Sustainability House: Electrification Proposal

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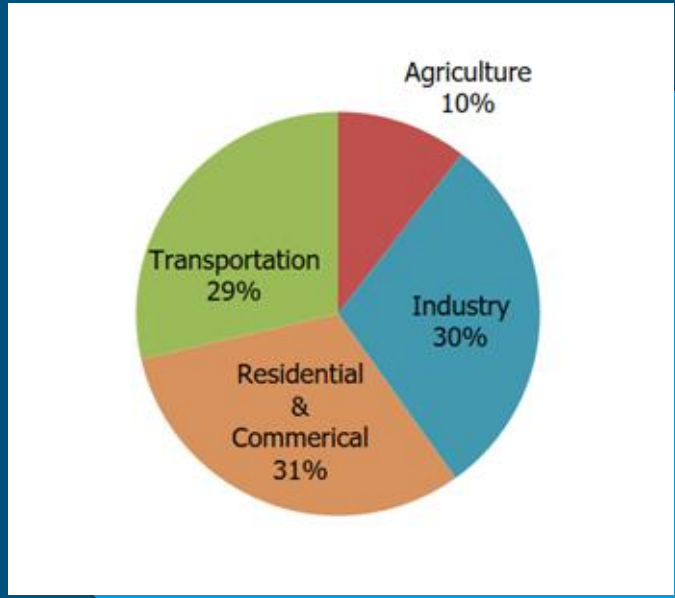
Making the Sustainability House a Model for Reduced Emission Housing

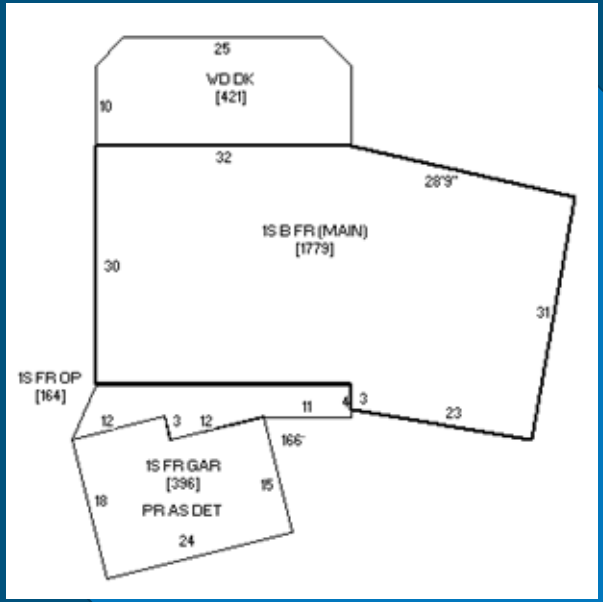
- 31% of Greenhouse Gas Emissions come from Residential and Commercial Buildings
- Luther's 2030 Net Zero Goal
- Electrification is Solution
- We aim to turn the Sustainability House into a model of this idea
- Sustainability House can be used for education on solution to household energy emissions



Total U.S. Greenhouse Gas Emissions by Economic Sector Including Electricity End-Use Indirect Emissions. Source: US Environmental Protection Agency

Sustainability House Layout

Source: Luther



Souce: Beacon

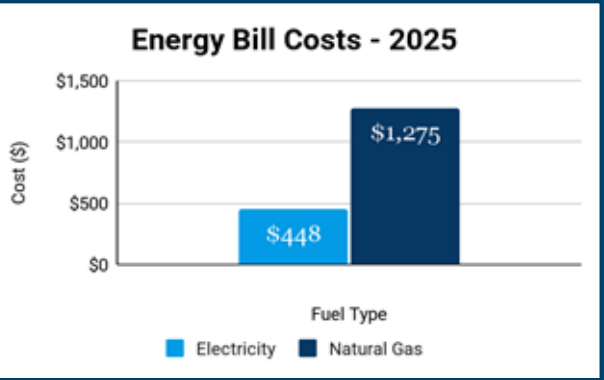
Sustainability House Today

Home Features: 2579 sqft, built in 1957

- Pole mounted ground solar panel, natural gas furnace + water heater, electric kitchen appliances, LED and CFL light bulbs, 100 Amp electrical breaker

