study of Zero-Net Energy Housing in Northern Minnesota

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Contents

Introduction

Greenhouse gas emissions, the most prevalent being CO_2, methane, and nitrous oxide are collecting in the atmosphere and impacting all organisms that reside on this planet. We have the resources, knowledge, and technology to reduce these emissions, thereby slowing, stopping, and even reversing the negative impacts if we move quickly and make the big investments needed to make a difference. Each sector can make significant contributions to reducing emissions and this paper models the energy, financial, and CO2 savings of a net-zero residential home design in a very cold climate (northern Minnesota, USA) compared with the same design built to current Minnesota Residential Energy Code minimums. Results of the modeling and next steps are discussed.

Defining the Problem

According to the EPA, the human activities in the U.S. that contribute the most to greenhouse gas emissions are burning fossil fuels for electricity, heat, and transportation [1]. Emissions sources are often attributed to each of the major economic sectors: Transportation, electricity generation, industry, commercial, residential and agriculture. In 2019, the emissions from these sectors were 6,558 million metric tons (MMt) of CO_2 equivalent [1].

All of these sectors have one thing in common: they need energy. Energy to move, energy for production, energy for heating, and growing crops. One of the major costs of generating and using this energy is greenhouse gas emissions. Burning non-renewable energy sources is one of the greatest contributors to emissions, and one of the most popular methods for on-demand energy generation. Non-renewable energy sources include natural gas, coal, petroleum and other fuel oils. They are typically composed of carbon and hydrogen, and when burned, release CO_2, along with other pollutants.

Of the major sectors defined by the EPA, the residential sector accounts for about 20% of greenhouse gas emissions in the United States [2]. The most common sources of energy for the residential sector are electricity and natural gas [3]. Together, they accounted for 85% of end-use energy usage in the residential sector in 2020 according to the EIA [3]. Renewable resources only accounted for 7% of the end-use energy use, where sources include geothermal, solar, and wood fuels [3].

Some of the biggest energy consumers in the common U.S. household are space heating and cooling systems. Other common electric appliances in most single-family households include stoves, washers and dryers, refrigerators and freezers, small appliances and water heaters. Appliances fueled by natural gas, propane or fuel oil include stoves, dryers, furnaces, water heaters, and boilers. According to the U.S. Census, 55% of single-family homes built in 2020 in the U.S. were heated by natural gas instead of electricity [4].

The residential sector contributes 20% of U.S. greenhouse gas emissions, which means there is opportunity to reduce emissions in a significant way. One way to reduce emissions from the residential sector is to start at the very beginning of a house's life and build it right to ensure that

it uses the least amount of energy possible in the most clean and efficient manner. This can be accomplished by implementing more rigorous standards in home building that reduce energy waste by improving the homes' thermal boundaries and maximize energy efficiency through more efficient appliances and mechanical equipment.

Paving the Way Towards Net-Zero Carbon

Several studies have queried the possibility of moving energy generation towards net-zero carbon, and some have focused specifically on the residential sector. Many have found it possible to move in a low to net-zero carbon direction, and some cities have even implemented laws and guidelines to become low to net-zero carbon [5, 6].

To analyze the general energy generation trends of the United States, a study performed by Williams *et al.* analyzed 9 different pathways forward to reduce emissions and become net-zero carbon. One pathway is if we continue as we are now (Based on DOE *Annual Energy Outlook*), and the rest are pathways towards carbon neutrality. The only case with complete dependence on electricity was paving a path forward with 100% renewable resources [7]. The other paths still had some nonrenewable resources, but their effects were mitigated through sequestration and utilization to become net zero carbon. By moving forward with 100% renewable resources, 87% of demanded energy will be in electricity. The DOE also predicts that the residential energy demand will decline from 11.02 EJ to 6.54 EJ.

More specifically to the residential and commercial building sector, a review of current literature on low and net-zero carbon cities by Seto *et al.* analyses current studies on low and net-zero carbon cities based on their objectives, methodology, and performance. When reviewing literature about reducing urban demand for energy, one common pathway forward was by increasing single-sector efficiency by more efficient buildings [5]. Other pathways towards low or net-zero carbon included the decarbonization of electricity through renewable resources which can be accomplished at both macro and micro scales. Local implementation of solar panels for medium to high density housing was shown to cover community electricity demands by several sources in the review [5]. Seto *et al.* stresses the importance of systemic transformation to achieve net-zero carbon across the globe to achieve the goal of net-zero carbon.

Policies around the globe to reduce emissions and improve efficiency for buildings were outlined by Ürge-Vorsatz *et al*. They found from an evaluation performed by the United Nations Economic Commission for Europe (UNECE) that most jurisdictions in the United States do not have efficiency requirements for buildings and rely on voluntary efficiency improvements from builders [6]. One example of a country with strict efficiency standards is China. Despite the fact that it is a source of massive emissions, it also is the world leader in total floorspace of zero-net energy buildings at 7 million m^2 and number of zero-net energy buildings [6]. It has standards dictating energy usage in severe cold and cold zones to steer the design of ultra-low energy buildings. Another example of the success of implementing efficiency standards is demonstrated by Brussels. They went from having the least efficient buildings in Western Europe to the most efficient in 7 years by requiring Passive House standards across the Capital Region [6]. This resulted in a drop of heating energy use and greenhouse gas emissions by 25% and 16%

respectively [6]. They phased in their Passive House requirements, so that by the time the Passive House standard became a building requirement, most builders were already adhering to the code.

Most of the preceding studies have had one step in common to achieve their low to net-zero goals: electrification. Electrification is the transition to electricity for end-use energy needs of heating, cooling, and running appliances rather than fossil fuels. Further, by using renewable resources to power electrification, emissions can be rapidly reduced in a more sustainable manner.

Based on the literature, a phased approach assisted by government regulations is often recommended to ensure that the demand for electricity does not exceed supply, causing detrimental societal and economic impacts.

Minnesota's Residential Energy Picture

Minnesota is located in IECC climate zones 6 and 7, and experiences harsh winters and hot summers. Despite being a leader in energy efficiency policy (ranked 9 of 50 states in 2021), Minnesota has actually increased its energy usage by 32% from 2005 to 2018 in the residential sector [8, 9].

Due to the colder climate, Minnesota homes demand significant heating energy loads, with the majority of households (66.1%) using natural gas for heating [10]. In 2018, Minnesota homes used 450 billion cubic feet of natural gas, which is the equivalent of about 27 million tons of CO2 just for heating their homes [11, 12].

Energy Source Used for Home Heating (share of households)	Minnesota	U.S. Average	Period
Natural Gas	66.2 %	47.8 %	2019
Fuel Oil	1.5 %	4.4 %	2019
Electricity	17.3 %	39.5 %	2019
Propane	11.2 %	4.8 %	2019
Other/None	3.7 %	3.5 %	2019

Fig. 1: MN Energy Source for Home Heating, 2019 from:
https://www.eia.gov/state/data.php?sid=MN#ConsumptionExpenditures

In 2016, Minnesota households used an average of 9,200 kW of electricity/year according to the EIA [13]. The inputs used to generate electricity in Minnesota have changed significantly in the last 15 years, with the state seeing a 47% decrease in coal and renewables now accounting for 21.7% of overall electricity generation (up from 5.5% of the total in 2005). These shifts are significant as we discuss moving residential heating leads to electricity versus fossil fuel based sources. If the state is generating electricity from coal, it would not be advisable to shift more demand onto that high emitting power generation. However, our electic grid is greening and there are less emissions associated with electricity generation than on other fossil fuels for our residential energy demands.

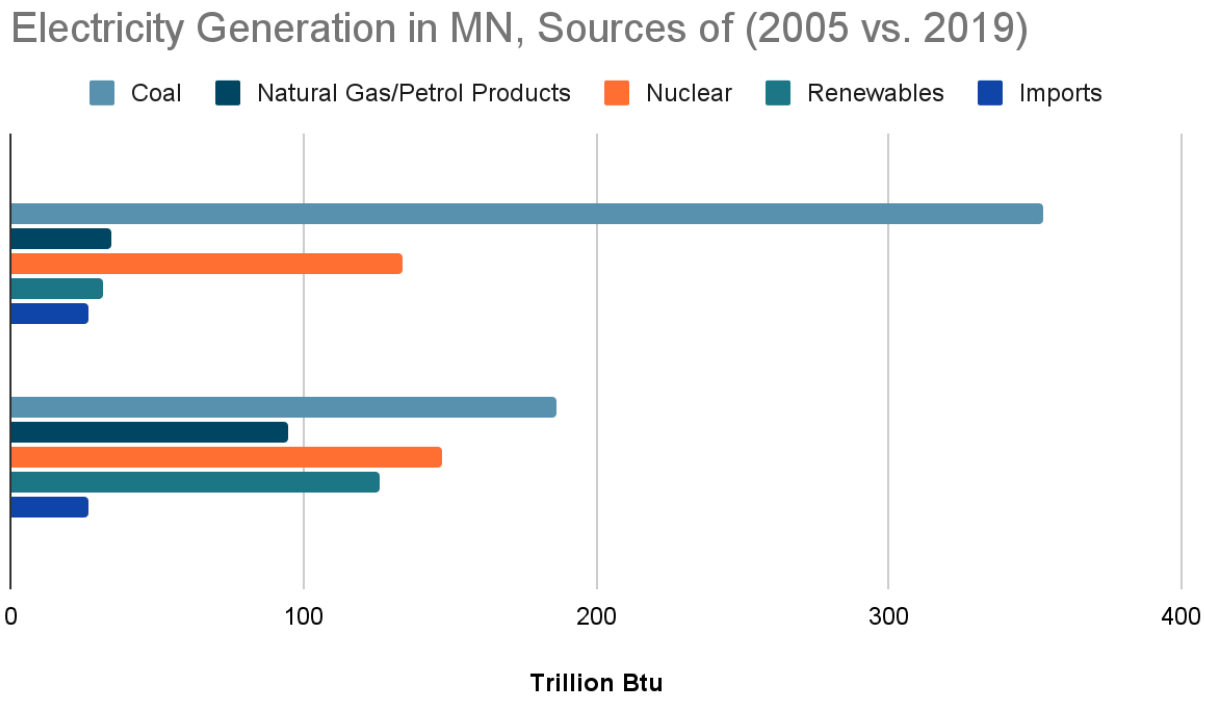


Fig. 2: Sources of Electricity Generation in MN, 2005 vs. 2019 from: https://www.eia.gov/state/seds/sep_use/eu/pdf/use_eu_MN.pdf

A Proposed Solution

Over time, houses in the U.S. have been built more efficiently and are using less energy as a result. Despite improvements in technology, however, carbon emissions in the residential sector have remained static over the last 30 years due to a variety of factors including increase in average size of a home, number of appliances, and the total number of houses [3].

In Minnesota, all new home construction must adhere to the current Residential Building Code standards which contains regulations regarding energy efficiency, etc. This is considered “code minimum”. However, more rigorous standards exist that maximize energy efficiency for the home and these methods have been demonstrated and confirmed through multiple studies.

One such standard is Passive House, a standard used in both the U.S. and abroad (Passiv Haus). Passive Houses operate efficiently by meeting strict criteria to dramatically reduce the amount of household energy consumption. The five main criteria pertain to space heating demand, space cooling demand, primary energy demand (for domestic applications), airtightness and thermal comfort [14].

Another classification for a maximally energy efficient home, and the focus of the current research, is *zero-net energy (ZNE).* A zero-net energy home combines superior energy efficiency with a renewable energy source to generate all of the energy a home needs. A house with superior energy efficiency, excluding the renewable energy source, can be termed *zero-net energy ready (ZNR).* One voluntary zero-net energy ready standard in the U.S. is the Department of Energy's Zero Energy Ready Home (ZERH) program [15].

Zero-Net Energy House Components

There are several core ideas that support the ZNE house construction to make it more energy efficient. Since a majority of energy usage is dedicated towards temperature control, controlling the thermal boundaries of the house is of high priority, both with the design and construction of the home. Other methods for increasing efficiency include selective determination of the electrical appliances used in the home. This can reduce energy usage, while also improving performance. Eliminating non-electrical appliances that are used in heating, cooling and other domestic activities stops end-use emissions at the home. Finally, introducing a renewable energy source to the home can make the home net-zero carbon by ensuring that all of the home's electricity is coming from a renewable energy source that produces no emissions.

