

Lesson 4.4: Conserving Energy and Water: the Home Energy Audit

Unit: Unit 4, Spaces We Live In (Environmental Design and Management) **Topic:** 4.1 Safe, Healthy, Sustainable Homes **Grade:** 6 to 8 (written at grade 7; see Differentiation for the grade 6 support and grade 8 stretch) **Days:** 2 class periods of 40 minutes (days 95 and 96 of the year) **Room:** Either (classroom or FACS lab; Day 2 audits the room you are in)

Standards

- NYS module line: NYS EDM 1. Healthy, Safe, Sustainable Living Spaces d) Investigate ways to conserve natural resources in family, school, work, and community settings
- NYS module line: NYS EDM 2. Environment and Interior Design d) Research how environmental and green home factors influence the design of functional, safe and aesthetic living spaces
- CTE theme line: CTE SUS 3. Energy Conservation d) Define “conservation” as it applies to energy
- CTE theme line: CTE SUS 3. Energy Conservation e) List and describe methods for energy conservation in the home, workplace, and community
- CTE theme line: CTE SUS 1. Resources e) Investigate practices that promote stewardship of environmental resources
- NYS FACS Learning Standard 3 (Intermediate), Key Idea: Students will understand and be able to manage personal resources of talent, time, energy, and money and make effective decisions in order to balance their obligations to work, family, and self.; Performance Indicator: Students understand the resources available to them, make informed decisions about the use of those resources, and know some ways to expand resources.
- CDOS Standard 3a Universal Foundation Skills: Managing Resources
- National FCS 3.0: 3.4.3 Try out different ways to save energy and cut waste.
- National FCS 3.0: 2.2.3 Practice habits that conserve, reuse, and recycle so resources and the environment last.

Standard 3 is cited here because the EDM module’s own Standards Addressed block lists Standards 2 and 3, and the crosswalk row for EDM 1. d) assigns Standard 3 (energy and money as personal resources).

Enduring understanding and essential question

Big idea: Energy and water in a home are invisible until the bill comes. An audit makes them visible, and once you can see where they go, the cheapest fixes are usually free.

Essential question: If you could only change three things in a home to cut the energy bill, which three, and how would you prove they worked?

Objectives

By the end of this lesson, students will be able to:

1. (Low: remember or understand) Given the categories of home energy use and home water use, list the top three of each and define phantom load and conservation.
2. (Mid: apply or analyze) Given the wattage, hours, days, and price per kilowatt-hour, calculate the yearly cost of one bulb and the savings from switching to LED, and given gallons per day, calculate the yearly water lost to one dripping faucet.
3. (High: evaluate or create) Given an audit checklist, audit the classroom and a described home, then rank the ten cheapest fixes by yearly savings and justify the top three.

Vocabulary

Tier 2 (general academic): conserve, audit, estimate, rank Tier 3 (FACS): kilowatt-hour (kWh), watt, phantom load (standby power), LED, incandescent, thermostat, setback, low-flow, weatherstripping, supply charge and delivery charge (on a bill). See the unit vocabulary list for Turkish, Portuguese, and Spanish.

Materials and setup

- Handout, one per student: Handout 04.04 - Home Energy Audit Checklist and Sample Bill.md (the math page, the audit checklist for the classroom and the described home, the ten-fixes table, the sample bill)
- Calculators, one per pair
- One incandescent bulb (60 W) and one LED bulb (9 W, “60 W equivalent”) to pass around; read the wattage on each
- A plug-in electricity meter (about \$20) *[Sal: optional; if you have one, plug the classroom’s phone charger or a laptop charger into it during Day 1 Step 1 and read the standby watts; students believe a number they watched]*
- A clipboard per team for Day 2
- Slides: Slides 04.04 - Conserving Energy and Water the Home Energy Audit (Day 1 and Day 2 labeled)
- Timer visible to the class
- Setup notes: before Day 2, leave a few things “on” in the room on purpose: a charger with nothing attached, lights on in an empty corner, a window slightly open near a heater, a faucet dripping in the FACS kitchen if you have one. Photograph the room for reset. Allergy check: none needed.

