

HOW A HEAT PUMP WORKS

A heat pump moves heat from one place to another very efficiently. It works a bit like a **fridge in reverse!**



Heat pumps use electricity, but they move 3–4 units of heat for every 1 unit of electricity used.

1 HEAT IS COLLECTED

In winter, the ground below a certain depth stays around 8–12°C all year. The heat pump collects this stored heat.

2 HEAT IS ABSORBED

A liquid in the ground pipes absorbs the heat and turns into a gas (still low temperature).

3 HEAT IS BOOSTED

The gas goes into a compressor. Electricity powers the compressor, which increases the temperature of the gas a lot.

4 HEAT IS RELEASED

The hot gas passes through a heat exchanger inside the house. It gives out its heat to warm the rooms and hot water.

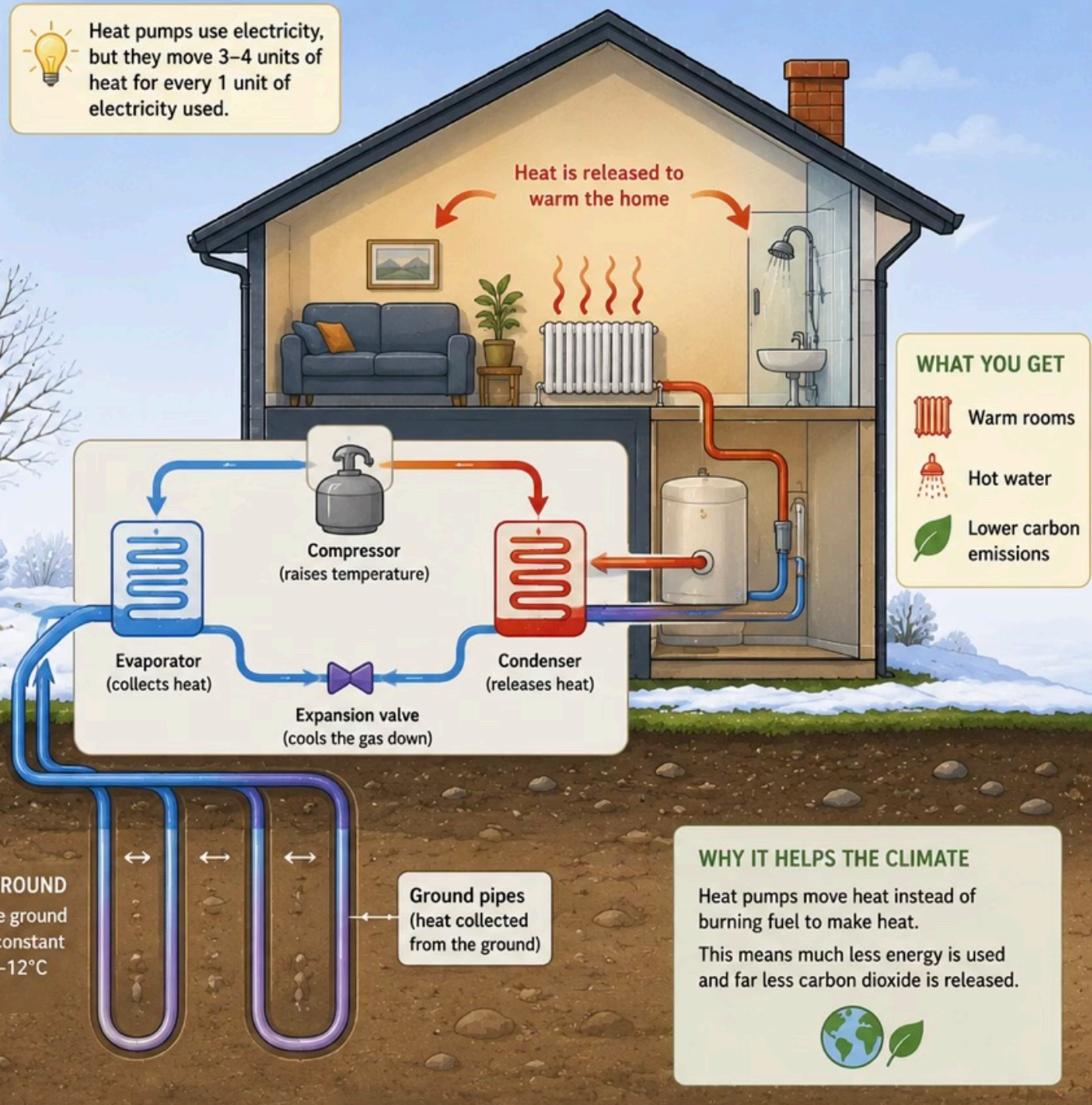
5 THE CYCLE REPEATS

The gas cools down, turns back into a liquid and flows back underground to collect more heat.