Insulation through Exterior Boundary Control

Controlling the thermal boundary (also termed the envelope) of the home reduces a lot of the energy demand on a home. This is accomplished by increasing the insulation and insulation quality of the home to reduce the heat transfer between the interior and the exterior and also by reducing the air leakage of the envelope. Insulation can be added in the exterior walls, the attic and in the basement or under the slab.

Thoughtful design can also reduce the amount of heat transfer between interior and the exterior via thermal bridges. Thermal bridges occur when there is a heat conductive material used along that boundary that creates direct heat flow pathways through the thermal boundary. By reducing these thermal bridges, houses will have less heat transfer and less need for energy to control the interior temperature.

The heat transfer through windows and doors can also be reduced with window glazing choice and window placement. Triple-pane windows are an appropriate choice in a cold climate like Minnesota, with two insulating gas layers and three panes of glass. Windows can also be placed to reduce the amount of incoming solar radiation. Placement is location dependent and should be implemented into the design of the house. Window shading is also important to reduce the amount of incoming solar radiation, during the hot seasons.

Heat transfer can also occur through physical openings, and thus controlling the sealing of the home can reduce heat and air transfer. The airtightness of the home can be described as the number of air exchanges per hour, and by reducing the number of air exchanges, reducing the amount of uncontrolled heat flow. There is a caveat, however. Occupants need a steady supply of fresh air to breathe. This is called "ventilation." Opening windows provides ventilation but relying solely on windows for ventilation can cause unwanted discomfort (in winter or summer) and heat loss. Mechanical ventilation is required by code in all new Minnesota homes. Controlling the flow of heat through mechanical ventilation is more energy efficient, and can improve indoor air quality with filtration.

ENERGY STAR® Appliances

Increased end-use efficiency of energy reduces the overall draw of the household on the energy supply. This can be achieved by using appliances that are more efficient and have better performance indicators. Appliances and equipment rated as ENERGY STAR® certified must meet the strict energy efficiency criteria set by the EPA or the DOE [16]. By using appliances with increased efficiency, less electricity will be used, reducing emissions, and saving the consumer money in energy costs over time.

Air Source Heat Pump (ASHP)

Air source heat pumps are a more efficient system for home heating and cooling as compared to traditional systems, such as combustion heating systems and air conditioners [17]. They perform better than traditional systems because a heat pump transfers heat directly, instead of burning a fuel to move heat. By moving heat directly, there is less energy loss and less energy used to move the heat from one space to another. Air-source heat pumps need to be chosen based on the climate zone they are installed in to optimize performance. By implementing air-source heat pumps in homes, heating and cooling energy consumption can be greatly reduced, which are two of the most energy demanding needs of a household. According to the U.S. Department of Energy, air-source heat pumps can reduce energy usage by 3,000 kWh, when compared to more often used electric resistance heaters [17].

Renewable Energy Source

Introducing a renewable energy source to a household can reduce the home's energy-associated CO2 emissions and reduce the household money spent on purchased energy. Solar panels used for generating electricity are called photovoltaic (PV) panels. They produce electricity by converting solar radiation directly to electricity utilizing a positive and negative layer of a silicon solar cell to separate the electrons to harvest them for electricity. They can be placed on the roofs of houses, or in open space, to gather solar radiation. They usually last 25 years, but some can last upwards of 40 years.

Decreased reliance on non-renewable energy sources in the residential sector can be accomplished in several ways; reduced energy needs for heating and cooling, reduced energy draw from small appliances, and renewable energy generation linked directly to the residence. These can all be accomplished by following the stricter standards set by institutions like Passiv Haus, Passive House Institute U.S. (PHIUS), ENERGY STAR®, and the DOE.

Case Study for Northern Minnesota in Two Parts

Part 1: Energy & Emissions Modeling

Purpose

To determine and compare the energy demand and CO_2 emissions of one house design (in the same location) using 3 different standards: the 2015 Minnesota Residential code, zero-net energy ready (ZNR), and zero-net energy (ZNE).

Scope

A design for a 1,500 square foot single-family detached home, the Evergreen House, was modeled to Minnesota 2015 Residential Code and compared to the same single-family home modeled to be ZNR and ZNE. Comparisons will be made based on end-use loads, annual estimated energy cost, HERS® Index, estimated greenhouse gas emissions, and estimated energy cost savings (only applicable to ZNR and ZNE).

Methodology

REM/*Design* 16.0.2 was used to model a single-family detached home to a given set of construction drawings according to 3 standards. Each house was modeled as if built in the same location in Duluth, MN[1], but varied according to the enclosure and systems design and energy performance standards. The building form, size, window and door sizes, interior details, orientations and locations did not vary between the models.

The code house was modeled to the current Minnesota Residential Energy Code minimums and feature a natural gas forced air furnace. The ZNR and ZNE versions were modeled with advanced energy efficiency specifications regarding the enclosure, insulation, and airsealing and the mechanical systems were all electric with air source heat pumps, with the only difference that the ZNE home was modeled with a roof-mounted PV array. The differences in assembly and system specifications are summarized in Table 1. More specific building specifications are included in Appendix B.

The National Renewable Energy Laboratory's (NREL) PVWatts ® Calculator was used to determine the PV system specifications. The PV DC system size was a 9.6 kW standard fixed roof mounted array at a 40° tilt with an array azimuth southeast (225°).

Each model was given a HERS® rating calculated through REM/*Rate.* The Home Energy Rating System (HERS ®) is the nationally used system for rating the energy performance of a home. A HERS ® score of 100 indicates that a home is performing at the same level as the reference home used on the scale, which conforms to IECC 2006. A higher score indicates a less energy efficient home, where a lower score indicates a more efficient home. A score that is zero or less can only be obtained by a net-zero energy home.

[1] The location used in REM/*Design* was International Falls, Minnesota. This location more accurately represents the expected weather and heating conditions than the preset values for Duluth, Minnesota.

Models were submitted to the Minnesota Center for Energy and Environment (MnCEE) for verification. Duct systems were added by MnCEE staff. REM/*Rate* reports are included in Appendix B.

All three models, once verified, were compared based on HERS ® Index, estimated annual energy cost, estimated annual energy consumption, estimated annual savings and CO_2 emissions. Results are summarized in Tables 2 and 3.

Results

Table 1. Building assembly and system specification comparison to the 2015 MN Residential Energy Code.

	2015 MN Residential Energy Code			**As Designed – ZNR**			**As Designed - ZNE**		
Assemblies	*Cavity*	*Continuous*	*U-Value*	*Cavity*	*Continuous*	*U-Value*	*Cavity*	*Continuous*	*U-Value*
Foundation Walls		R-10			R-22			R-22	
Framed Walls	R-21			R-21[2]	R-15		R-21[2]	R-15	
Windows			0.32			0.20[3]			0.20[3]
Doors		3.0	0.203		10	0.084		10	0.084
Attic		R-49			R-70			R-70	
Systems									
Mechanical Ventilation		Balanced			Balanced			Balanced	
Air Tightness		3 ACH @ 50 Pa			< 1 ACH @ 50 Pa			< 1 ACH @ 50 Pa	
Lighting		0% LED			90% LED			90% LED	
Heating		90 AFUE Gas Furnace 100K			Midea 24k Ducted			Midea 24k Ducted	
Cooling		14 SEER A/C 2 Ton			Midea 24k Ducted			Midea 24k Ducted	
Hot Water		Conventional Electric			Heat Pump Electric			Heat Pump Electric	

[2] Minimum

[3] Maximum

Table 2. Energy performance comparison between the MN 2015 Residential Energy Code home to the ZNR and ZNE built homes.

	2015 MN Residential Energy Code	As Designed – ZNR	As Designed - ZNE
HERS® Index Score[4]	73	35	-8
Estimated Annual Energy Cost ($/year)	$1,070.00	$791.00	-$102.00
Estimated Annual Energy Consumption (MWh/year)	27	9	-2
Annual Savings ($/year)*	$561.00	$1760	$2,653.00

Table 3. Greenhouse gas emissions comparison between the MN 2015 Residential Energy Code home to the ZNR and ZNE built homes.

Emissions	2015 MN Residential Energy Code	As Designed – ZNR	As Designed - ZNE
CO_2 (tons/year)	9	6	-1
SO_2 (lbs./year)	17.4	23.2	-0.2
NOx (lbs./year)	26.8	18.4	-0.2
Emissions Reductions			
CO_2 (tons/year)	-	10.4	10.4
SO_2 (lbs./year)	-	31.4	31.4
NOx (lbs./year)	-	25.0	25.0

[4]A HERS ® score of 100 indicates that a home is performing at the same level as the reference home used on the scale, which conforms to IECC 2006.

Discussion

The results of the REM/*Rate* analysis show that CO2 emissions decrease by 3 tons/year for the ZNR house, and 10 tons/year for the ZNE house as compared to the home built to minimum code requirements. This decrease in CO2 emissions is due to the decreased energy load on the house from the increase in thermal envelope sealing and the increased efficiency of the mechanical equipment used to provide heating and cooling to the home, as well as the elimination of fossil fuel burning equipment.

The estimated annual energy consumption for the code modeled home was 27 MWh/year – this figure includes natural gas usage for the forced air furnace, which has been converted from cubic feet to Megawatt hours. Energy consumption decreases to 9 MWh/year for the ZNR home and goes net negative for the ZNE home at -2 MWh/year, indicating that the house would be selling energy to the grid, instead of buying from it. The ZNR home is interesting because that is the entire energy consumption of the house (including heating and cooling), whereas an average Minnesota home (noted above) uses 9.2 MWh/year which does not include heating and cooling.

REM/Rate was used to determine the HERS ® ratings for the home modeled to the 3 different standards by submission to the Minnesota Center for Energy and the Environment (MnCEE). The HERS ® rating of the ZNR home was less than half that of the home modeled to code, at 35 and 73 respectively, whereas the ZNE home was at -8 (due to producing more energy than the home uses). This is an indication of the impact a more rigorous energy code can have on new home construction which translates to less energy demand and less energy costs.

Due to the stark drop in energy demand, energy costs drop accordingly. The modeled code house costs an estimated $1072.00 per year, which drops to $791.00 for the ZNR modeled home and to -$102.00 for the ZNE home, which means that the home is making a profit based on estimation of annual energy gain from the attached PV system. All 3 modeled homes incur savings when compared to the HERS ® reference home at $591.00, $1,760.00 and $2,653.00 for the code, ZNR, and ZNE home respectively.

The ZNE modeled home has the greatest savings in energy per year, the least CO2 emissions per year, and a -8 HERS ® score, indicating the best energy efficiency. The results of this study clearly show that a ZNE home is the most environmentally friendly to operate/live in.

Part 2: Cost of Construction

Purpose

To determine and compare the cost of construction and costs over the life of a mortgage for one house design (in the same location) using 3 different standards: the 2015 Minnesota Residential Code, zero-net energy ready (ZNR) and zero-net energy (ZNE).

Scope

The Evergreen House, a 1,500 square foot, single family, single-level detached home was cost estimated to Minnesota 2015 Residential Code building standards and compared to the same

home cost-estimated to be ZNR and ZNE. Comparisons will be made based on construction costs, mortgage and down payment costs, and monthly mortgage + energy costs.

Methodology

The cost estimates were compiled from January 2022 - April 2022 utilizing bids from contractors and subcontractors in the Duluth, MN area and detailed to the specifications of the Evergreen house as either a Minnesota Residential Code house, a ZNR, or a ZNE. The ZNR home is the same as the ZNE, just without the cost of the PV array. All costs are reflective of the local availability of materials/labor as well as reflective of the inflated prices of materials and freight costs as a result of the Covid-19 pandemic.

Pandemic Impacts on the Current State of Home Construction/Buying

Due to the Covid-19 pandemic that started in 2020, prices of homes, for building and buying, have increased significantly. The cost analysis done for the model of the Evergreen zero-net energy homes reflects these increases in prices, and cost comparisons between the Evergreen modeled to the Minnesota Residential Energy Code, ZNR and ZNE were all made at the inflated prices. In Duluth, the average cost of homes rose by 17% [18] and costs for construction of new homes has increased by 20% due to supply chain issues and high demand [19]. As an example, lumber costs alone have increased 3 times in price from 2020 to 2022 [20]. The increases in cost for homebuying and home building are comparable, but the energy efficiency savings from building a new home make it more economically desirable when considering the costs of homeownership over the life of the mortgage.

Results

Table 4. Construction & monthly cost comparison between the MN 2015 Residential Energy Code home to the ZNR and ZNE built homes.