Pre-assessment

The Unit 4 pre-test asked “Name one thing that uses electricity in your home even when nobody is using it.” The pile splits between “nothing” and “the fridge.” That split is the phantom load lesson. Today’s do now asks the same question a different way.

Do now and hook (Time: 5 min)

Day 1. On the board: “Name three things in your home that are using electricity right now, while nobody is using them. Then guess: what does one light bulb cost to run for a year?”

Debrief: write the three-things list on the board; circle the ones that are phantom loads (chargers, TVs, game consoles, microwaves with clocks). Hook: hold up the two bulbs. “Same light. One costs about \$25 a year and one costs about \$4. You are going to prove that with math in ten minutes, and then you are going to audit this room and find everything that is wasting money right now.”

Day 2. On the board: “One bulb: 60 watts, 5 hours a day, 365 days. How many watt-hours? Divide by 1,000 for kilowatt-hours.” Debrief: 109,500 Wh, 109.5 kWh. The number is on the board for the whole audit.

Procedure

Day 1

Step	Teacher will	Students will	Time
1. Direct instruction: where energy and water go	Two slides. Energy in a typical U.S. home: heating and cooling about half; water heating about a fifth; everything else (lights, refrigerator, laundry, electronics, cooking) the rest. Water: toilets about a quarter, showers a fifth, faucets a fifth, laundry a sixth, leaks about a tenth. Then phantom load: a device that draws power while “off,” about 5 to 10 percent of a home’s electricity. If you have the meter, plug in a charger with nothing attached and read it. Define conservation the state’s way: using less of a resource on purpose so it lasts. Distinguish conservation (use	Fill in the two pie charts on the handout, Part 1, and write the two definitions.	8 min

	less) from efficiency (get the same result with less).		
2. Learning activity: the math	Work the bulb problem on the board with the class: $60 \text{ W} \times 5 \text{ hours} \times 365 \text{ days} = 109,500 \text{ Wh} = 109.5 \text{ kWh. At } \$0.25 \text{ per kWh, } \$27.38 \text{ a year. LED: } 9 \text{ W} \times 5 \times 365 = 16,425 \text{ Wh} = 16.4 \text{ kWh} = \$4.11.$ Savings \$23.27 per bulb. Then the faucet: one drip per second is about 5 gallons a day; $\times 365 = 1,825$ gallons a year, about 30 bathtubs. Then the thermostat: each degree you set back for eight hours saves about 1 percent of the heating bill; 7 degrees at night saves about 7 percent; the free fix is a sweater and a blanket. Pairs do the three practice problems on the handout, Part 2, with different numbers.	Follow the worked problems, then solve the three practice problems in pairs with a calculator. Check with the pair next to them.	10 min
3. Guided practice: the audit checklist	Walk the checklist on the handout, Part 3: lights (on in empty rooms? LED?), phantom loads (chargers, screens, consoles),	Score the bedroom photo as a class, one line at a time.	9 min

	heating and cooling (thermostat setting, windows open with heat on, vents blocked, drafts at doors and windows), water (drips, toilet running, shower length), appliances (fridge door seal, dishwasher full, laundry cold). Show how to score each line: OK, Fix (free), or Fix (costs money). Practice on one photo of a described bedroom on the slide.		
4. Share and preview	Two pairs read their practice problem answers. Preview: tomorrow the room is the client. Assign five teams and five zones of the room.	Report; write their team's zone on the handout.	4 min

