NO PREP

Sustainable and Energy-Efficient Homes

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Includes: Student reading, case study, differentiated questions, teacher key

Name: Period: Date:

Sustainable and Energy-Efficient Homes

Where the Money and the Energy Go

Sustainability in housing sounds like an environmental topic and functions mostly as a household budget topic, which is why it belongs in a Family and Consumer Science course rather than only in a science class. Residential buildings account for roughly one fifth of energy consumption in the United States, and the household paying for that energy feels it monthly. Knowing where it goes is the beginning of controlling it.

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Where the Money and the Energy Go

Sustainability in housing sounds like an environmental topic and functions mostly as a household budget topic, which is why it belongs in a Family and Consumer Science course rather than only in a science class. Residential buildings account for roughly one fifth of energy consumption in the United States, and the household paying for that energy feels it monthly. Knowing where it goes is the beginning of controlling it. Space heating and cooling together typically consume the largest share of home energy, commonly around half in many climates. Water heating usually ranks second at roughly fifteen to twenty percent. Appliances, electronics, and lighting divide most of the rest, with refrigerators running continuously and clothes dryers drawing heavily in short bursts. That distribution explains why the highest-value improvements are almost never the visible ones. People tend to imagine sustainability as solar panels, which are genuine but expensive and usually the last step rather than the first. The established professional sequence is to reduce demand before generating supply, meaning seal and insulate the building first so it needs less energy, then upgrade the systems that deliver it, and only then consider producing energy on site. Following that order matters financially, since installing solar panels on a leaky, poorly insulated house means paying to generate energy that immediately escapes through the attic. The cheapest unit of energy is always the one a household never needs to use. Utility companies frequently offer free or discounted home energy audits, which identify the largest losses in a specific house rather than relying on national averages, and many states fund rebates for the improvements an audit recommends.

The Building Envelope

The building envelope is the physical barrier separating conditioned indoor air from outdoor air, consisting of walls, roof, foundation, windows, and doors. Nearly every efficiency conversation starts here because the envelope determines how hard the heating and cooling systems must work. Two properties govern it. Insulation resists heat flow and is rated by R-value, where a higher R-value means greater resistance, and recommended levels vary by climate zone, with attics often calling for R-38 to R-60 in colder regions. Air sealing addresses leaks, which is a separate problem from insulation and frequently a larger one, since insulation slows heat moving through materials while air sealing stops it from simply blowing through gaps. Typical leakage points are attic hatches, recessed lights, plumbing and wiring penetrations, rim joists, and the frames around windows and doors. Caulk and weatherstripping are among the cheapest improvements available, often costing under fifty dollars for a whole house and returning that within a single season. Windows deserve realistic treatment. They are the weakest thermal point in most walls, and double or triple glazing with low-emissivity coatings and inert gas fills performs far better than single panes, but full window replacement is expensive and pays back slowly. Weatherstripping existing windows, adding cellular shades, and using exterior shading on the sun-exposed sides deliver much of the benefit at a small fraction of the cost. Insulation also loses much of its value when it is compressed or installed with gaps, so the quality of the installation matters nearly as much as the R-value printed on the package.

Systems, Water, and Labels Worth Reading

Once the envelope is tight, the systems inside it matter. Heating and cooling equipment carries efficiency ratings that allow direct comparison: furnaces use AFUE as a percentage of fuel converted to heat, air conditioners use SEER, and heat pumps use both SEER and HSPF. Heat pumps have become significant because they move heat rather than generating it and can deliver substantially more heat energy than the electrical energy they consume, which is why they are now used well beyond mild climates. A programmable or smart thermostat is among the cheapest meaningful upgrades, since setting temperatures back while a household sleeps or is away reduces consumption without any equipment change. Water heating responds to insulating the tank and the first several feet of pipe, lowering the setting to about

one hundred twenty degrees Fahrenheit, and installing low-flow fixtures. Water conservation overlaps directly, since heating water is where much of its cost lives. WaterSense-labeled fixtures meet federal efficiency criteria, and a running toilet, the single most common household water waste, can lose hundreds of gallons a day from a part costing a few dollars. Two labels are worth genuine trust. ENERGY STAR identifies appliances meeting federal efficiency standards, and the yellow EnergyGuide label on new appliances states estimated annual energy use and operating cost, which allows shoppers to compare lifetime cost rather than sticker price alone. A cheaper appliance that costs more to run every day for a decade is not actually the cheaper appliance.

Materials, Air Quality, and Building Green

Sustainable housing extends past energy to the materials a home is built and furnished with, and here the criteria are durability, source, and what the material releases indoors. Durable materials that last decades outperform cheap materials replaced repeatedly, since every replacement carries the energy embedded in manufacturing and shipping. Recycled-content and rapidly renewable materials such as bamboo, cork, and reclaimed wood reduce demand on slow-growing resources. Locally sourced materials cut transportation impact. Indoor air quality has become a central concern because modern homes are sealed far tighter than older ones, which saves energy and also traps whatever is released inside. Volatile organic compounds, or VOCs, are chemicals that off-gas from paints, adhesives, finishes, carpets, and pressed-wood furniture, and they can cause headaches, irritation, and respiratory symptoms, with concentrations highest when materials are new. Low-VOC and zero-VOC paints and finishes are now widely available at ordinary prices, making this an easy substitution rather than a sacrifice. Adequate ventilation, exhaust fans that vent outdoors rather than into an attic, and controlling humidity between thirty and fifty percent to limit mold complete the picture. Whole-building standards exist as well, with LEED being the most recognized certification system for green buildings and ENERGY STAR certifying homes meeting efficiency criteria. Understanding these labels helps a buyer distinguish a genuinely efficient home from one marketed with the word green and no evidence behind it.