	Construction Cost/ Mortgage	**Down Payment***	**Monthly Mortgage, Taxes, Insurance + Energy Costs**
2015 MN Residential Energy Code Home	$418,256	$41,826	$2,555
ZNR Home	$437,684	$43,768	$2,581
ZNE Home	$461,584	$46,158	$2,553

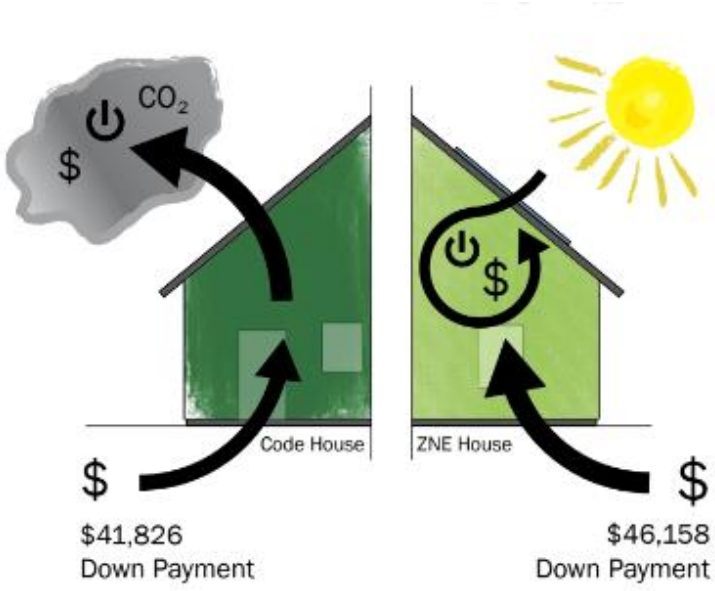
*10% down payment assumed

Discussion

The examination of costs between the code home, ZNR, and ZNE yielded interesting results. At the time this study was conducted, it would cost $418,256 to build the code version of the 1,500 square foot Evergreen Home (not including land purchase). That is $279/sq. ft. which (in 2022) is at the lower end of the “typical starter or mid-range move-up home” cost of $275 - $350/sq. ft.

according to Minneapolis-based Sustainable Nine Design + Build Company [20]. The ZNR and ZNE homes come in at $292 and $308 per square foot – still well within the "starter/mid-range" home defined above.

Despite the $43,000 difference in construction price tag, the initial upfront cost to a homebuyer by way of down payment is only $4,332 more for the ZNE home than that of the code home. Drilling down even further, the differences to the homeowner in terms of monthly cost are actually $2.31 **less** than that of the code home. See Appendix A for cost summary information.



Graphic Credit: Madeline Snow, in collaboration with Green New Deal Homes SBC

This cost analysis shows that a zero net energy home constructed in Duluth, Minnesota will cost 10.4% more than a home built to code minimum at 2022 prices. Additionally, the energy savings realized from greater energy efficiency of the ZNE home as well as the PV array, create a cost-equivalency to the code home in terms of monthly mortgage + energy costs with the added benefits of greater occupant comfort, zero fossil fuel combustion (and therefore zero chance of carbon monoxide exposure), resilience to changes in energy prices, and a smaller carbon footprint[5].

Conclusion

Fighting climate change through emissions reductions requires changes and effort in every sector. New homes today will be the old homes of tomorrow and it is of utmost importance that new construction lead by example of what can be done within the building industry to create a

[5] 66.4% of Americans make less than $100,000/year and 81.7% make less than $150,000, which depending on income/debt ratios would be the minimum salary needed to qualify for a $400,000+ mortgage. https://www.statista.com/statistics/203183/percentage-distribution-of-household-income-in-the-us/#main-content (2020).

better, more valuable, sustainable, and resilient product for the future. Deep energy retrofits of existing homes are another important area of effort that could halve CO2 emissions in the residential sector [21].

This study shows that enhancing the efficiency of newly built homes decreases the amount of greenhouse gases released into the environment, improving future environmental, societal, and economic outlooks. In 2021, over 1.1 million single family housing units were built in the United States [19]. If all these new homes were built to Minnesota Residential Energy Code, the homes would generate an additional 10.1 million tons of CO2 emissions annually. Conversely, if built to the Evergreen House ZNE standard, there would actually be zero additional CO2 emissions and positive clean energy would be added to the grid from the solar arrays. Building to a higher standard of energy efficiency and removing fossil fuels from new housing's energy mix would lead to 10 million+ tons of CO2 emissions avoided annually and compounding avoidance each year after. Building ZNE homes also creates resilience for the homeowner, reduces the impacts of future energy price fluctuations, increases occupant comfort and reduces health hazards.

The more rigorous energy efficiency standards we need already exist and homes are being built to meet these standards across the U.S. What we hoped to convey with this study to homebuyers, the construction industry, realtors, and lenders is that these homes are financially viable, cost-competitive to code-built homes, and that the ZNE features have value to the homeowner above and beyond the initial cost to add them to the home. Now is the time for policy to catch up and implement more rigorous building standards across the U.S. to bring home building to a climate-ready level and help meet emission reduction goals.

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Appendix A: Monthly and Annual Cost Analysis

Comparison of 3 homes

ENERGY -- Monthly Estimates			
Element	**Code**	**ZER**	**ZNE**
Electricity Consumption (kWh)	882	908	908
Electricity Production from Solar (kWh)	0	0	942
Natural Gas Consumption (Therms)	63.33	0	0
Electricity cost	$123.17	$126.89	$0.00
Electricity service fee	$8.00	$8.00	$8.00
Natural gas cost	$66.50	$0.00	$0.00
Natural gas service fee	$8.63	$0.00	$0.00
Monthly Totals	**$206.30**	**$134.89**	**$8.00**

**Average electricity cost for ZNE is zero because over the course of a year the ZNE home will generate as much or more electricity than it consumes.*

ENERGY -- Yearly estimates			
Element	**Code**	**ZNR**	**ZNE**
Electricity Consumption (kWh)	10,580	10,900	10,900
Electricity Production from Solar (kWh)	0	0	11,306
Natural Gas Consumption (Therms)	760	0	0
Electricity cost	$1,478.03	$1,522.73	$0.00
Electricity service fee	$96.00	$96.00	$96.00
Natural gas cost	$798.00	$0.00	$0.00
Natural gas service fee	$103.56	$0.00	$0.00
Monthly Totals	**$2,475.59**	**$1,618.73**	**$96.00**

**Energy consumption estimates received from energy models specific to each home. Therms of natural gas used in the code home are equivalent to 22,268 kWh (multiply therms by 29.3).*

TOTAL MONTHLY MORTGAGE + ENERGY COSTS			
Element	**Code**	**ZNR**	**ZNE**
Mortgage Amount	$1,884.00	$1,981.00	$2,080.00
Property Tax	$375.00	$375.00	$375.00
Homeowner's Insurance	$90.00	$90.00	$90.00
Electricity	$131.17	$134.89	$8.00
Natural Gas	$75.13	$0.00	$0.00
Monthly Totals	**$2,555.30**	**$2,580.89**	**$2,553.00**

Appendix B: Building Summaries from REM/*Design*

Evergreen Code Model

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55806

Weather:International Falls, MN
Evergreen Code
Sam_Evergreen Code2 16.0.2 CEE HERS.blg

Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Builder

Property/Builder Information

Building Name	Evergreen Code
Owner's Name	Green New Deal Homes
Property Address	108 E 11th St
City, St, Zip	Duluth, MN 55806
Phone Number	
Builder's Name	
Phone Number	
Email Address	
Plan/Model Name	
Community/Development	
Identifier/Other	

Organization Information

Organization Name	Green New Deal Homes SBC
Address	2201 W 1st St
City, St, Zip	Duluth, MN 55806
Phone Number	2183435583
Website	greennewdealhomes.com
Verifier's Name	Rachel Wagner
Verifier's Email	rwagner@greennewdealhomes.com

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55806

Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Weather:International Falls, MN
Evergreen Code
Sam_Evergreen Code2 16.0.2 CEE HERS.blg

Builder

General Building Information

Area of Conditioned. Space(sq ft)	1494
Volume of Conditioned. Space	13446
Year Built	2022
Housing Type	Single-family detached
Level Type(Apartments Only)	None
Floors on or Above-Grade	1
Number of Bedrooms	3
Foundation Type	Slab
Foundation is w/in Infiltration Volume:	N/A
Enclosed Crawl Space Type	N/A
Number of Stories Including Conditioned Basement	1
Thermal Boundary Location	N/A

Slab Floor Information

Name	Library Entry	Area(sq ft)	Depth Below Grade(ft)	Full Perimeter(ft)	Exposed Perimeter(ft)	On-Grade Perimeter(ft)
	MN 2015 Code Slab**0***	1494	0.00	163	163	163

Slab Floor Library List

Slab Floor: MN 2015 Code Slab**0***

Slab Covering	Vinyl
Perimeter Insulation (R-Value)	10.0
Perimeter Insulation Depth (ft)	5.0
Under-Slab Insulation (R-Value)	10.0
Under-Slab Insulation Width (ft)	14.0
Slab Insulation Grade	3
Radiant Slab	No
Note	

Above-Grade Wall

Name	Library Entry	Location	Exterior Color	Area(sq ft)	Uo Value
Code Wall	MN 2015 Code Wall**0***	Cond -> ambient	Medium	1488.00	0.065

Building Summary

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Green New Deal Homes
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Sam_Evergreen Code2 16.0.2 CEE HERS.blg

Builder

Above-Grade Wall Library List

Above-Grade Wall: MN 2015 Code Wall**0***

Information From Quick Fill Screen	
Wall Construction Type	Standard Wood Frame
Continuous Insulation (R-Value)	0.0
Frame Cavity Insulation (R-Value)	21.0
Frame Cavity Insulation Thickness (in)	3.5
Frame Cavity Insulation Grade	3
Stud Size (w x d, in)	1.5 x 5.5
Stud Spacing (in o.c.)	16.0
Framing Factor - (defined)	0.2100
Gypsum Thickness (in)	0.5
Note	

Window Information

						Overhang			Interior		Adjacent	
Name	Wall Assignment	Orient	U-Value	SHGC	Area (sqft)	Depth (ft)	To Top (ft)	To Btm (ft)	Winter Shading	Summer Shading	Winter Shading	Summer Shading
A	AGWall 1	Northeast	0.320	0.300	8.00	2.0	1.8	4.8	0.85	0.70	None	None
B	AGWall 1	Northeast	0.320	0.300	4.70	2.0	1.8	4.0	0.85	0.70	None	None
C	AGWall 1	Northeast	0.320	0.300	4.70	2.0	1.8	4.0	0.85	0.70	None	None
D	AGWall 1	Northeast	0.320	0.300	11.60	2.0	1.8	6.5	0.85	0.70	None	None
E	AGWall 1	Southeast	0.320	0.300	11.60	1.0	9.0	13.6	0.85	0.70	None	None
F	AGWall 1	Southeast	0.320	0.300	11.60	1.0	9.0	13.6	0.85	0.70	None	None
G	AGWall 1	Southwes	0.320	0.300	11.60	2.0	1.8	6.5	0.85	0.70	None	None
H	AGWall 1	Southwes	0.320	0.300	34.70	2.0	1.8	6.5	0.85	0.70	None	None
I	AGWall 1	Southwes	0.320	0.300	34.70	2.0	1.8	6.5	0.85	0.70	None	None
J	AGWall 1	Southwes	0.320	0.300	26.00	2.0	1.8	6.5	0.85	0.70	None	None
K	AGWall 1	Northwes	0.320	0.300	13.00	1.0	8.0	12.7	0.85	0.70	None	None
L	AGWall 1	Northwes	0.320	0.300	8.90	4.0	1.0	4.3	0.85	0.70	None	None
M	AGWall 1	Northeast	0.320	0.300	4.70	2.0	1.8	4.0	0.85	0.70	None	None
Side door	AGWall 1	Northeast	0.320	0.300	6.00	2.0	2.0	5.0	0.85	0.70	None	None
Front door	AGWall 1	Northwes	0.320	0.300	6.00	4.0	1.2	4.2	0.85	0.70	None	None

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55806

Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Weather:International Falls, MN
Evergreen Code
Sam_Evergreen Code2 16.0.2 CEE HERS.blg