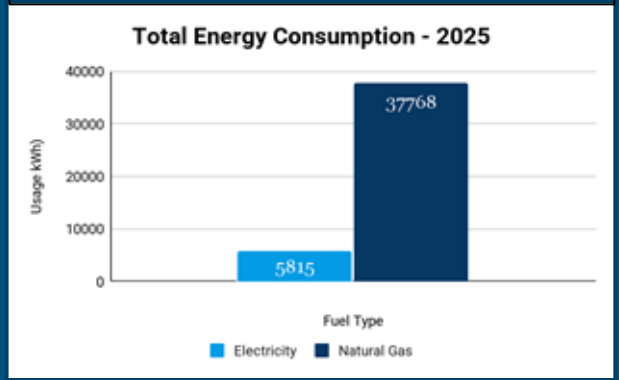
Overall Energy Bill Cost: $1723

- Below Iowa average due to low electricity and cheap gas costs



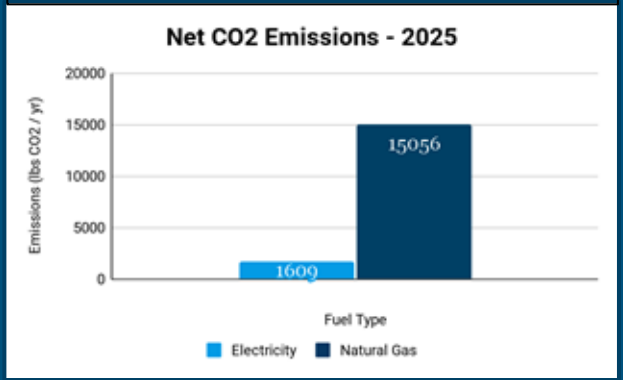
Combined Energy Use: 43583 kWh/yr

- Higher than average due to extremely high natural gas usage



Total Carbon Footprint: 16665 lb CO2/yr

- Below Iowa average due to low emissions from electricity



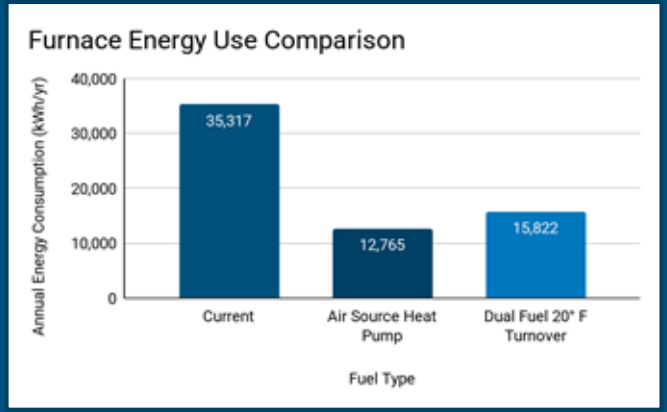
Our Approach to Electrification

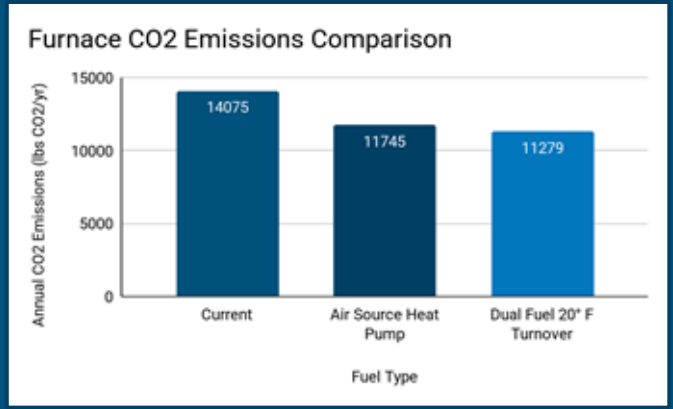
- Blower Door and Smoke Test
- Used OptiMiser App to create current home model
- Researched various climate conscious home improvements
- Proposed four different improvement plans
  - Full Electrification
  - Full Electrification with Solar
  - Partial Electrification
  - Partial Electrification with Solar
- Collaborated with solar/metering project team
- Collaborated with education group

