

ENVS 150 Energy Proposal

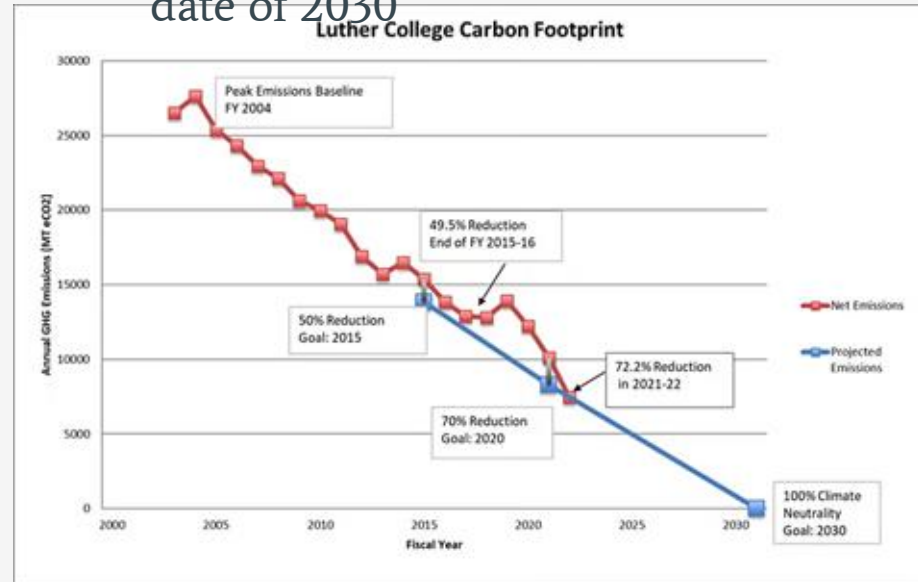


Sustainability House + College Apartments

Global Climate and Net-Zero Emissions

- Global Warming continues to be an ever increasing problem
- Minimizing the effects requires us to achieve net zero emissions as soon as possible
- Net zero: we don't release more greenhouse gases into the atmosphere than we remove from the atmosphere
- In order to reach Luther Colleges sustainability goal we need to continue working towards net zero emissions

- “Luther College has a deep and lasting commitment to sustainability . . . carbon neutrality date of 2030”



How Houses Can Go to Net-Zero Emissions

Direct Emissions:

- Emissions produced on-site by burning fossil fuel
- Examples:
 - Space heating
 - Water heating
 - Cooking
 - Dryer
 - Natural gas/propane use



Source: Sustainability House Photos

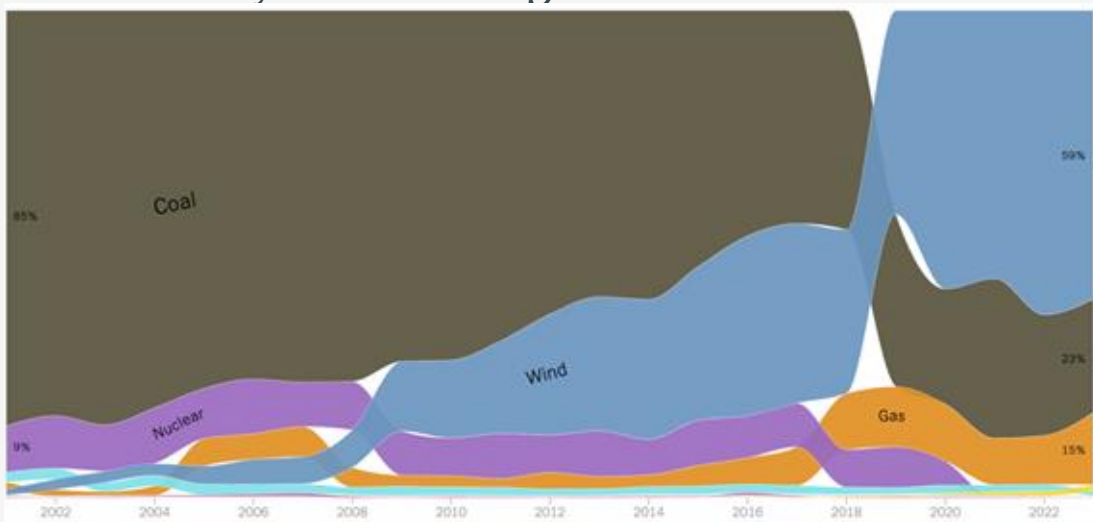
Solutions:

- Electrification
 - Replace fossil fuel-based appliances to electric alternatives
 - Heat pumps, induction/electric cooktops
- Biogas as renewable source