Builder

Door Information

Name	Library Entry	Wall Assignment	Opaque Area(sq ft)	Uo Value	R-Value of Opaque Area	Storm Door
Side door	MN 2015 Code Door**0***	AGWall 1	14.0	0.203	3.0	Yes
Front door	MN 2015 Code Door**0***	AGWall 1	14.0	0.203	3.0	Yes

Roof Information

Name	Library Entry	Ceiling Area(sq ft)	Roof Area(sq ft)	Exterior Color	Radiant Barrier	Type	Uo Value	Cement or Clay Tiles	Roof Tile Ventilation
	MN 2015 Code Ceiling**0***	1494.00	1942.00	Medium	No	Attic	0.021	No	No

Roof Library List

Ceiling: MN 2015 Code Ceiling**0***

Information From Quick Fill Screen	
Continous Insulation (R-Value)	37.0
Cavity Insulation (R-Value)	12.0
Cavity Insulation Thickness (in)	3.5
Cavity Insulation Grade	3
Gypsum Thickness (in)	0.500
Insulated Framing Size(w x h, in)	1.5 x 5.5
Insulated Framing Spacing (in o.c.)	24.0
Framing Factor - (defined)	0.2100
Ceiling Type	Attic
Note	

Building Summary

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Builder

Mechanical Equipment

Number of Mechanical Systems	3
Heating SetPoint(F)	68.0
Heating Setback Thermostat	Not Present
Cooling SetPoint(F)	78.0
Cooling Setup Thermostat	Not Present
DHW SetPoint(F)	125.0

Heat: 90AFUE Gas Furn 100k**0***

SystemType	Fuel-fired air distribution
Fuel Type	Natural gas
Rated Output Capacity (kBtuh)	100.0
Seasonal Equipment Efficiency	90.0 AFUE
Auxiliary Electric	992 Eae
Note	80% AFUE is the DOE minimum.
Number Of Units	1
Location	Conditioned area
Performance Adjustment	100
Percent Load Served	100

DHW: Code WH**0***

Water Heater Type	Conventional
Fuel Type	Electric
Energy Factor	0.90
Recovery Efficiency	0.98
Water Tank Size (gallons)	50
Extra Tank Insulation (R-Value)	0.0
Note	
Number Of Units	1
Location	Conditioned area
Performance Adjustment	100
Percent Load Served	100

Cool: 14SEER A/C 2 ton

Building Summary

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Sam_Evergreen Code2 16.0.2 CEE HERS.blg

Builder

Mechanical Equipment

System Type	Air conditioner
Fuel Type	Electric
Rated Output Capacity (kBtuh)	24.0
Seasonal Equipment Efficiency	14.0 SEER
Sensible Heat Fraction (SHF)	0.70
Note	
Number Of Units	1
Location	Conditioned area
Performance Adjustment	100
Percent Load Served	100

DHW Efficiencies

All bath faucets & showers <= 2gpm	true
All DHW pipes fully insulated >= R-3	true
Recirculation type	None (standard system)
Farthest fixture to DHW heater	18
TOTAL Pipelength for longest DHW run	28
DWHR unit present?	false
DHW Diagnostics	
dhwGpd	45.34
peRatio	0.32
dishwasherGpd	4.32
clothesWasherHotWaterGPD	3.89
EDeff	0.89
ewaste	14.13
tmains	44.10
dwhrWhInletTempAdj	0.00
pumpConsKwh	0.00
pumpConsMmbtu	0.00

Building Summary

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Sam_Evergreen Code2 16.0.2 CEE HERS.blg

Builder

Duct Systems

Name	Ducts
Conditioned Floor Area(sq ft)	1494.0
# of Returns	1
Heating System	90AFUE Gas Furn 100k**0***
Cooling System	14SEER A/C 2 ton
Supply Duct Surface Area(sq ft)	403.4
Return Duct Surface Area(sq ft)	74.7
No bldg cavities used as ducts	FALSE

Type	Location	Percent Location	R-Value
Supply	Conditioned space	100.0	0.0
Return	Conditioned space	100.0	0.0

Test Exemptions

IECC	FALSE
RESNET 2019	FALSE
ENERGY STAR LtO	FALSE

Duct Leakage

Input Type	Measured
Test Type	Both Tested
Duct Test Stage	Postconstruction Test

	LtO (Leakage to Outside)	Total Duct Leakage
Supply & Return	100.00 CFM @ 25 Pascals	400.00 CFM @ 25 Pascals
Supply Only	Not Applicable	
Return Only	Not Applicable	

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Builder

Infiltration and Mechanical Ventilation

Whole Dwelling Infiltration	
Input Type	Blower door
Heating Season Infiltration Value	3.00 ACH @ 50 Pascals
Cooling Season Infiltration Value	3.00 ACH @ 50 Pascals
Shelter Class	4
Code Verification	Tested
Mechanical Ventilation for IAQ	
Type	Balanced
Unable to Measure Mechanical Ventilation	FALSE
Rate(cfm)	90
Adjusted Sensible Recovery Efficiency(%)	0.00
Adjusted Total Recovery Efficiency(%)	0.00
Hours per Day	24.0
Fan Power (watts)	60.00
ECM Fan Motor	true
Ventilation Strategy for Cooling	
Cooling Season Ventilation	Natural Ventilation
Good Air Exchange for Multi-Family	NA

Building Summary

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Builder

Lights and Appliances

Rating/RESNET audit	
Ceiling Fan CFM / Watt	0.00
Refrigerator kWh/yr	691
Refrigerator Location	Conditioned
Range/Oven Fuel Type	Natural gas
Induction Range	No
Convection Oven	No
Dishwasher	
Energy Factor	0.46
Dishwasher kWh/yr	0
Place Setting Capacity	12
Clothes Dryer	
Fuel Type	Natural gas
Location	Conditioned
Moisture Sensing	Yes
CEF	2.32
Clothes Washer	
Location	Conditioned
LER (kWh/yr)	704
IMEF	0.331
Capacity (CU.Ft)	2.874
Electricity Rate	0.08
Gas Rate	0.58
Annual Gas Cost	23.00
Qualifying Light Fixtures	
Interior Lights %	100.0
Exterior Lights %	0.0
Garage Lights %	0.0
Interior LEDs %	0.0
Exterior LEDs %	0.0
Garage LEDs %	0.0

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Builder

Mandatory Requirements

IECC Requirements	
Verified IECC 06	false
Verified IECC 09	false
Verified IECC 12	false
Verified IECC 15	false
Verified IECC 18	false
Verified NY-ECCC 2016	false
Verified IECC MI	false
Verified IECC NC 2018	false
EPA Requirements	
Rater certifies that the home complies with the following requirements for:	None
ENERGY STAR Version 3 Appliances	Amount
Refrigerators	0
Ceiling Fans	0
Exhaust Fans	0
Dishwashers	0
ENERGY STAR Multi-Family Checks	
Clothes washer is in a category with no ENERGY STAR options.	NA
Clothes dryer is in a category with no ENERGY STAR options.	NA
Apt or Townhome uses 'Class AW' Windows.	NA
ENERGY STAR Version 3 Basements	
Basement Wall Area 50% Below Grad:	false
Basement Floor Area	0.00
Slab Insulation Exemption:	false
Indoor airPlus Verification Checklist	false
EPA Field App ID	

Building Summary

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Builder

DOE Zero Energy Ready Home

Home Builder ID Number

Mandatory Requirements	
Verified Fenestration	false
Verified Insulation	false
Verified Duct Location	false
Verified Appliance	false
Verified Lighting	false
Verified Fan Efficiency	false
Verified Water Efficiency	false
Verified EPA Indoor airPLUS	false
Verified Renewable Energy Ready Solar Electric	false
Optional Home Builder Commitments for Recognition	
Certified under the EPA WaterSense for New Homes Program	No
Certified under the IBHS fortified for Safer Living Program	No
Followed the DOE Zero Energy Ready Home Quality Management Guidelines	No
The buyer of this home signed a waiver giving DOE Zero Energy Ready Home access to utility bill data for one year.	No

Active Solar

System Type	None
Collector Loop Type	None
Collector Type	None
Collector Orientation	None
Area(sq ft)	0.0
Tilt(degrees)	0.0
Volume(cu ft/gal)	0.0

Evergreen ZNR Model

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55806

Weather:International Falls, MN
Evergreen ZNR
Sam_Evergreen ZNE 16.0.2 CEE HERS.blg

Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Builder

Property/Builder Information

Building Name	Evergreen ZNR
Owner's Name	Green New Deal Homes
Property Address	108 E 11th St
City, St, Zip	Duluth, MN 55806
Phone Number	
Builder's Name	
Phone Number	
Email Address	
Plan/Model Name	
Community/Development	
Identifier/Other	

Organization Information

Organization Name	Green New Deal Homes SBC
Address	2201 W 1st St
City, St, Zip	Duluth, MN 55806
Phone Number	2183435583
Website	greennewdealhomes.com
Verifier's Name	Rachel Wagner
Verifier's Email	rwagner@greennewdealhomes.com

Building Summary

Property
Green New Deal Homes
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Duluth, MN 55806

Organization
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2183435583
Rachel Wagner

Weather:International Falls, MN
Evergreen ZNR
Sam_Evergreen ZNE 16.0.2 CEE HERS.blg

Builder

General Building Information

Area of Conditioned. Space(sq ft)	1494
Volume of Conditioned. Space	13446
Year Built	2022
Housing Type	Single-family detached
Level Type(Apartments Only)	None
Floors on or Above-Grade	1
Number of Bedrooms	3
Foundation Type	Slab
Foundation is w/in Infiltration Volume:	N/A
Enclosed Crawl Space Type	N/A
Number of Stories Including Conditioned Basement	1
Thermal Boundary Location	N/A

Slab Floor Information

Name	Library Entry	Area(sq ft)	Depth Below Grade(ft)	Full Perimeter(ft)	Exposed Perimeter(ft)	On-Grade Perimeter(ft)
House Slab	Evergreen Slab**	1494	0.00	163	163	163

Slab Floor Library List

Slab Floor: Evergreen Slab**

Slab Covering	Vinyl
Perimeter Insulation (R-Value)	11.0
Perimeter Insulation Depth (ft)	5.0
Under-Slab Insulation (R-Value)	24.0
Under-Slab Insulation Width (ft)	14.0
Slab Insulation Grade	1
Radiant Slab	No
Note	

Above-Grade Wall

Name	Library Entry	Location	Exterior Color	Area(sq ft)	Uo Value
Exterior Wall	Exterior ZNE Wall**	Cond -> ambient	Medium	1488.00	0.029

Building Summary

Property
Green New Deal Homes
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Evergreen ZNR
Sam_Evergreen ZNE 16.0.2 CEE HERS.blg

Builder

Above-Grade Wall Library List

Above-Grade Wall: Exterior ZNE Wall**

Information From Quick Fill Screen	
Wall Construction Type	Standard Wood Frame
Continuous Insulation (R-Value)	15.0
Frame Cavity Insulation (R-Value)	21.0
Frame Cavity Insulation Thickness (in)	5.5
Frame Cavity Insulation Grade	1
Stud Size (w x d, in)	1.5 x 5.5
Stud Spacing (in o.c.)	16.0
Framing Factor - (defined)	0.1800
Gypsum Thickness (in)	0.5
Note	

Window Information

						Overhang			Interior		Adjacent	
Name	Wall Assignment	Orient	U-Value	SHGC	Area (sqft)	Depth (ft)	To Top (ft)	To Btm (ft)	Winter Shading	Summer Shading	Winter Shading	Summer Shading
A	AGWall 1	Northeast	0.200	0.400	8.00	2.0	1.8	4.8	0.85	0.70	None	None
B	AGWall 1	Northeast	0.200	0.400	4.70	2.0	1.8	4.0	0.85	0.70	None	None
C	AGWall 1	Northeast	0.200	0.400	4.67	2.0	1.8	4.0	0.85	0.70	None	None
D	AGWall 1	Northeast	0.200	0.400	11.56	2.0	1.8	6.5	0.85	0.70	None	None
E	AGWall 1	Southeast	0.200	0.400	11.56	1.0	9.0	13.6	0.85	0.70	None	None
F	AGWall 1	Southeast	0.200	0.400	11.56	1.0	9.0	13.6	0.85	0.70	None	None
G	AGWall 1	Southwes	0.200	0.400	11.56	2.0	1.8	6.5	0.85	0.70	None	None
H	AGWall 1	Southwes	0.200	0.400	34.67	2.0	1.8	6.5	0.85	0.70	None	None
I	AGWall 1	Southwes	0.200	0.400	34.67	2.0	1.8	6.5	0.85	0.70	None	None
J	AGWall 1	Southwes	0.200	0.400	26.00	2.0	1.8	6.5	0.85	0.70	None	None
K	AGWall 1	Northwes	0.200	0.400	13.00	1.0	8.0	12.7	0.85	0.70	None	None
L	AGWall 1	Northwes	0.200	0.400	8.89	4.0	1.0	4.3	0.85	0.70	None	None
M	AGWall 1	Northeast	0.200	0.400	4.67	2.0	1.8	4.0	0.85	0.70	None	None
Side door	AGWall 1	Northeast	0.200	0.400	6.00	2.0	2.0	5.0	0.85	0.70	None	None
Front door	AGWall 1	Northwes	0.200	0.400	6.00	4.0	1.2	4.2	0.85	0.70	None	None