Source: Sustainability House Photos

Furnace

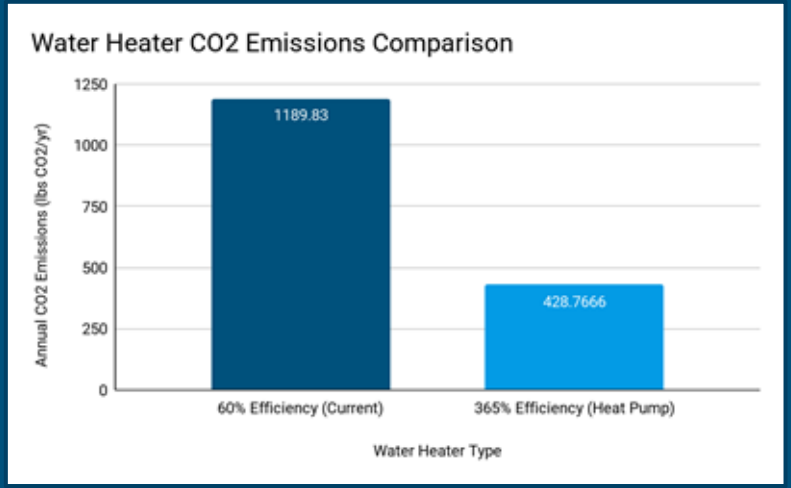
- Current Natural Gas Furnace
  - 30-35 years old
  - 90% efficiency
- Dual-Fuel Furnace
  - Gas and heat pump furnace proposed for partial electrification
  - Heat pump used at 20*F and above (81% of time), gas used below 20*F (19% of time)
  - Heat pump has 270% efficiency, gas has 96% efficiency
- Air-to-Air Heat pump furnace
  - Proposed under full-electrification plan
  - Highest upfront cost and highest annual energy costs due to high electricity costs
  - 249% efficiency





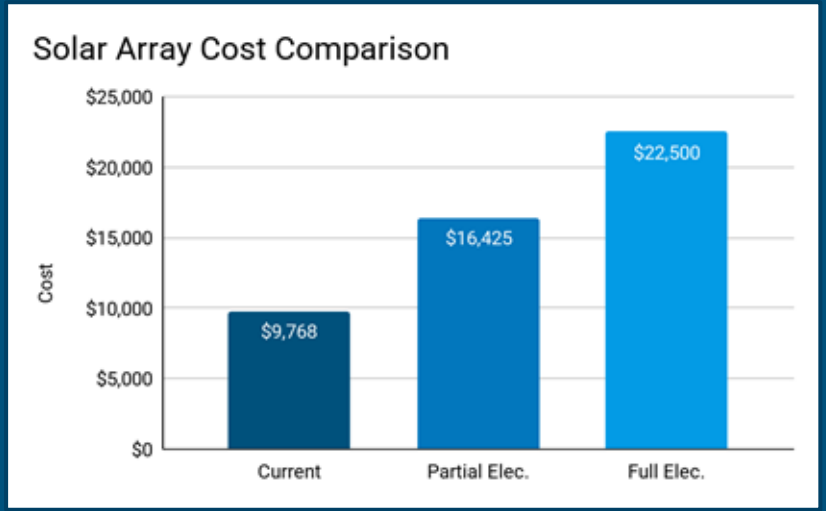
Water Heater

- Current water heater uses natural gas.
  - Uses 102 therms per year.
  - Costs $81.60 per year.
  - Puts 1191 lbs of CO2 into atmosphere each year.
- Heat-pump water heater would be under consideration for full electrification.
  - Uses 466 kWh per year.
  - Costs $74.54 per year.
  - Puts 429 lbs of CO2 into atmosphere each year.



