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## Theme

Smart energy management and home efficiency

## Duration

75 minutes

## Level

Intermediate

# LEARNING BOX OF UNPLUGGED ACTIVITIES

# Optimizing Heating with Heat Pumps or Traditional Systems

This unplugged activity helps learners understand how to efficiently manage home heating systems, including heat pumps and traditional heating methods. Participants work with a written home layout description, a heating systems comparison table, and written weather and usage scenario descriptions — all provided at the end of this document. They analyze how heating systems operate, identify inefficiencies, and design simple rules to optimize comfort while reducing energy consumption and costs. The activity reflects the current transition toward more energy-efficient solutions in households.

## Target Group

- ☑ Low-skilled adults with low digital competences
- ☐ Low-skilled adults with limited formal education or qualifications
- ☐ Low-skilled adults with low participation in lifelong learning / training opportunities

## Learning Objectives

- Understand how different heating systems work (heat pumps vs. traditional systems)
- Identify heating zones and temperature control strategies
- Recognize how outdoor climate affects energy consumption
- Develop efficient heating habits and routines
- Apply computational thinking to optimize energy use at home

## Competence Areas

*a) Innovation Competences*

- ☑ Creativity
- ☑ Critical thinking

## Computational Thinking Steps Used

☑ Decomposition
☑ Pattern recognition
☐ Abstraction
☑ Algorithmic thinking

## Methodological Approach

☐ Gamification
☑ Challenge-Based Learning
☐ Collaborative learning
☑ Experiential learning

☑ Problem solving
☑ Communication
☑ Collaboration

*b) Information Literacy Competences*

☐ Ability to access, understand, and critically analyse information
☐ Interpretation of digital and visual content
☐ Awareness of media influence and biases

*c) Life and Career Competences*

☐ Flexibility and adaptability
☐ Initiative and autonomy
☐ Sociability and intercultural competence
☐ Productivity
☐ Leadership and responsibility

## Learning Outcomes

By the end of the activity, participants will be able to:

- Break down a home heating system into zones and components
- Identify patterns in heating needs based on weather and time of day
- Focus on key factors that influence energy efficiency
- Create simple automated rules for heating management
- Make informed decisions to reduce heating costs while maintaining comfort

## Notes

- Home Layout Description and Heating Systems Reference Table (see end of document): A text description of a typical home with heating zones, and a table comparing heat pump vs. gas boiler, are provided below — no printed diagrams or cards needed.
- Include scenarios with different weather conditions (cold waves, mild winter days)
- Encourage participants to share real-life heating challenges

- Facilitators can introduce constraints (e.g., limited budget, poorly insulated home)
- Highlight practical, easy-to-apply solutions

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## Step 1: Decomposition of the Heating System

Participants refer to the Home Layout Description and Heating Systems Reference Table at the end of this document. The layout describes a typical home divided into three heating zones; the table compares the heat pump and gas boiler on efficiency, cost, emissions, and suitability.

They are asked to:

- Break down the home into heating zones (e.g., frequently used vs. rarely used rooms)
- Identify where and how heating is used in each space
- Recognize different system components (heat sources, controls, insulation factors)
- Discuss which areas consume the most energy

Facilitator support:

- Ask guiding questions like: “Which rooms need heating the most?”, “Where is energy being wasted?”
- Encourage thinking in smaller parts (zones, devices, usage)

This step helps participants understand a heating system by dividing it into manageable components.

## Step 2: Pattern Recognition

Participants read the four Heating Scenario Descriptions at the end of this document — a cold winter evening with everyone home, a weekday with no one home, a mild spring day, and a very cold night — and identify energy use patterns in each.

They are asked to:

- Identify patterns in heating needs, such as:
  - Higher demand in evenings or early mornings
  - Reduced need when no one is home
  - Differences between rooms (e.g., living room vs. bedroom)

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- Recognize how outdoor temperature and daily habits affect energy consumption
- Compare seasonal variations (e.g., winter vs. milder periods)

Facilitator support:

- Prompt reflection: “When is heating used the most?”, “What changes during the day or season?”
- Highlight recurring behaviors and energy use trends

This step helps participants identify patterns that influence heating efficiency.

## Step 3: Heating Strategy Design (Algorithmic Thinking)

Participants develop simple, rule-based strategies for managing heating efficiently.

They should:

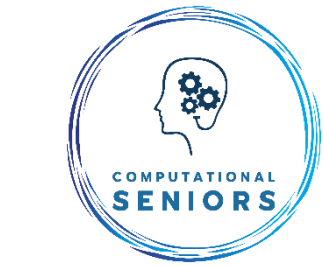
- Create practical “if–then” rules, such as:
  - “If no one is home, lower the temperature”
  - “If a room is unused, turn off or reduce heating”
  - “If outside temperature rises, reduce heating levels”
- Combine rules into a daily routine or schedule, for example:
  1. Morning: increase heating in key rooms
  2. Daytime: reduce heating when house is empty
  3. Evening: heat living areas more
  4. Night: lower overall temperature

Finally, participants:

- Present their heating strategy to the group
- Explain how it improves efficiency and reduces costs
- Compare different approaches and suggest improvements

Facilitator support:

- Encourage realism: “Would this work in your home?”
- Introduce constraints (e.g., poor insulation, limited budget) and discuss adaptations






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**Optimizing Heating with Heat Pumps or Traditional Systems**

This step helps participants develop structured, repeatable routines for efficient heating management.