Day 2

Step	Teacher will	Students will	Time
1. Practice: audit the classroom	Teams take their zone with the checklist and a clipboard: lights, outlets and chargers, windows and vents, the FACS kitchen faucets and fridge if you have them, the thermostat if you can read it. Ten minutes. Circulate with the clipboard	Audit the zone, score every line, list every fix as free or money.	10 min

	check. Reveal the planted wastes at the end.		
2. Practice: audit the described home	Teams read the described home on the handout (the Marchetti-Oyelaran apartment, described room by room with its wastes written in) and score it on the same checklist.	Read, score, list fixes.	10 min
3. Learning activity: rank the ten cheapest fixes	Show the twelve-fix table on the slide (each with a cost and an estimated yearly saving). Task: cross out the two that cost more than \$50, then rank the ten cheapest by yearly savings, highest first. Then compute payback for the three that cost money (cost divided by yearly savings equals years to pay back). Write why the top three are the top three.	Rank, compute payback, justify.	8 min
4. Direct instruction: read a sample bill	Show the sample electric bill on the handout, Part 5. Find the kWh used, the supply charge, the delivery charge, the fixed charge, and the total. Ask: if this family swapped ten bulbs to LED, how much would next month's bill drop? (About \$19, using	Find and circle the five numbers; do the one subtraction.	3 min

	the classroom math divided by 12.)		
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Questions to ask

Monitor understanding:

- What is a kilowatt-hour? How many watt-hours is that?
- Name two phantom loads in this room right now.
- Which uses more water in a home, the toilet or the shower?

Deepen learning:

- The LED costs \$3 more than the incandescent. How many months until it pays for itself? (About two, at \$23 a year.) Why do people still buy the cheaper bulb?
- Who pays the electric bill in a rented apartment, and who chooses the appliances? What does that do to the landlord's reasons to fix things?
- A family lowers the thermostat 7 degrees at night and saves 7 percent. Is the sweater "worth" the 7 percent? Who decides what worth means in a home?

Check for understanding

Day 1: during Step 2, the pair check on the three practice problems; a pair with all three right (within rounding) is ready to audit. Day 2: clipboard checklist during Step 1, for each team a yes or no on "every line scored," "each fix labeled free or money," and "the planted waste in their zone was found." Two of three is "got it."

Closure (Time: 4 min)

Day 1. 3-2-1 exit card: 3 places a home's energy goes, 2 phantom loads you will unplug tonight, 1 number from today's math you will remember. Three students read line 3.

Day 2. Exit card: the top three fixes from your ranking and one sentence on why the first one is first. Sort the cards into "got it" and "needs more." The quiz in Lesson 4.5 has one energy math item and one water math item with numbers given; the "needs more" pile decides whether the review before the quiz works one more problem.

Differentiation and supports

- ELL: the pie charts on the slides are labeled with pictures (a furnace, a shower, a bulb); the handout word bank gives energy, water, save, cost, bill, and bulb in Turkish, Portuguese, and Spanish (see Vocabulary 04.md); the math problems use a fill-in template (watts x hours x days = ___ Wh; divide by 1,000 = ___ kWh; times price = \$) **so the steps are the same every time; sentence starter for the ranking:** "is first because it saves \$___ and costs \$___."
- IEP and 504 (general): calculators for everyone; the template does the order of operations; a team role card for the audit (reader, checker, writer) so no one does all

three; extended time by finishing the described-home audit as homework; a printed copy of the pie charts; fidgets allowed.

- Grade 6 support: the practice problems give the watt-hours already computed and ask only for the kWh and dollar steps; the ranking uses six fixes instead of ten; the described home has its wastes marked with a star.
- Grade 8 stretch: students also compute the whole-house savings for twenty bulbs and the payback in months for the programmable thermostat and the low-flow showerhead, and write one paragraph on whether a renter or an owner should pay for each (this previews EDM 3. a) and FCL 4. f)).
- UDL checkpoint used: multiple means of representation (each fact is a picture, a number, and a real object passed around) and multiple means of engagement (the audit is a real room with planted wastes and a team score).
- No-kitchen or no-machine alternative: not a lab. If the room has no faucet or fridge, the water lines on the classroom checklist are scored on the described home only. If no plug-in meter, the phantom load number on the slide stands in.