What a Student or Renter Can Actually Do

Most of the improvements above assume ownership, which excludes exactly the people reading this in a high school classroom, so it is worth ending with what is available to someone who cannot touch the building. Behavior alone moves the number more than students expect. Lowering a thermostat a few degrees in winter and raising it in summer, running full loads in dishwashers and washing machines, washing clothes in cold water, air-drying when possible, shortening showers, and turning off lights and electronics produce measurable savings without a dollar spent. Phantom load, meaning the electricity devices draw while switched off but plugged in, can account for several percent of a household's bill, and a power strip switched off at night eliminates it. Swapping incandescent bulbs for LEDs cuts lighting energy by roughly seventy-five to eighty percent and is permitted in any rental. Removable weatherstripping and door draft stoppers install without permanent alteration. Cellular shades and thermal curtains improve window performance and move out with the tenant. Renters can also ask a landlord about insulation, request repairs to leaky windows in writing, and request the property's past utility costs before signing, which is a legitimate question few applicants think to ask. Sustainability is often framed as a moral position, and it is more useful as a set of skills: reading a label, calculating a payback period, and understanding that the largest savings usually come from the least visible work. Those skills transfer directly to a first apartment and to every home afterward.

Key Information: Energy Efficiency and Sustainable Housing

Detail	Information
Biggest Energy Use	Heating and cooling, often about half of home energy
Correct Sequence	Seal and insulate first, upgrade systems, then generate
Building Envelope	Walls, roof, foundation, windows, and doors as a barrier
R-Value	A material's resistance to heat flow; higher is better
Air Sealing	Caulk and weatherstripping; stops air blowing through gaps
ENERGY STAR	Federal label identifying efficient appliances and homes

Detail	Information
EnergyGuide Label	Yellow tag stating estimated annual energy use and cost
VOCs	Chemicals off-gassing from paints, carpets, and finishes

Case Study: The Nguyens Chase the Wrong Fix

The Nguyen family opens a February heating bill for three hundred forty dollars and starts pricing solar panels that evening. Their daughter Linh is taking a FACS housing unit and asks whether they can do the assignment's walkthrough first. They spend an hour with a stick of incense, watching the smoke bend near the attic hatch, along two window frames, and around the outlet on the north wall. The attic insulation measures about four inches, well under what their climate zone calls for. Linh writes the sequence from her notes on the kitchen whiteboard: reduce demand, then upgrade systems, then generate. Her father argues that panels are the real solution. Linh points out that panels would power a house that leaks heat all winter. They spend ninety-one dollars on caulk, weatherstripping, and an attic hatch cover that weekend, and add attic insulation in the fall. The next February bill is two hundred twelve dollars. Her father still wants panels eventually, and now says he wants them on a house that holds heat.

1. Linh argued against buying solar panels first. Using the reading's sequence, explain why her order of operations saved the family money.

2. The Nguyens used incense smoke near the attic hatch and window frames. Explain what they were testing for and why the reading treats it separately from insulation.

Multiple Choice

1. What sequence does the reading recommend for improving home efficiency?

    a) Upgrade appliances first because they run continuously

    b) Seal and insulate, then upgrade systems, then generate energy

    c) Replace all windows first, then add solar panels, then seal gaps

    d) Generate energy, then upgrade systems, then insulate last

2. What does R-value measure in a building material?

    a) The percentage of recycled content it contains

    b) Its resistance to heat flowing through it

    c) The amount of moisture it can absorb safely

    d) How many years the manufacturer warrants it

3. What is phantom load as the reading describes it?

    a) Heat escaping through an uninsulated attic hatch

    b) Water lost overnight through a toilet that keeps running slowly

    c) The extra cost of running appliances at peak hours

    d) Electricity drawn by devices switched off but plugged in

Matching

Write the letter of the correct definition on the line next to each term.

Term	Definition
1. ___ building envelope	A) Chemicals that off-gas indoors from paints and carpets
2. ___ R-value	B) Closing gaps with caulk and weatherstripping to stop leaks
3. ___ air sealing	C) A rating of how well a material resists heat flow
4. ___ phantom load	D) The barrier of walls, roof, windows, and doors around a home
5. ___ VOCs	E) Power drawn by devices that are off but still plugged in

Fill-in-the-Blank

1. Insulation resistance to heat flow is rated by its _____.

2. The yellow tag stating annual energy cost is the _____ label.

3. Water heater settings are usually lowered to _____ degrees.

Short Answer

Answer each question in 2-4 complete sentences.

1. Why does the reading say solar panels are usually the last step, not the first?

_____

_____

_____

2. Explain why tighter modern homes made indoor air quality a bigger concern.

3. Why is asking a landlord for past utility costs a useful move before signing?