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55806

Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Weather:International Falls, MN
Evergreen ZNR
Sam_Evergreen ZNE 16.0.2 CEE HERS.blg

Builder

Door Information

Name	Library Entry	Wall Assignment	Opaque Area(sq ft)	Uo Value	R-Value of Opaque Area	Storm Door
Exterior Door E	ZNE Ins Door**	AGWall 1	14.0	0.084	10.0	Yes
Exterior Door E.1	ZNE Ins Door**	AGWall 1	14.0	0.084	10.0	Yes

Roof Information

Name	Library Entry	Ceiling Area(sq ft)	Roof Area(sq ft)	Exterior Color	Radiant Barrier	Type	Uo Value	Cement or Clay Tiles	Roof Tile Ventilation
ZNE Ceiling	ZNE Ceiling**	1494.00	1942.00	Medium	No	Attic	0.014	No	No

Roof Library List

Ceiling: ZNE Ceiling**

Information From Quick Fill Screen	
Continous Insulation (R-Value)	54.0
Cavity Insulation (R-Value)	20.0
Cavity Insulation Thickness (in)	5.5
Cavity Insulation Grade	1
Gypsum Thickness (in)	0.500
Insulated Framing Size(w x h, in)	1.5 x 5.5
Insulated Framing Spacing (in o.c.)	24.0
Framing Factor - (default)	0.1100
Ceiling Type	Attic
Note	

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55806

Weather:International Falls, MN
Evergreen ZNR
Sam_Evergreen ZNE 16.0.2 CEE
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Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Builder

Mechanical Equipment

Number of Mechanical Systems	2
Heating SetPoint(F)	68.0
Heating Setback Thermostat	Present
Cooling SetPoint(F)	78.0
Cooling Setup Thermostat	Present
DHW SetPoint(F)	125.0

ASHP: Midea24k ducted**

Fuel Type	Electric
Heating Seasonal Efficiency	11.60 HSPF
Compressor Heating Output Capacity at 17F (kBtuh)	16.5
Compressor Heating Output Capacity at 47F (kBtuh)	27.0
Electric Resistance Backup Capacity (kW)	5
Cooling Output Capacity (kBtuh)	22.0
Cooling Seasonal Efficiency	20.00 SEER
Desuperheater	No
Note	
Number Of Units	1
Location	Conditioned area
Performance Adjustment	100
Percent Heating Load Served	100
Percent Cooling Load Served	100

DHW: HPWH60**

Water Heater Type	Heat pump
Fuel Type	Electric
Energy Factor	3.40
Recovery Efficiency	0.00
Water Tank Size (gallons)	60
Extra Tank Insulation (R-Value)	0.0
Note	
Number Of Units	1
Location	Conditioned area

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55806

Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Weather:International Falls, MN
Evergreen ZNR
Sam_Evergreen ZNE 16.0.2 CEE HERS.blg

Builder

Mechanical Equipment

Performance Adjustment	100
Percent Load Served	100

DHW Efficiencies

All bath faucets & showers <= 2gpm	true
All DHW pipes fully insulated >= R-3	true
Recirculation type	None (standard system)
Farthest fixture to DHW heater	18
TOTAL Pipelength for longest DHW run	28
DWHR unit present?	false

DHW Diagnostics	
dhwGpd	40.03
peRatio	0.32
dishwasherGpd	2.49
clothesWasherHotWaterGPD	0.41
EDeff	0.89
ewaste	14.13
tmains	44.10
dwhrWhInletTempAdj	0.00
pumpConsKwh	0.00
pumpConsMmbtu	0.00

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55806

Weather:International Falls, MN
Evergreen ZNR
Sam_Evergreen ZNE 16.0.2 CEE HERS.blg

Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Builder

Duct Systems

Name	Ducts
Conditioned Floor Area(sq ft)	1494.0
# of Returns	1
Heating System	Midea24k ducted**
Cooling System	Midea24k ducted**
Supply Duct Surface Area(sq ft)	403.4
Return Duct Surface Area(sq ft)	74.7
No bldg cavities used as ducts	FALSE

Type	Location	Percent Location	R-Value
Supply	Conditioned space	100.0	0.0
Return	Conditioned space	100.0	0.0

Test Exemptions

IECC	FALSE
RESNET 2019	FALSE
ENERGY STAR LtO	FALSE

Duct Leakage

Input Type	Measured
Test Type	Both Tested
Duct Test Stage	Postconstruction Test

	LtO (Leakage to Outside)	Total Duct Leakage
Supply & Return	15.00 CFM @ 25 Pascals	80.00 CFM @ 25 Pascals
Supply Only	Not Applicable	
Return Only	Not Applicable	

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55806

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Weather:International Falls, MN
Evergreen ZNR
Sam_Evergreen ZNE 16.0.2 CEE
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Builder

Infiltration and Mechanical Ventilation

Whole Dwelling Infiltration	
Input Type	Blower door
Heating Season Infiltration Value	0.05 CFM50/sf shell
Cooling Season Infiltration Value	0.05 CFM50/sf shell
Shelter Class	4
Code Verification	Tested
Mechanical Ventilation for IAQ	
Type	Balanced
Unable to Measure Mechanical Ventilation	FALSE
Rate(cfm)	80
Adjusted Sensible Recovery Efficiency(%)	77.00
Adjusted Total Recovery Efficiency(%)	69.00
Hours per Day	24.0
Fan Power (watts)	130.00
ECM Fan Motor	true
Ventilation Strategy for Cooling	
Cooling Season Ventilation	Natural Ventilation
Good Air Exchange for Multi-Family	NA

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55806

Weather:International Falls, MN
Evergreen ZNR
Sam_Evergreen ZNE 16.0.2 CEE HERS.blg

Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Builder

Lights and Appliances

Rating/RESNET audit	
Ceiling Fan CFM / Watt	0.00
Refrigerator kWh/yr	385
Refrigerator Location	Conditioned
Range/Oven Fuel Type	Electric
Induction Range	Yes
Convection Oven	No
Dishwasher	
Energy Factor	0.70
Dishwasher kWh/yr	0
Place Setting Capacity	12
Clothes Dryer	
Fuel Type	Electric
Location	Conditioned
Moisture Sensing	Yes
CEF	9.10
Clothes Washer	
Location	Conditioned
LER (kWh/yr)	152
IMEF	2.060
Capacity (CU.Ft)	4.200
Electricity Rate	0.12
Gas Rate	1.09
Annual Gas Cost	12.00
Qualifying Light Fixtures	
Interior Lights %	10.0
Exterior Lights %	0.0
Garage Lights %	0.0
Interior LEDs %	90.0
Exterior LEDs %	0.0
Garage LEDs %	0.0

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55806

Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Weather:International Falls, MN
Evergreen ZNR
Sam_Evergreen ZNE 16.0.2 CEE
HERS.blg

Builder

Mandatory Requirements

IECC Requirements	
Verified IECC 06	true
Verified IECC 09	true
Verified IECC 12	true
Verified IECC 15	true
Verified IECC 18	true
Verified NY-ECCC 2016	false
Verified IECC MI	false
Verified IECC NC 2018	false
EPA Requirements	
Rater certifies that the home complies with the following requirements for:	ENERGY STAR v3.1
Rater Design Review Checklist	
Rater Field Checklist	
HVAC Design Report	
HVAC Commissioning Checklist (optional)	
ENERGY STAR Version 3 Appliances	Amount
Refrigerators	1
Ceiling Fans	0
Exhaust Fans	0
Dishwashers	0
ENERGY STAR Multi-Family Checks	
Clothes washer is in a category with no ENERGY STAR options.	NA
Clothes dryer is in a category with no ENERGY STAR options.	NA
Apt or Townhome uses 'Class AW' Windows.	NA
ENERGY STAR Version 3 Basements	
Basement Wall Area 50% Below Grad:	false
Basement Floor Area	0.00
Slab Insulation Exemption:	false
Indoor airPlus Verification Checklist	true
EPA Field App ID	

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55806

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Builder

DOE Zero Energy Ready Home

Home Builder ID Number	1
Mandatory Requirements	
Verified Fenestration	true
Verified Insulation	true
Verified Duct Location	true
Verified Appliance	true
Verified Lighting	true
Verified Fan Efficiency	true
Verified Water Efficiency	true
Verified EPA Indoor airPLUS	true
Verified Renewable Energy Ready Solar Electric	true
Optional Home Builder Commitments for Recognition	
Certified under the EPA WaterSense for New Homes Program	No
Certified under the IBHS fortified for Safer Living Program	No
Followed the DOE Zero Energy Ready Home Quality Management Guidelines	No
The buyer of this home signed a waiver giving DOE Zero Energy Ready Home access to utility bill data for one year.	No

Active Solar

System Type	None
Collector Loop Type	None
Collector Type	None
Collector Orientation	None
Area(sq ft)	0.0
Tilt(degrees)	0.0
Volume(cu ft/gal)	0.0

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55805

Weather:International Falls, MN
Evergreen ZNE
Sam_Evergreen ZNEwPV CEE
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Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Builder

Property/Builder Information

Building Name	Evergreen ZNE
Owner's Name	Green New Deal Homes
Property Address	108 E 11th St
City, St, Zip	Duluth, MN 55805
Phone Number	
Builder's Name	
Phone Number	
Email Address	
Plan/Model Name	
Community/Development	
Identifier/Other	

Organization Information

Organization Name	Green New Deal Homes SBC
Address	2201 W 1st St
City, St, Zip	Duluth, MN 55806
Phone Number	2183435583
Website	greennewdealhomes.com
Verifier's Name	Rachel Wagner
Verifier's Email	rwagner@greennewdealhomes.com

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55805

Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Weather:International Falls, MN
Evergreen ZNE
Sam_Evergreen ZNEwPV CEE
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Builder

General Building Information

Area of Conditioned. Space(sq ft)	1494
Volume of Conditioned. Space	13446
Year Built	2022
Housing Type	Single-family detached
Level Type(Apartments Only)	None
Floors on or Above-Grade	1
Number of Bedrooms	3
Foundation Type	Slab
Foundation is w/in Infiltration Volume:	N/A
Enclosed Crawl Space Type	N/A
Number of Stories Including Conditioned Basement	1
Thermal Boundary Location	N/A

Slab Floor Information

Name	Library Entry	Area(sq ft)	Depth Below Grade(ft)	Full Perimeter(ft)	Exposed Perimeter(ft)	On-Grade Perimeter(ft)
House Slab	Evergreen Slab****	1494	0.00	163	163	163

Slab Floor Library List

Slab Floor: Evergreen Slab****

Slab Covering	Vinyl
Perimeter Insulation (R-Value)	11.0
Perimeter Insulation Depth (ft)	5.0
Under-Slab Insulation (R-Value)	24.0
Under-Slab Insulation Width (ft)	14.0
Slab Insulation Grade	1
Radiant Slab	No
Note	

Above-Grade Wall

Name	Library Entry	Location	Exterior Color	Area(sq ft)	Uo Value
Exterior Wall	Exterior ZNE Wall****	Cond -> ambient	Medium	1488.00	0.029

Building Summary

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Green New Deal Homes
108 E 11th St
Duluth, MN 55805

Organization
Green New Deal Homes SBC
2183435583
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Evergreen ZNE
Sam_Evergreen ZNEwPV CEE
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Builder

Above-Grade Wall Library List

Above-Grade Wall: Exterior ZNE Wall****

Information From Quick Fill Screen	
Wall Construction Type	Standard Wood Frame
Continuous Insulation (R-Value)	15.0
Frame Cavity Insulation (R-Value)	21.0
Frame Cavity Insulation Thickness (in)	5.5
Frame Cavity Insulation Grade	1
Stud Size (w x d, in)	1.5 x 5.5
Stud Spacing (in o.c.)	16.0
Framing Factor - (defined)	0.1800
Gypsum Thickness (in)	0.5
Note	