Assessment

Objective	Standards met	Learning task	Assessment (formative or summative; tool)
1. List where energy and water go; define phantom load and conservation	SUS 3. d); EDM 1. d); Std 3 KI	Part 1 of the handout, Day 1 Step 1; exit card	Formative; handout checked, exit card sorted
2. Calculate bulb cost, LED savings, and faucet loss	SUS 3. e); CDOS 3a Managing Resources; National FCS 3.4.3	Practice problems, Day 1 Step 2	Formative; pair check; summative on the Home Safety and Conservation Quiz (two math items)
3. Audit two spaces, rank ten fixes, justify the top three	EDM 1. d), 2. d); SUS 1. e); Std 3 PI B; National FCS 2.2.3	The two audits and the ranking, Day 2 Steps 1 to 3	Formative; clipboard checklist during the classroom audit; the ranking sheet scored complete, partial, or missing; the top three feed the Greener Room Swap in Lesson 4.5

Homework

None. Optional: count the phantom loads in one room at home and unplug the ones nobody will miss. Tell me the count, not the room.

Connections

Math: unit conversions (Wh to kWh), percent (the thermostat setback), and payback (cost divided by savings) are the math teacher's ratio and percent unit; FACS gives real bills, math gives the fluency. Science: the science teacher can take the "what is a watt" question; FACS keeps the money. Community: the local utility often runs a free home energy audit program and a school outreach kit with meters and LED bulbs. *[Sal: name the utility and ask for the kit; PSEG Long Island and National Grid both have school programs on Long Island.]* *[Sal: your zero-energy home project from Penn State belongs on Day 1 between Step 1 and Step 2. Two minutes: what a zero-energy home is, what it cost, what surprised you. Students remember a story better than a pie chart.]*

Sources

- NYS Middle Level CTE FACS Content Module 04, Environmental Design and Management (nyctecenter.org, June 2018), lines 1. d) and 2. d). Copy in 02 Standards/NYS Module PDFs/.
- NYS Middle Level CTE Theme Module, Sustainability, lines 1. e), 3. d), and 3. e). Text per 02 Standards/NYS ML CTE FACS Modules - verbatim extract of all twelve.md.
- NYS Learning Standards for Health, Physical Education, and Family and Consumer Sciences (1996), Standard 3, Intermediate. Wording per the crosswalk, Part A.6.
- National Standards for Family and Consumer Sciences Education 3.0 (LEAD FCS Education, 2018), competencies 3.4.3 and 2.2.3, per 02 Standards/STANDARDS SOURCES - web research.md.
- Energy and water shares are rounded from U.S. Energy Information Administration residential energy consumption data and the U.S. EPA WaterSense residential water use breakdown; the drip figure is rounded from the USGS drip calculator; the thermostat setback rule of thumb is from the U.S. Department of Energy. All are rounded for grade 7 math and marked "about." *[Sal: check the price per kWh against a current local bill; \$0.25 is a Long Island working figure and changes.]*
- Sal's own materials: the "Sustainable Style" Brentwood packet supplied the "free fix first" idea; the ClassroomStreet utility expense line is where students see the bill again in Unit 2.

Teacher notes

- If Day 1 runs short, cut Step 3 to the checklist read-through without the bedroom photo; the classroom audit on Day 2 teaches the checklist anyway. If Day 2 runs short, drop Step 4 and read the bill at the start of Lesson 4.5.

- Common mistake: forgetting to divide by 1,000. The template on the handout has the divide step printed in its own box for that reason. Say “watt-hours are pennies, kilowatt-hours are dollars” and it sticks.
- Common mistake: ranking by cost instead of by savings. The instruction says cheapest first, then rank by savings. Read it twice.
- The plug-in meter is the best \$20 you will spend in this unit. A charger with nothing on it reads about 0.1 to 0.5 W, which is almost nothing; a cable box or a game console reads 10 to 20 W in standby, which is the story. Test a few before class and pick the one with the biggest number.
- The Marchetti-Oyelaran apartment on the handout is a rental on purpose. It sets up the “who pays and who chooses” question that comes back in the Design a Room budget.
- *[Sal: your zero-energy home project. Tell it. Two minutes, Day 1.]*