How Houses Can Go to Net-Zero Emissions

Indirect Emissions:

- Emissions from purchased electricity
- Intensity of the Iowa grid



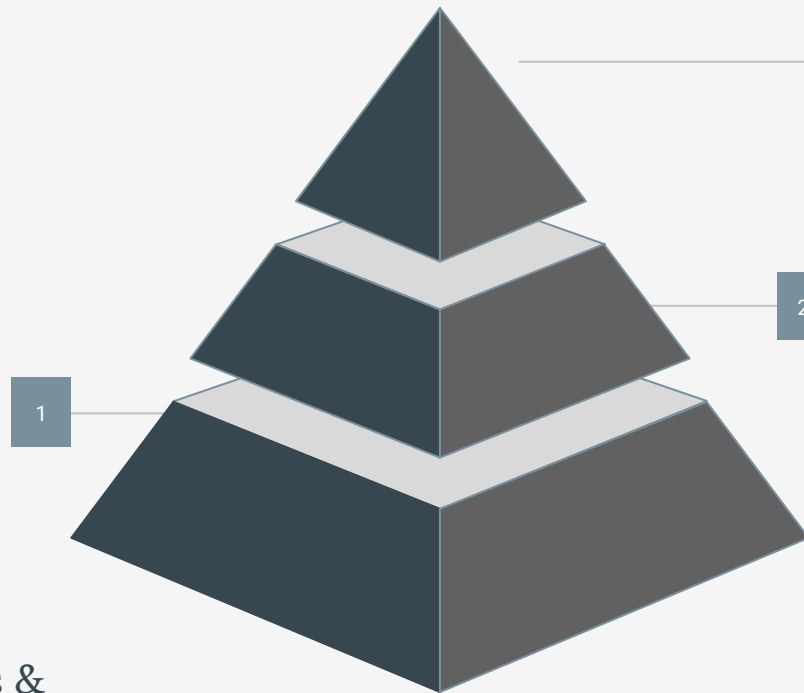
Source: NYTimes

- Zero-carbon grid electricity
- On-site renewable energy production
 - Rooftop solar
 - Wind

Class Process

Class Work

- Concepts
- Household Energy Tours
- Warm-up exercises & Practice Projects



Final Proposal and Recommendation

- How to allocate the \$20,000 budget

Group Projects

- Energy Education
- College Apartments Electrification
- Sustainability House Electrification
- Solar and Electric Metering

College Apartments

Research and Recommendations

College Apartments

Contents:

1. College Apartments Now
1. Net-Zero Options
1. Recommendations
1. Joint Metering
1. Project Phases and Costs

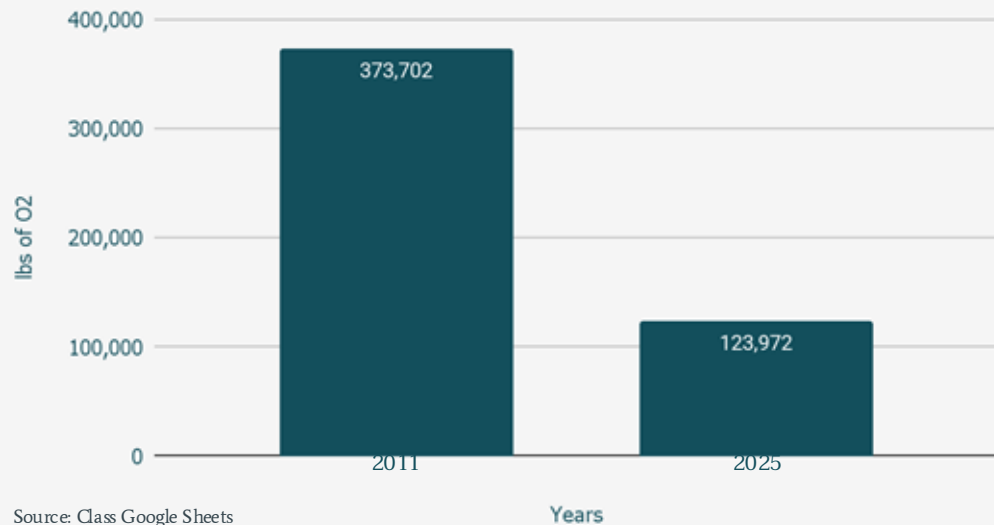


Source: Luther College

College Apartments Now

- Past: fully electric until 2012
 - Inefficient appliances and dirty grid
- Now: natural gas hydronic heating and natural gas water heater
 - $\frac{2}{3}$ reduction in emissions
 - $\frac{1}{2}$ reduction in annual costs
 - Newer Appliances
- Future: need for re-electrification
 - Highly efficient electric options
 - Net-Zero goals to reach