Window Information

						Overhang			Interior		Adjacent	
Name	Wall Assignment	Orient	U-Value	SHGC	Area (sqft)	Depth (ft)	To Top (ft)	To Btm (ft)	Winter Shading	Summer Shading	Winter Shading	Summer Shading
A	AGWall 1	Northeast	0.200	0.400	8.00	2.0	1.8	4.8	0.85	0.70	None	None
B	AGWall 1	Northeast	0.200	0.400	4.70	2.0	1.8	4.0	0.85	0.70	None	None
C	AGWall 1	Northeast	0.200	0.400	4.67	2.0	1.8	4.0	0.85	0.70	None	None
D	AGWall 1	Northeast	0.200	0.400	11.56	2.0	1.8	6.5	0.85	0.70	None	None
E	AGWall 1	Southeast	0.200	0.400	11.56	1.0	9.0	13.6	0.85	0.70	None	None
F	AGWall 1	Southeast	0.200	0.400	11.56	1.0	9.0	13.6	0.85	0.70	None	None
G	AGWall 1	Southwes	0.200	0.400	11.56	2.0	1.8	6.5	0.85	0.70	None	None
H	AGWall 1	Southwes	0.200	0.400	34.67	2.0	1.8	6.5	0.85	0.70	None	None
I	AGWall 1	Southwes	0.200	0.400	34.67	2.0	1.8	6.5	0.85	0.70	None	None
J	AGWall 1	Southwes	0.200	0.400	26.00	2.0	1.8	6.5	0.85	0.70	None	None
K	AGWall 1	Northwes	0.200	0.400	13.00	1.0	8.0	12.7	0.85	0.70	None	None
L	AGWall 1	Northwes	0.200	0.400	8.89	4.0	1.0	4.3	0.85	0.70	None	None
M	AGWall 1	Northeast	0.200	0.400	4.67	2.0	1.8	4.0	0.85	0.70	None	None
Side door	AGWall 1	Northeast	0.200	0.400	6.00	2.0	2.0	5.0	0.85	0.70	None	None
Front door	AGWall 1	Northwes	0.200	0.400	6.00	4.0	1.2	4.2	0.85	0.70	None	None

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55805

Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Weather:International Falls, MN
Evergreen ZNE
Sam_Evergreen ZNEwPV CEE
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Builder

Door Information

Name	Library Entry	Wall Assignment	Opaque Area(sq ft)	Uo Value	R-Value of Opaque Area	Storm Door
Exterior Door E	ZNE Ins Door****	AGWall 1	14.0	0.084	10.0	Yes
Exterior Door E.1	ZNE Ins Door****	AGWall 1	14.0	0.084	10.0	Yes

Roof Information

Name	Library Entry	Ceiling Area(sq ft)	Roof Area(sq ft)	Exterior Color	Radiant Barrier	Type	Uo Value	Cement or Clay Tiles	Roof Tile Ventilation
ZNE Ceiling	ZNE Ceiling****	1494.00	1942.00	Medium	No	Attic	0.014	No	No

Roof Library List

Ceiling: ZNE Ceiling****

Information From Quick Fill Screen	
Continous Insulation (R-Value)	54.0
Cavity Insulation (R-Value)	20.0
Cavity Insulation Thickness (in)	5.5
Cavity Insulation Grade	1
Gypsum Thickness (in)	0.500
Insulated Framing Size(w x h, in)	1.5 x 5.5
Insulated Framing Spacing (in o.c.)	24.0
Framing Factor - (default)	0.1100
Ceiling Type	Attic
Note	

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55805

Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Weather:International Falls, MN
Evergreen ZNE
Sam_Evergreen ZNEwPV CEE
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Builder

Mechanical Equipment

Number of Mechanical Systems	2
Heating SetPoint(F)	68.0
Heating Setback Thermostat	Present
Cooling SetPoint(F)	78.0
Cooling Setup Thermostat	Present
DHW SetPoint(F)	125.0

ASHP: Midea24k ducted****

Fuel Type	Electric
Heating Seasonal Efficiency	11.60 HSPF
Compressor Heating Output Capacity at 17F (kBtuh)	16.5
Compressor Heating Output Capacity at 47F (kBtuh)	27.0
Electric Resistance Backup Capacity (kW)	5
Cooling Output Capacity (kBtuh)	22.0
Cooling Seasonal Efficiency	20.00 SEER
Desuperheater	No
Note	
Number Of Units	1
Location	Conditioned area
Performance Adjustment	100
Percent Heating Load Served	100
Percent Cooling Load Served	100

DHW: HPWH60****

Water Heater Type	Heat pump
Fuel Type	Electric
Energy Factor	3.40
Recovery Efficiency	0.00
Water Tank Size (gallons)	60
Extra Tank Insulation (R-Value)	0.0
Note	
Number Of Units	1
Location	Conditioned area

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55805

Weather:International Falls, MN
Evergreen ZNE
Sam_Evergreen ZNEwPV CEE
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Organization
Green New Deal Homes SBC
2183435583
Rachel Wagner

Builder

Mechanical Equipment

Performance Adjustment	100
Percent Load Served	100

DHW Efficiencies

All bath faucets & showers <= 2gpm	true
All DHW pipes fully insulated >= R-3	true
Recirculation type	None (standard system)
Farthest fixture to DHW heater	18
TOTAL Pipelength for longest DHW run	28
DWHR unit present?	false

DHW Diagnostics	
dhwGpd	40.03
peRatio	0.32
dishwasherGpd	2.49
clothesWasherHotWaterGPD	0.41
EDeff	0.89
ewaste	14.13
tmains	44.10
dwhrWhInletTempAdj	0.00
pumpConsKwh	0.00
pumpConsMmbtu	0.00

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55805

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Evergreen ZNE
Sam_Evergreen ZNEwPV CEE HERS.blg

Builder

Duct Systems

Name	Ducts
Conditioned Floor Area(sq ft)	1494.0
# of Returns	1
Heating System	Midea24k ducted****
Cooling System	Midea24k ducted****
Supply Duct Surface Area(sq ft)	403.4
Return Duct Surface Area(sq ft)	74.7
No bldg cavities used as ducts	FALSE

Type	Location	Percent Location	R-Value
Supply	Conditioned space	100.0	0.0
Return	Conditioned space	100.0	0.0

Test Exemptions

IECC	FALSE
RESNET 2019	FALSE
ENERGY STAR LtO	FALSE

Duct Leakage

Input Type	Measured
Test Type	Both Tested
Duct Test Stage	Postconstruction Test

	LtO (Leakage to Outside)	Total Duct Leakage
Supply & Return	15.00 CFM @ 25 Pascals	80.00 CFM @ 25 Pascals
Supply Only	Not Applicable	
Return Only	Not Applicable	

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55805

Organization
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2183435583
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Evergreen ZNE
Sam_Evergreen ZNEwPV CEE
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Builder

Infiltration and Mechanical Ventilation

Whole Dwelling Infiltration	
Input Type	Blower door
Heating Season Infiltration Value	0.05 CFM50/sf shell
Cooling Season Infiltration Value	0.05 CFM50/sf shell
Shelter Class	4
Code Verification	Tested
Mechanical Ventilation for IAQ	
Type	Balanced
Unable to Measure Mechanical Ventilation	FALSE
Rate(cfm)	80
Adjusted Sensible Recovery Efficiency(%)	77.00
Adjusted Total Recovery Efficiency(%)	69.00
Hours per Day	24.0
Fan Power (watts)	130.00
ECM Fan Motor	true
Ventilation Strategy for Cooling	
Cooling Season Ventilation	Natural Ventilation
Good Air Exchange for Multi-Family	NA

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55805

Organization
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2183435583
Rachel Wagner

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Evergreen ZNE
Sam_Evergreen ZNEwPV CEE
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Builder

Lights and Appliances

Rating/RESNET audit	
Ceiling Fan CFM / Watt	0.00
Refrigerator kWh/yr	385
Refrigerator Location	Conditioned
Range/Oven Fuel Type	Electric
Induction Range	Yes
Convection Oven	No
Dishwasher	
Energy Factor	0.70
Dishwasher kWh/yr	0
Place Setting Capacity	12
Clothes Dryer	
Fuel Type	Electric
Location	Conditioned
Moisture Sensing	Yes
CEF	9.10
Clothes Washer	
Location	Conditioned
LER (kWh/yr)	152
IMEF	2.060
Capacity (CU.Ft)	4.200
Electricity Rate	0.12
Gas Rate	1.09
Annual Gas Cost	12.00
Qualifying Light Fixtures	
Interior Lights %	10.0
Exterior Lights %	0.0
Garage Lights %	0.0
Interior LEDs %	90.0
Exterior LEDs %	0.0
Garage LEDs %	0.0

Building Summary

Property
Green New Deal Homes
108 E 11th St
Duluth, MN 55805

Organization
Green New Deal Homes SBC
2183435583
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Evergreen ZNE
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HERS.blg

Builder

Mandatory Requirements

IECC Requirements	
Verified IECC 06	true
Verified IECC 09	true
Verified IECC 12	true
Verified IECC 15	true
Verified IECC 18	true
Verified NY-ECCC 2016	false
Verified IECC MI	false
Verified IECC NC 2018	false
EPA Requirements	
Rater certifies that the home complies with the following requirements for:	ENERGY STAR v3.1
Rater Design Review Checklist	
Rater Field Checklist	
HVAC Design Report	
HVAC Commissioning Checklist (optional)	
ENERGY STAR Version 3 Appliances	Amount
Refrigerators	1
Ceiling Fans	0
Exhaust Fans	0
Dishwashers	0
ENERGY STAR Multi-Family Checks	
Clothes washer is in a category with no ENERGY STAR options.	NA
Clothes dryer is in a category with no ENERGY STAR options.	NA
Apt or Townhome uses 'Class AW' Windows.	NA
ENERGY STAR Version 3 Basements	
Basement Wall Area 50% Below Grad:	false
Basement Floor Area	0.00
Slab Insulation Exemption:	false
Indoor airPlus Verification Checklist	true
EPA Field App ID	

Building Summary

Property
Green New Deal Homes
108 E 11th St
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HERS.blg

Builder

DOE Zero Energy Ready Home

Home Builder ID Number	1
Mandatory Requirements	
Verified Fenestration	true
Verified Insulation	true
Verified Duct Location	true
Verified Appliance	true
Verified Lighting	true
Verified Fan Efficiency	true
Verified Water Efficiency	true
Verified EPA Indoor airPLUS	true
Verified Renewable Energy Ready Solar Electric	true
Optional Home Builder Commitments for Recognition	
Certified under the EPA WaterSense for New Homes Program	No
Certified under the IBHS fortified for Safer Living Program	No
Followed the DOE Zero Energy Ready Home Quality Management Guidelines	No
The buyer of this home signed a waiver giving DOE Zero Energy Ready Home access to utility bill data for one year.	No