Solar

- House already has 4.8 kW solar array
- Most effective solar arrays will cover house's total usage
- Partial Electrification Array, additional 7.3 kW, costing $16,425
- Full Electrification Array, additional 10 kW, costing $22,500



Other Variables of Electrification

- Electrical breaker:
  - Larger Amperage needed
  - Greater than $1,000
- Dropping natural gas connection fee
  - Saves $21/month currently
- Lighting
  - $20 - $200 Improvement
  - Quality of life improvement
  - Low Cost

Source: The Spruce

Electrification Plans: Improvements

Full Electrification:

- Heat Pump Furnace
  - Ductless Mini Splits
- Heat Pump Water Heater

Full Electrification with Solar:

- Same improvements as above
- Rooftop solar array

Partial Electrification:

- Dual-Fuel Furnace

Partial Electrification with Solar:

- Dual-Fuel Furnace
- Rooftop solar array

Source: Sustainability House Photos

Electrification Plans: Price

Full Electrification

- Upfront cost of all-new space/water heating
- Doesn't account for subsequent breaker improvement

Full Electrification with Solar

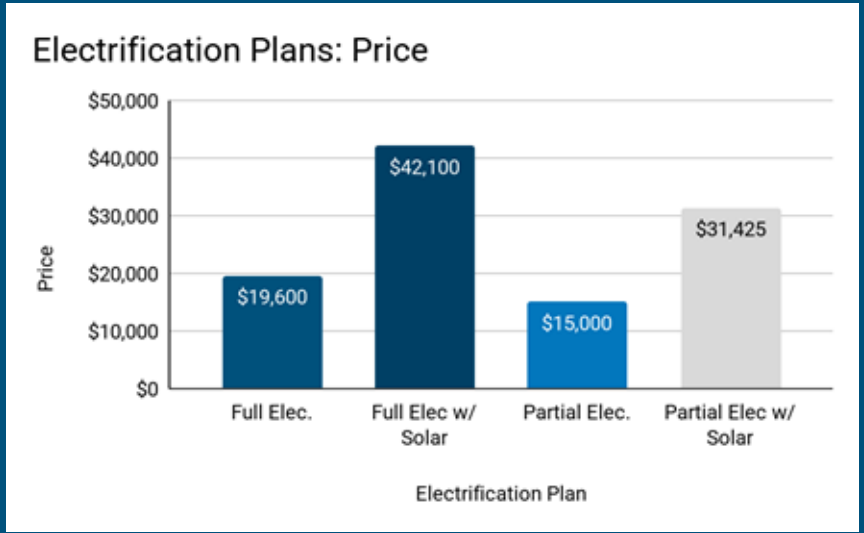
- Solar doubles the project cost

Partial Electrification

- $15,000 just for a new dual fuel furnace

Partial Electrification with Solar

- Solar also doubles this project's cost
- Smaller panel needed for less electrification