Annual Carbon Footprint (lbs of CO₂/yr)



Source: Class Google Sheets

Current Annual Usage and Costs

- Electricity: 59.4 MWh and \$16,634
- Natural Gas: 5937 Therms and \$5,352

Net-Zero Options

1. Air to Water: Air Source Heat Pump

- Upfront Cost \$\$\$
- Efficiency 225%
- Electrification and gets greener with the grid
- Highest cost per year

1. Biogas: Black Hills Green Forward

- Upfront Cost \$ (~\$720 annual premium)
- Maintains current gas boiler
- Company has Net-Zero goals by 2035
- Premium goes to BH projects, mostly offsets - not true emission reductions



3. Geothermal: Ground Source Heat Pump

- Upfront Cost \$\$\$\$\$
- Efficiency 400%
- Largest CO2 emission reductions
- Largest upfront cost

College Apartments Recommendations

- Replace older lighting with more efficient LED bulbs
- Replace Parking Lot Flood Lights
 - More efficient and lower usage LEDs
 - Pricing: Up to \$1000, could be eligible for incentives through Alliance Energy
- Savings from outside lighting
 - Current ~ \$2900/yr
 - Savings ~ \$2000/yr
 - Payback Period: 6 Months
- A/C Covers
 - Blower door results:
 - Air flow through uncovered units
 - Less for covered units, but still significant
 - Suggestion: Modern covers that will trap heat inside
 - Cost \$2,000



Source: Ansel Kowitz



Source: [link](#)

Joint Metering

- Currently college apartments are each metered individually
 - Separate meters are often used to bill the tenants in apartments
 - However Luther pays for all the connection fees
- Luther spends: \$6,960/year on just connection fees
- One meter per building
 - Luther spends: \$795/year
 - Luther saves: \$6,164/year
- Joint meters would bump the college apartments into commercial electric rate (\$0.12/kWh)
 - Boost savings to: \$10,300/year
- Payback period:
 - \$5,000/meter project - Total of \$20,000
 - Project pays itself off in: ~1.9 years



Source: College Apartment Photos (Isaac Ayers)

Joint Metering - Other Considerations

- Meters are heavily regulated and have many policies in place
 - Iowa Code often requires separate meters for multi-tenant buildings
 - Flat rate loophole allows Luther to join meters
- If Luther College ever sells the apartments:
 - Landlords need to individually meter and bill tenants
 - Luther would have a hard time selling the building because of the joint meters
- These factors make this a college decision that our class can't make



Image: Google Maps

College Apartment Project Phases & Costs

Phase 1: Lighting and Weatherization

- Change outdoor lighting to LEDs
- Improve CFL indoor lighting
- Modern AC covers
- \$2000/yr savings
- ~1.5 year payback period

Cost: \$3,000

Phase 2: Joint Metering

- Combine the 34 meters into 4
- \$5,000 per building
- \$10,300/yr in savings
- ~1.9 year payback period
- Set aside savings for future sustainability projects

Cost: \$20,000

Phase 3: Replace Heating Systems & Add Solar

- 27kW
- 60,000

Cost: \$180,000-

— Sustainability House —

Research and Recommendations

Sustainability House

Contents:

1. Sustainability House Now
1. Group Findings
1. Electrification Proposal
1. Proposal Costs and Phases



Source: Sustainability House Photos

Sustainability House Overview

Home Features

- 2579 sqft
- Built: 1957
- 4.8 kW ground mount solar array
- Electric kitchen appliances
- Electric dryer + washer
- LED + CFL light bulbs
- 100 Amp electrical panel
- Natural gas furnace + water heater

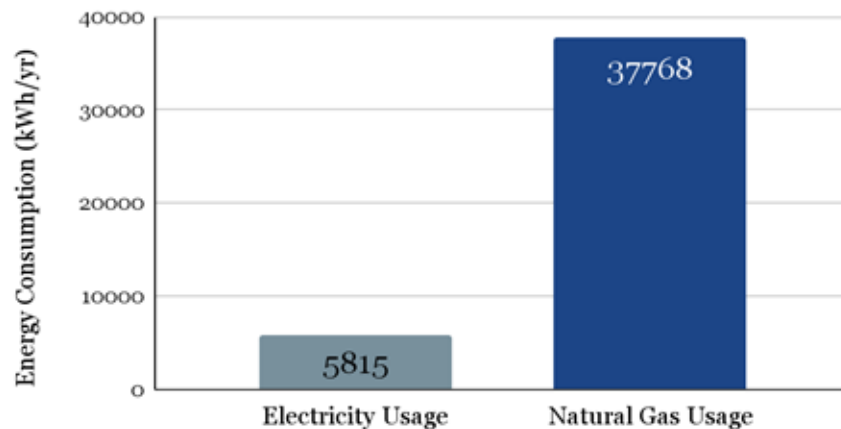
Energy Bill Cost - 2025: \$1723

CO2 Emissions - 2025: 16665 lbs CO2



Source: Luther

Current House Energy Consumption - 2025



Source: Class Google Sheets

Findings

High natural gas usage due to:

- Old gas furnace (30-35 years old)
- Insulation limited by home design
 - Many large windows
 - Heat loss through ductwork
 - Flat roof limits roof insulation

Different Proposals to Electrify

- Partial - Dual-fuel heat pump and addition to electrical panel
- Complete - Ducted heat pump, heat pump water heater, and addition to electrical panel

Corresponding Solar Array Additions

- Partial - 7.3 kW array
- Complete - 10 kW array



Source: Sustainability House Photos

Sustainability House Electrification Proposal

Phase 1: Electrified Space Heating (Using Donor Money)

- Ducted heat pump and mini splits
 - Less wasted energy under slab
- Reconfiguration of electrical panel

Phase 2: Solar

- Solar project topping off at a 10 kW array
 - Will help cover increase in electricity usage

Phase 3: Electrified Water Heating

- Heat pump water heater
- Complete Electrification



Source: Sustainability House Photos

Sustainability House Project Phases & Costs

Phase 1: Electrified Space Heating

- Replace gas furnace with ducted heat pump and mini split units
- Reconfigure main panel
- Increased electricity costs (\$1,000/yr)

Cost: \$17,000-\$24,000
Donor Money Investment

Phase 2: Solar

- Add maximum 10 kW solar array
- Savings of \$2,700/yr offset increased electricity costs
- Add net zero aspect
- Urgent: laws regarding customer owned solar changing in late 2027

Cost: \$23,000

Phase 3: Electrified Water Heating

- Replace gas water heater with heat pump
- Disconnect from natural gas line (\$252/yr in savings)

Cost: \$3,000

— Energy Education —

College Apartment Education

- Educate students about sustainability and energy topics
- General information on net zero housing and direct and indirect carbon emissions.
- Help students realize how their everyday choices impact energy use and carbon footprint



Sustainability House Education

- Educate students living in the Sustainability House
- The future changes to the house = educational example for sustainability

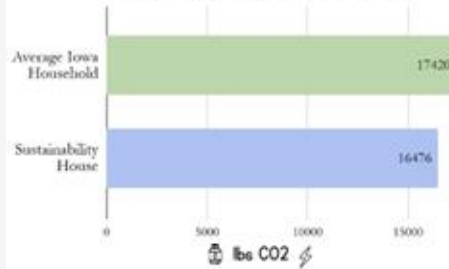
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Net Zero

Net zero is releasing equal or less greenhouse gas emissions than the amount that is being removed from the atmosphere. This can be achieved by switching from natural gas to all electric energy and using clean energy including solar, wind power, nuclear and more.

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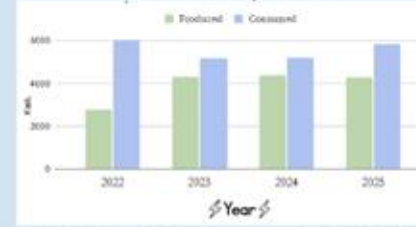
Carbon Footprint 2025



The Sustainability house emits about 1,000 pounds less CO2 in 2025 than the average Iowa household. The main reason for this is that the Sustainability house has solar panels, without the solar panels the carbon footprint of the house would be approximately 4,000 pounds more than with the panels. Currently only 9 % of the carbon footprint is because of the electricity use and 91 % of the carbon footprint comes from natural gas combustion.

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Solar Production and Electric Consumption



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Sustainable Future

Limiting natural gas heat sources and switching to all electric appliances is an important step to reduce direct carbon emissions and achieve a net zero future.

Cleaning the electric grid through clean resources like wind solar or nuclear will get rid of indirect carbon emissions energy and help us meet our goal of net zero greenhouse gas emissions.