Active Solar

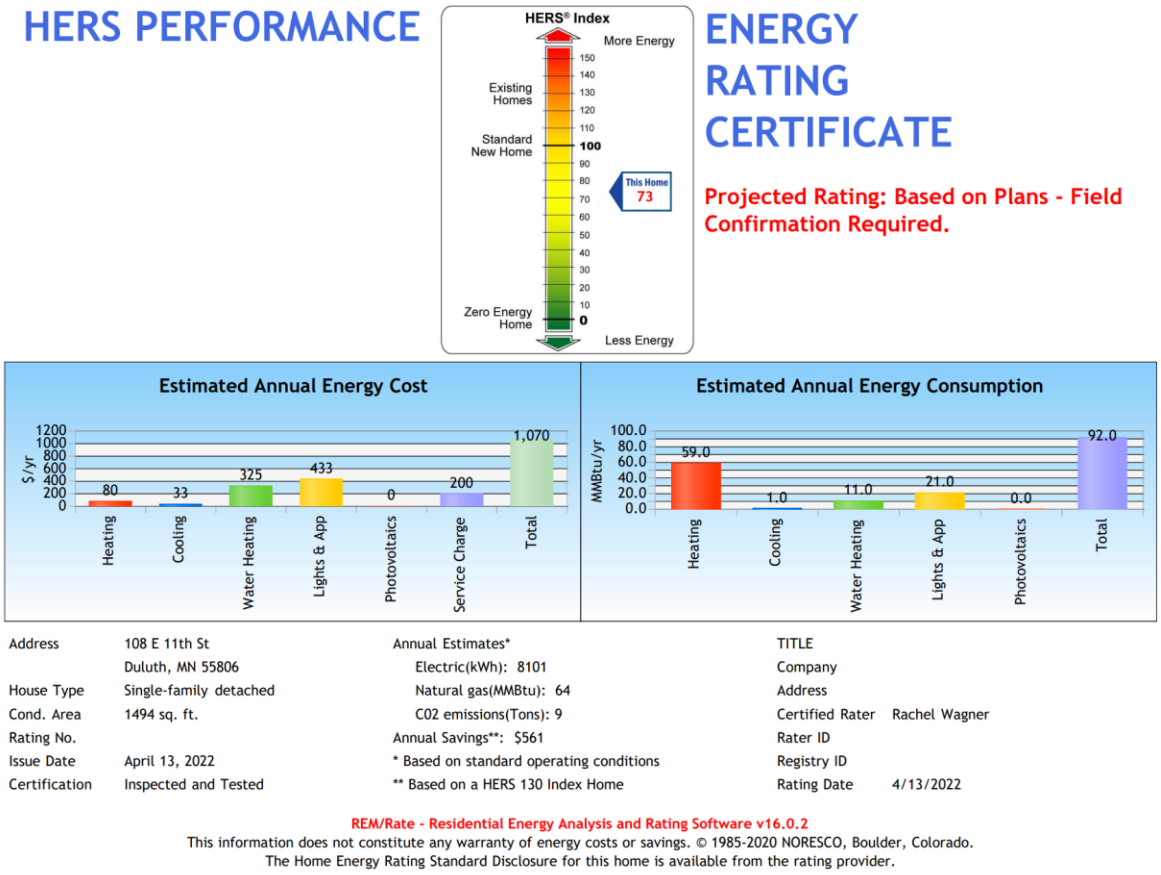
System Type	None
Collector Loop Type	None
Collector Type	None
Collector Orientation	None
Area(sq ft)	0.0
Tilt(degrees)	0.0
Volume(cu ft/gal)	0.0

Photovoltaics

Name	Collector Orientation	Collector Area(sq ft)	PV Panel Peak Power(Watts)	Collector Tilt(degrees)	Inverter Efficiency(%)
9.6 kW	Southeast/Southwest	507.0	9600.0	40.0	97.0

Appendix C: REM/*Rate* Reports from MnCEE

Evergreen Code Model

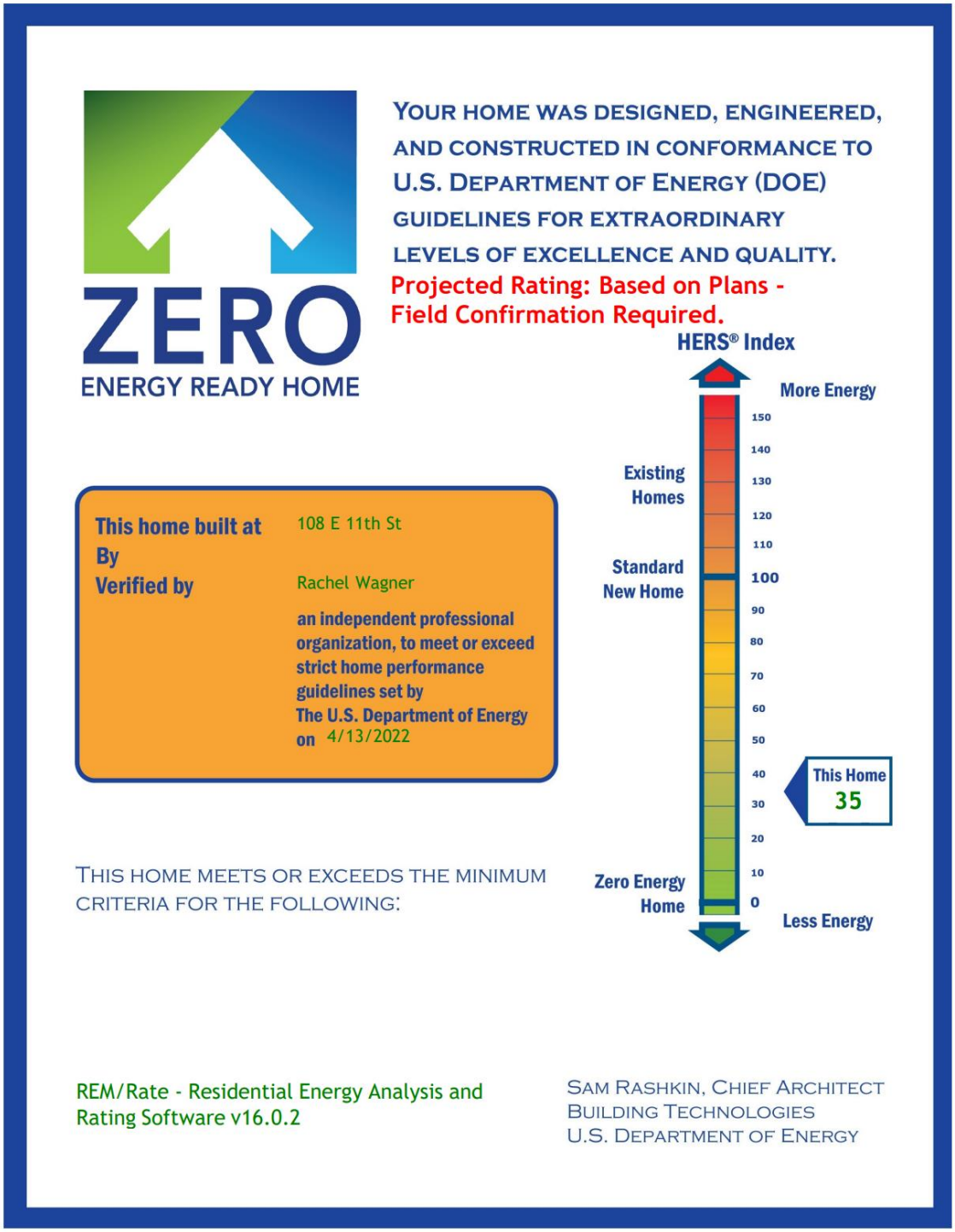


Address	108 E 11th St	Annual Estimates*		TITLE	
	Duluth, MN 55806	Electric(kWh): 8101		Company	
House Type	Single-family detached	Natural gas(MMBtu): 64		Address	
Cond. Area	1494 sq. ft.	C02 emissions(Tons): 9		Certified Rater	Rachel Wagner
Rating No.		Annual Savings**: $561		Rater ID	
Issue Date	April 13, 2022	* Based on standard operating conditions		Registry ID	
Certification	Inspected and Tested	** Based on a HERS 130 Index Home		Rating Date	4/13/2022

REM/Rate - Residential Energy Analysis and Rating Software v16.0.2

The Home Energy Rating Standard Disclosure for this home is available from the rating provider.

Evergreen ZNR Model



ENERGY STAR v3.1 Home Report

Property	Organization	HERS
Green New Deal Homes	Green New Deal Homes SBC	Projected Rating
108 E 11th St	2183435583	4/13/2022
Duluth, MN 55806	Rachel Wagner	Rater ID:
Weather:International Falls, MN	**Builder**	
Evergreen		
Sam_Evergreen ZNE 16.0.2 CEE HERS.blg		

Projected Rating: Based on Plans - Field Confirmation Required.

Normalized, Modified End-Use Loads (MMBtu/yr)

	ENERGY STAR	As Designed
Heating	13.3	13.7
Cooling	0.1	0.1
Water Heating	12.9	2.0
Lights and Appliances	17.3	16.5
Total	43.7	32.4
ENERGY STAR HERS Index Target	**52**	**35 HERS Index w/o PV**
		35 HERS Index

HERS Index w/o PV <= ES HERS Index Target to comply.

ENERGY STAR v3.1 Mandatory Requirements

X	Duct leakage at post construction better than or equal to ENERGY STAR v3/3.1 requirements.
X	Envelope insulation levels meet or exceed ENERGY STAR v3/3.1 requirements.
X	Slab on Grade Insulation must be > R-5, and at IECC 2009 Depth for Climate Zones 4 and above.
X	Envelope insulation achieves RESNET Grade I installation, or Grade II with insulated sheathing.
X	Windows meet the 2009 IECC Requirements - Table 402.1.1.
X	Duct insulation meets the EPA minimum requirements of R-6.
X	Mechanical ventilation system has been measured in the home.
X	ENERGY STAR Checklists fully verified and complete.

This home MEETS or EXCEEDS the energy efficiency requirements for designation as an EPA ENERGY STAR Version 3.1 Certified Home.

Pollution Prevented

Type of Emissions	*Reduction*
Carbon Dioxide (CO2) - tons/yr	10.4
Sulfur Dioxide (SO2) - lbs/yr	31.4
Nitrogen Oxides (NOx) - lbs/yr	25.0

Energy Cost Savings $/yr

Heating	707
Cooling	33
Water Heating	292
Lights & Appliances	153
Total	1185

The energy savings and pollution prevented are calculated by comparing the Rated Home to the Reference Home as defined in the Mortgage Industry National Home Energy Rating Systems Standards as promulgated by the Residential Energy Services Network (RESNET) . In accordance with these guidelines, building inputs affecting setpoints, infiltration rates, window shading and the existence of mechanical systems may have been changed prior to calculating loads.

ENERGY STAR v3.1 Home Verification Summary

Property	Organization	HERS
Green New Deal Homes	Green New Deal Homes SBC	Projected Rating
108 E 11th St	2183435583	4/13/2022
Duluth, MN 55806	Rachel Wagner	Rater ID:

Weather:International Falls, MN
Evergreen
Sam_Evergreen ZNE 16.0.2 CEE HERS.blg

Builder

Projected Rating: Based on Plans - Field Confirmation Required.

Building Information

Conditioned Area (sq ft)	1494
Conditioned Volume (cubic ft)	13446
Insulated Shell Area (sq ft)	4476
Number of Bedrooms	3
Housing Type	Single-family detached
Foundation Type	Slab

Rating

ENERGY STAR HERS Index Target	52
HERS Index w/o PV	35
HERS Index	35

HERS Index w/o PV <= ES HERS Index Target to comply.

This home MEETS or EXCEEDS the energy efficiency requirements
for designation as an EPA ENERGY STAR Version 3.1 Certified Home.

Building Shell

Ceiling w/Attic	ZNE Ceiling** U=0.014
Sealed Attic	None
Vaulted Ceiling	None
Above Grade Walls	Exterior ZNE Wall** U=0.029
Found. Walls(Cond)	None
Found. Walls(Uncond)	None
Floors	None
Slab Floors	Evergreen Slab** U=0.027

Window Type	Max U - Min SHGC**
Window	U-Value: 0.200, SHGC: 0.400
Window/Wall Ratio	0.13
Infiltration Type	Blower door
Infiltration	Htg: 0.05 Clg: 0.05 CFM50/sf sh
Duct Leakage to Outside	15.00 CFM @ 25 Pascals
Total Duct Leakage	80.00 CFM @ 25 Pascals

Mechanical Systems

ASHP	Htg: 44.1 kBtuh, 11.6 HSPF. Clg: 22.0 kBtuh, 20.0 SEER.
Water Heating	Heat pump, Elec, 3.40 EF.
Programmable Thermostat	Heat=Yes; Cool=Yes
Ventilation System	Balanced: ERV, 80 cfm, 130.0 watts.

Lights and Appliances

Interior LED Lighting (%)	90.00	Clothes Dryer Fuel	Electric
Refrigerator (kWh/yr)	385.00	Clothes Dryer CEF	9.10
Dishwasher Energy Factor	0.70	Clothes Washer LER	152.00
Ceiling Fan (cfm/Watt)	0.00	Clothes Washer Capacity	4.20
Range/Oven Fuel	Electric		

Note: Where feature level varies in home, the dominant value is shown.

Indoor airPLUS Qualified Home

This home built at
108 E 11th St
Duluth, MN 55806
was verified by
Rachel Wagner

to meet Indoor airPLUS construction specifications as established by the U.S. Environmental Protection Agency.

EPA Indoor airPLUS QUALIFIED HOMES

Indoor airPLUS qualified homes are designed to contribute to improved indoor air quality.