Electrification Plans: Energy Use

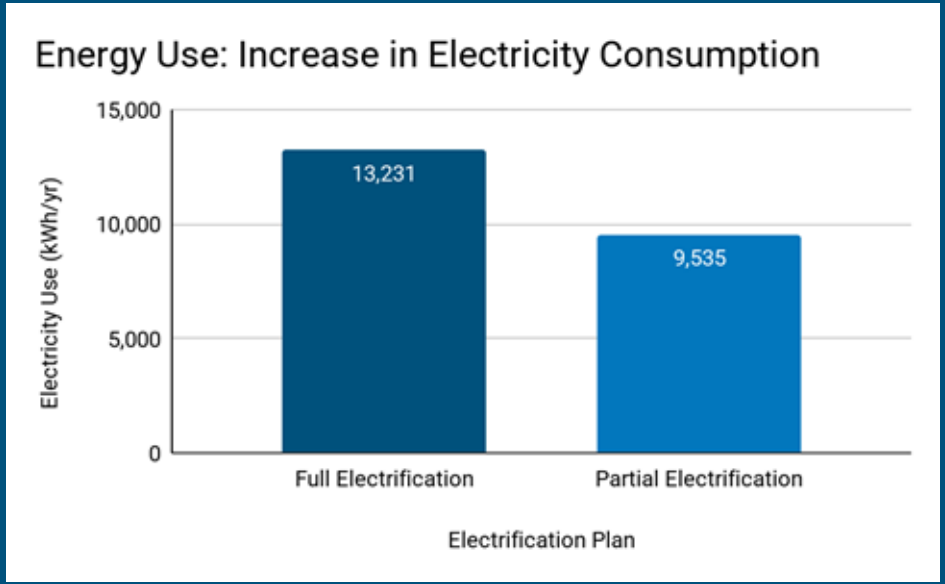
Full Electrification

- Using only electricity for heating increases consumption by 13,231 kWh
- Doesn't account for complete cutoff of current natural gas usage

Partial Electrification

- Dual fuel furnace uses similar amount of electricity from heat pump
- Only partially reduces natural gas usage

Both greatly decrease current total usage.



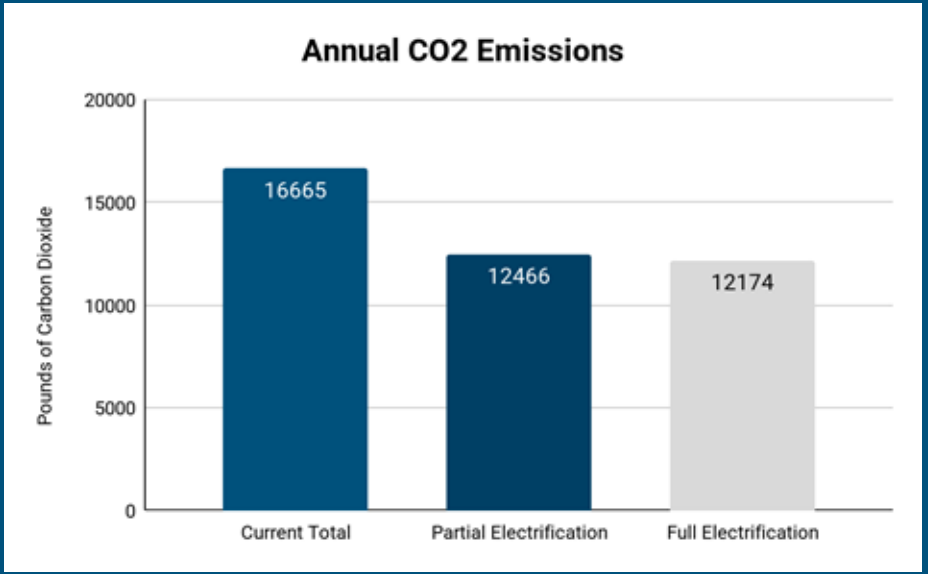
Electrification Plans: Emissions

Partial Electrification

- Natural gas is still present
- Just the dual fuel furnace reduces emissions 18%

Full Electrification

- Heat pump efficiency offsets dirty electrical grid
- Similar total emissions to partial electrification plan



Final Proposal

- Partial Electrification
  - Dual fuel heat pump replacement
  - Add breaker
- Benefits
  - Step to Electrification
  - Within Budget
  - Greatly reduces energy use
- The Future
  - Allows solar projects later
  - Allows heat pump water heater replacement later

Source: Lennox

A New Role in Sustainability

- Any electrification plan gives Sustainability House a new purpose
- Contributes to Luther's 2030 carbon neutrality plan
- Actively reduces emissions
- Can be used as an educational tool for teaching the community about the impact of household energy and it's emissions

Source: Canary Media