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Reduce Your Use

Here are ways you can reduce your energy use



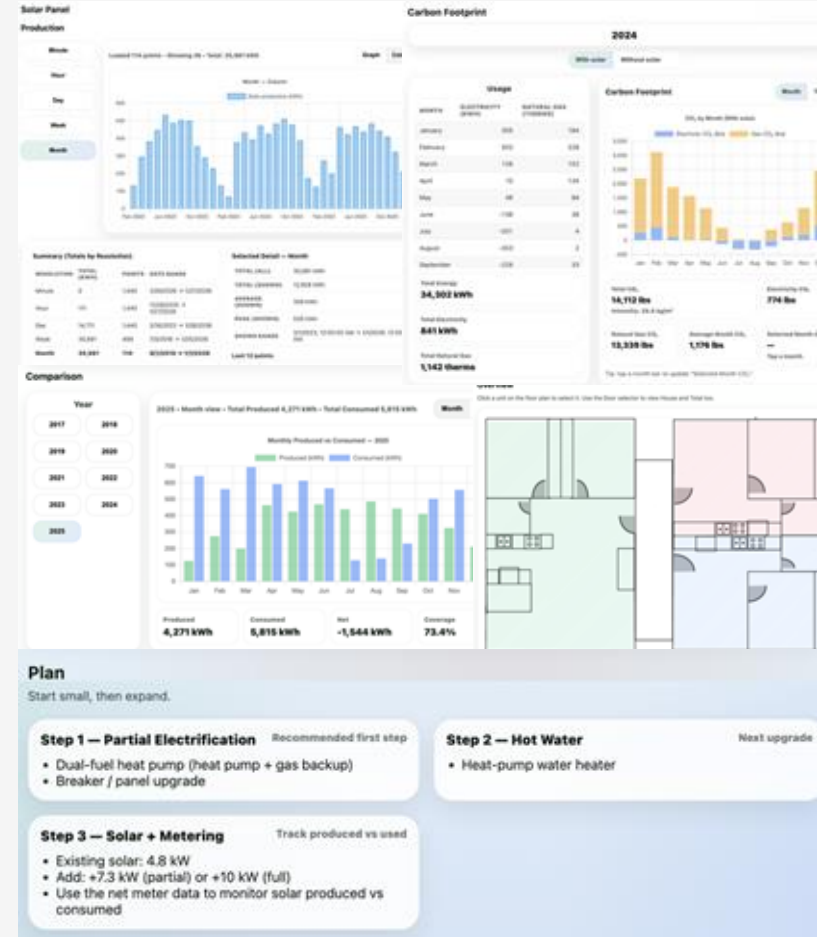
Energy Used per Hour:

- Air dry clothes
- Take shorter showers
- Wash clothes on cold
- Unplug unnecessary appliances
- Turn off lights when leaving a room

Website

Includes:

- Sustainability House: Solar Panel Statistics
 - Mamac System (<http://172.22.1.41/start.html>)
- Carbon Footprint by House
- Energy Use Comparison by House
- Brief Planning Summary for Each House
- Brief Project Plan



Summary

| | Cost | Annual Savings | Payback Period |
|---|----------|----------------|----------------|
| College Apartment Meters | \$20,000 | \$10,300 | 1.9 Years |
| College Apartment A.C. Covers | \$2,000 | | |
| College Apartment Outdoor Lights | \$200 | \$2,000 | 0.1 Years |
| Sustainability House Solar (Full Electrification) | \$22,000 | \$22,000 | 10.5 Years |
| Sustainability House Electrify Heating | \$17,000 | | |
| Sustainability House Heat Pump Water Heater | \$3,000 | | |



Source: Sustainability Photos



Source: Sustainability Photos

Overview of Project Phases

College Apartment:

- Phase 1 (\$3,000): LED upgrades and AC covers. Saves \$2000+/year with ~1.5 year payback
- Phase 2 (\$20,000): Joint metering consolidates 35 meters into 4, saves \$10,300/year with ~1.9 year payback
- Phase 3 (\$180,000): Full electrification of College apartments and Solar array to go net-zero

Sustainability House:

- Phase 1 (\$20,000 budget): Electrify space heating system and reconfigure main panel. 1st step to carbon reductions.
- Phase 2 (\$23,000): Add 10 kW solar array. Saves \$2,700/year and helps offset electricity costs from previous years without solar.
- Phase 3 (\$3,000): Electrify water heating and disconnect from gas. Completes full electrification and net zero of Sustainability House allowing it to be used as an education method for electrified, net zero housing.

These projects reduce emissions, generate long-term savings, and support Luther's 2030 carbon neutrality goal.

Thanks

Leon and Linda Gregg (donors)

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Homeowners: Jennifer Self, Mic & Linda Martin, Ted and Pine Wilson, Craig & Jeanette Spilde, Eric Baack

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Katy Jiran and members of Sustainability House

Laura Peterson

Thanks

to Jay Uthoff, in memoriam