## Facilitator Guidance

### Before the activity

Begin by asking participants how they currently heat their homes and what factors influence their energy consumption, such as outdoor temperature, room usage, or insulation. Encourage discussion about common challenges, including high heating costs during winter. Explain that the activity focuses on identifying practical ways to improve comfort while reducing unnecessary energy use.

### During the activity

Encourage participants to analyze each scenario carefully before developing their heating strategy. Ask questions such as: "Which rooms require heating throughout the day?", "How does outdoor temperature affect your decisions?", or "Which changes would save the most energy without reducing comfort?" If participants need additional support, provide practical examples, such as lowering the thermostat when the house is empty or heating only frequently used rooms. Encourage groups to explain the reasoning behind every rule they create.

### After the activity

Ask each group to present its heating strategy and discuss how it balances comfort, energy efficiency, and cost. Compare different approaches and encourage participants to identify ideas they could realistically apply in their own homes. Reinforce that effective energy management often depends on simple daily routines rather than expensive technological solutions. Conclude by highlighting how computational thinking helps people make informed, structured decisions that improve both energy efficiency and household sustainability.

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Optimizing Heating with Heat Pumps or Traditional Systems

## Home Layout Description

The activity uses a fictional two-storey detached house (the Papadopoulos household, built in the 1990s, average insulation). Use this layout in Step 1 to define heating zones.
Ground Floor — Zone 1 (High Use): Living room (large, south-facing, split-unit heat pump + radiator), kitchen/dining room (radiator), hallway (small radiator). In use daily from 7:00 am to 11:00 pm.

- First Floor — Zone 2 (Moderate Use): Master bedroom (north-facing, thermostat-controlled radiator), children's bedroom (small radiator), bathroom (electric towel rail). Heating mainly needed 6:30–8:00 am and 9:00–11:00 pm.
- Utility Area — Zone 3 (Low Use): Storage room and garage (no heating). Guest room (portable electric heater, used a few times per month).
- Installed systems: one air-source heat pump (split unit) in the living room; a gas boiler connected to radiators throughout the rest of the house; individual room thermostats in the master bedroom and living room; no smart thermostat or scheduling timer.

## Heating Systems Reference Table

Use this table in Steps 1 and 3 to compare the two heating systems in the Papadopoulos household.

| Characteristic | Heat Pump (Air-Source) | Gas Boiler (Traditional) |
|---|---|---|
| Energy source | Electricity (moves heat from outside air) | Natural gas (burns fuel to generate heat) |
| Efficiency | High (COP 3–4); less efficient below -5°C | Moderate (85–92%); consistent across temperatures |




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| | | |
|---|---|---|
| Running cost | Lower long-term (depends on electricity tariff) | Lower upfront cost; depends on gas price |
| Carbon emissions | Low (especially with renewable electricity) | Higher (direct $CO_2$ from gas combustion) |
| Response speed | Slower (gradual warming); best for steady low-temperature heating | Faster (radiators heat up quickly); suited to on-demand heating |
| Best suited for | Mild-to-cold climates; well-insulated homes; long heating periods | Older homes; very cold climates; flexible zone-by-zone control |

## Optimizing Heating with Heat Pumps or Traditional Systems

### Heating Scenario Descriptions

Use these in Steps 2 and 3. Each describes conditions in the Papadopoulos household at a different time, requiring different heating decisions.

**Scenario A — Cold Winter Evening (Everyone Home)**
It is 6:30 pm on a January evening. Outside: -2°C. Both adults are back from work; children are doing homework. The family wants the living room at 21°C and bedrooms at 19°C by 9:00 pm. The heat pump has been off all day (living room currently 14°C); the gas boiler ran on a low setting until 5:00 pm; all radiators are lukewarm. The guest room is empty. Last month's energy bill was higher than expected.
*Discussion prompt: "Which system should heat the living room? Should the guest room radiator be on? How could they have planned ahead to avoid a cold home at 6:30 pm?"*

**Scenario B — Weekday Daytime (No One Home)**
It is 10:00 am on a Tuesday in February. Outside: 5°C. The




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whole family left at 8:00 am and will return at 4:00 pm. The gas boiler is running at full setting (maintaining 20°C throughout the house), because the family forgot to turn it down before leaving.
*Discussion prompt: "What should be done immediately? What simple rule would prevent this happening again? What temperature is appropriate for an empty house in winter?"*

**Scenario C — Mild Spring Day**
It is 2:00 pm on a Saturday in April. Outside: 16°C and sunny. The family is home. The living room is already 20°C — comfortable without heating. The gas boiler is still on its winter schedule; radiators are warm. A window has been opened in the living room because it feels too warm.
*Discussion prompt: "What should the family do? How much energy is being wasted? What pattern does this represent, and what rule would fix it?"*

## Optimizing Heating with Heat Pumps or Traditional Systems

**Scenario D — Very Cold Night (Extreme Weather)**
It is midnight on a January night. Outside: -8°C. Everyone is asleep. The heat pump efficiency drops significantly at this temperature. The gas boiler provides background heating (radiators on low). The master bedroom thermostat reads 16°C — colder than comfortable for sleep. The family's gas bill is already high this month.
*Discussion prompt: "Should the heat pump or the boiler be increased? How do you balance comfort and cost? What temperature is acceptable for sleeping? What would you do differently before going to bed?"*