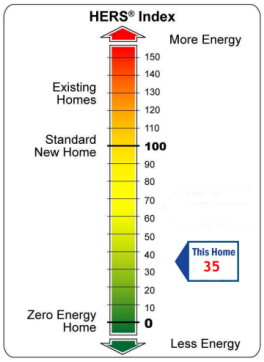
4/13/2022

Indoor airPLUS Features

- Moisture and Mold Control
- Radon Resistant Construction
- Pest Barriers
- Effective Heating, Ventilating, and Air-Conditioning Systems
- Safe Combustion
- Healthier Building Materials

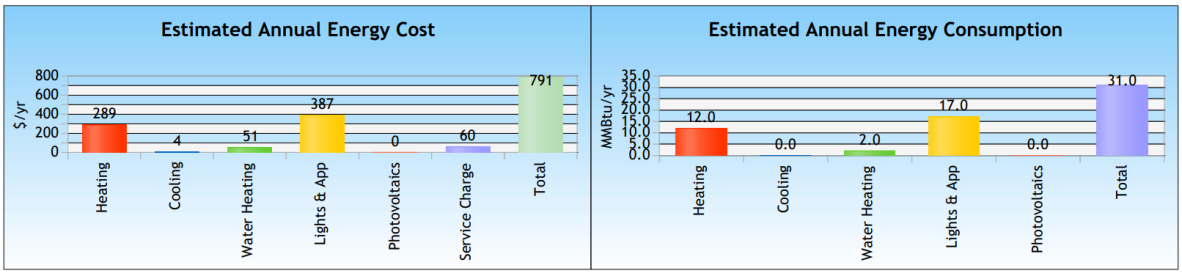
Not all features are required in all cases. To learn more about indoor air quality features in your home, ask your builder to review the Indoor airPLUS verification checklist with you, or visit www.epa.gov/indoorairplus.

HERS PERFORMANCE



ENERGY RATING CERTIFICATE

Projected Rating: Based on Plans - Field Confirmation Required.

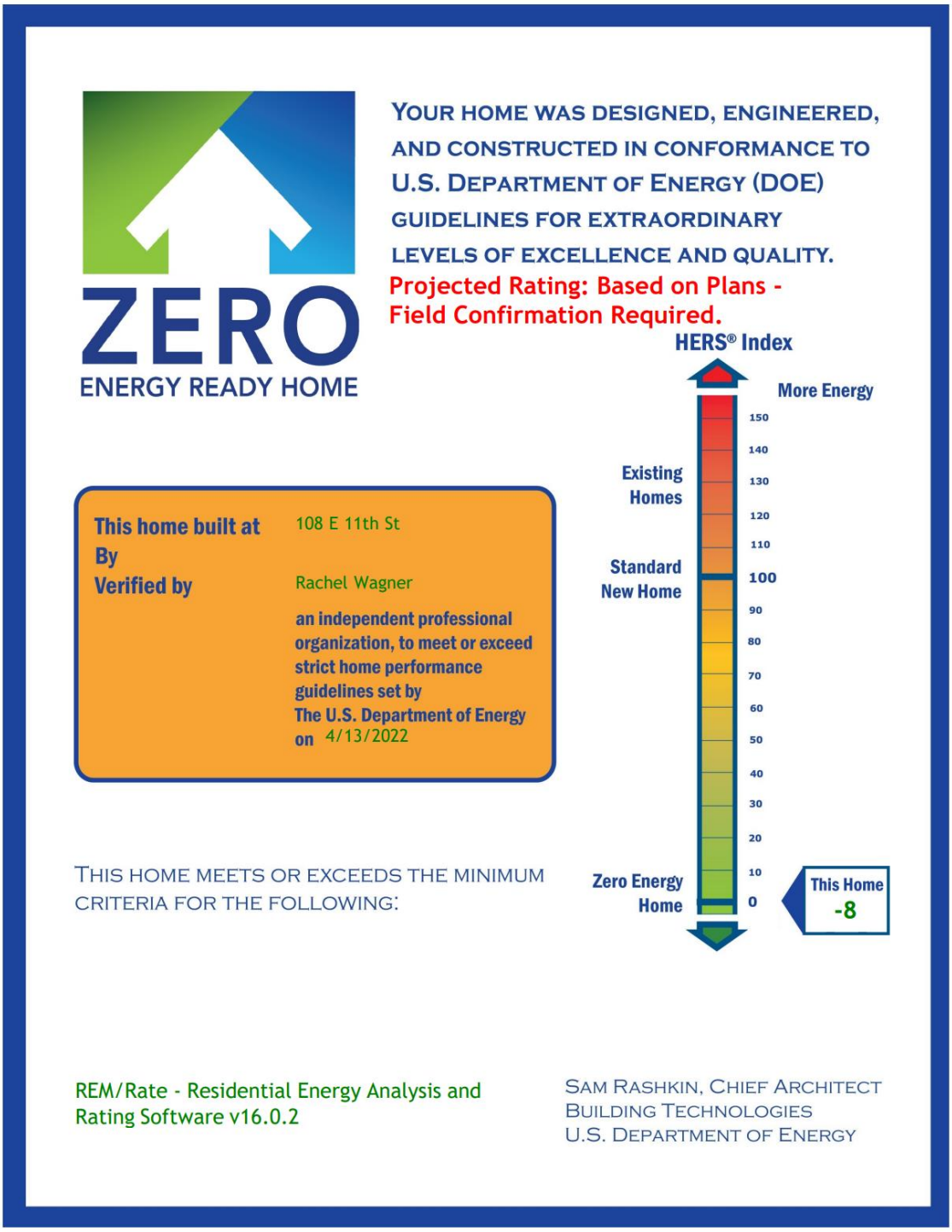


Address	108 E 11th St	Annual Estimates*	TITLE
	Duluth, MN 55806	Electric(kWh): 9150	Company
House Type	Single-family detached	C02 emissions(Tons): 6	Address
Cond. Area	1494 sq. ft.	Annual Savings**: $1760	Certified Rater Rachel Wagner
Rating No.		* Based on standard operating conditions	Rater ID
Issue Date	April 13, 2022	** Based on a HERS 130 Index Home	Registry ID
Certification	Inspected and Tested		Rating Date 4/13/2022

REM/Rate - Residential Energy Analysis and Rating Software v16.0.2

The Home Energy Rating Standard Disclosure for this home is available from the rating provider.

Evergreen ZNE Model



ENERGY STAR v3.1 Home Report

Property	Organization	HERS
Green New Deal Homes	Green New Deal Homes SBC	Projected Rating
108 E 11th St	2183435583	4/13/2022
Duluth, MN 55806	Rachel Wagner	Rater ID:
Weather:International Falls, MN	**Builder**	
Evergreen ZNE		
Sam_Evergreen ZNEwPV CEE		
HERS.blg		

Projected Rating: Based on Plans - Field Confirmation Required.

Normalized, Modified End-Use Loads (MMBtu/yr)

	ENERGY STAR	As Designed	
Heating	13.3	13.7	
Cooling	0.1	0.1	
Water Heating	12.9	2.0	
Lights and Appliances	17.3	16.5	
Total	43.7	32.4	
ENERGY STAR HERS Index Target	**52**	**35**	**HERS Index w/o PV**
		-8	**HERS Index**

HERS Index w/o PV <= ES HERS Index Target to comply.

ENERGY STAR v3.1 Mandatory Requirements

X	Duct leakage at post construction better than or equal to ENERGY STAR v3/3.1 requirements.
X	Envelope insulation levels meet or exceed ENERGY STAR v3/3.1 requirements.
X	Slab on Grade Insulation must be > R-5, and at IECC 2009 Depth for Climate Zones 4 and above.
X	Envelope insulation achieves RESNET Grade I installation, or Grade II with insulated sheathing.
X	Windows meet the 2009 IECC Requirements - Table 402.1.1.
X	Duct insulation meets the EPA minimum requirements of R-6.
X	Mechanical ventilation system has been measured in the home.
X	ENERGY STAR Checklists fully verified and complete.

This home MEETS or EXCEEDS the energy efficiency requirements for designation as an EPA ENERGY STAR Version 3.1 Certified Home.

Pollution Prevented

Type of Emissions	*Reduction*
Carbon Dioxide (CO2) - tons/yr	10.4
Sulfur Dioxide (SO2) - lbs/yr	31.4
Nitrogen Oxides (NOx) - lbs/yr	25.0

Energy Cost Savings $/yr

Heating	707
Cooling	33
Water Heating	292
Lights & Appliances	153
Total	1185

The energy savings and pollution prevented are calculated by comparing the Rated Home to the Reference Home as defined in the Mortgage Industry National Home Energy Rating Systems Standards as promulgated by the Residential Energy Services Network (RESNET) . In accordance with these guidelines, building inputs affecting setpoints, infiltration rates, window shading and the existence of mechanical systems may have been changed prior to calculating loads.

ENERGY STAR v3.1 Home Verification Summary

Property	Organization	HERS
Green New Deal Homes	Green New Deal Homes SBC	Projected Rating
108 E 11th St	2183435583	4/13/2022
Duluth, MN 55806	Rachel Wagner	Rater ID:

Weather:International Falls, MN
Evergreen ZNE
Sam_Evergreen ZNEwPV CEE HERS.blg

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Foundation Type	Slab

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HERS Index w/o PV	35
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ENERGY STAR

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Sealed Attic	None
Vaulted Ceiling	None
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Found. Walls(Cond)	None
Found. Walls(Uncond)	None
Floors	None
Slab Floors	Evergreen Slab**** U=0.027

Window Type	Max U - Min SHGC****
Window	U-Value: 0.200, SHGC: 0.400
Window/Wall Ratio	0.13
Infiltration Type	Blower door
Infiltration	Htg: 0.05 Clg: 0.05 CFM50/sf sh
Duct Leakage to Outside	15.00 CFM @ 25 Pascals
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Water Heating	Heat pump, Elec, 3.40 EF.
Programmable Thermostat	Heat=Yes; Cool=Yes
Ventilation System	Balanced: ERV, 80 cfm, 130.0 watts.

Lights and Appliances

Interior LED Lighting (%)	90.00	Clothes Dryer Fuel	Electric
Refrigerator (kWh/yr)	385.00	Clothes Dryer CEF	9.10
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Ceiling Fan (cfm/Watt)	0.00	Clothes Washer Capacity	4.20
Range/Oven Fuel	Electric		

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4/13/2022

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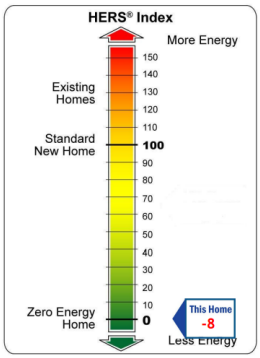
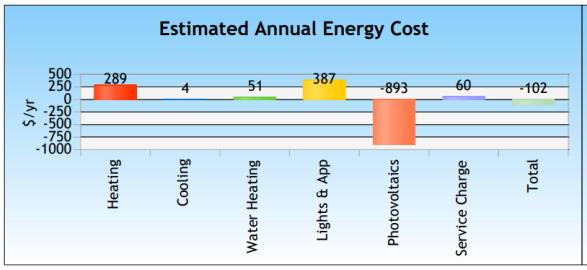
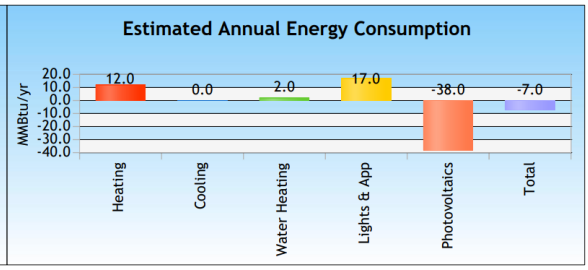
HERS PERFORMANCE



ENERGY RATING CERTIFICATE

Projected Rating: Based on Plans - Field Confirmation Required.





Address	108 E 11th St	Annual Estimates*	TITLE
	Duluth, MN 55806	C02 emissions(Tons): -1	Company
House Type	Single-family detached	Annual Savings**: $2653	Address
Cond. Area	1494 sq. ft.		Certified Rater Rachel Wagner
Rating No.		* Based on standard operating conditions	Rater ID
Issue Date	April 13, 2022	** Based on a HERS 130 Index Home	Registry ID
Certification	Inspected and Tested		Rating Date 4/13/2022