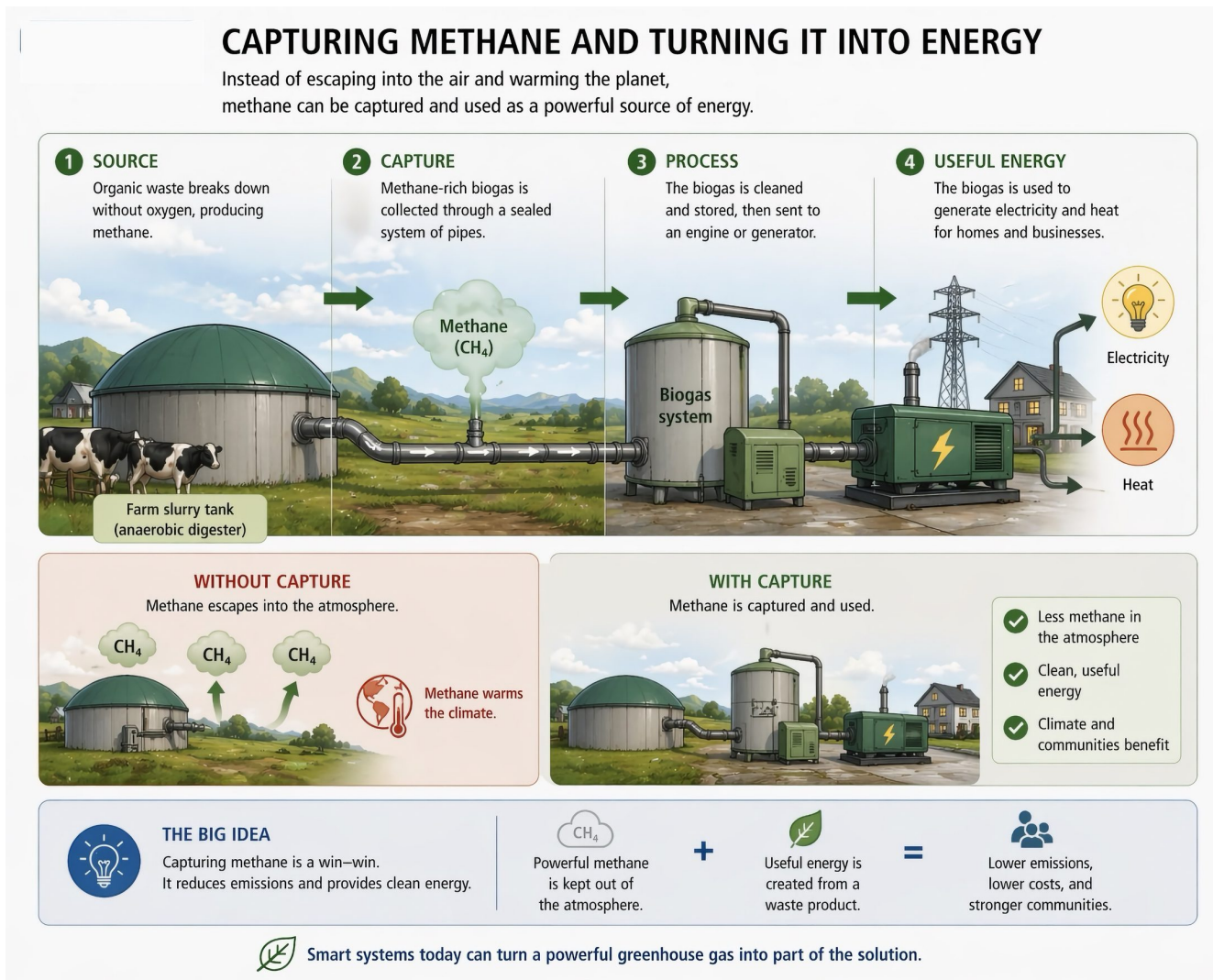


STEADY HEAT UNDERGROUND
Below a certain depth, the ground temperature stays fairly constant all year round, around 8–12°C depending on location.

8–12°C

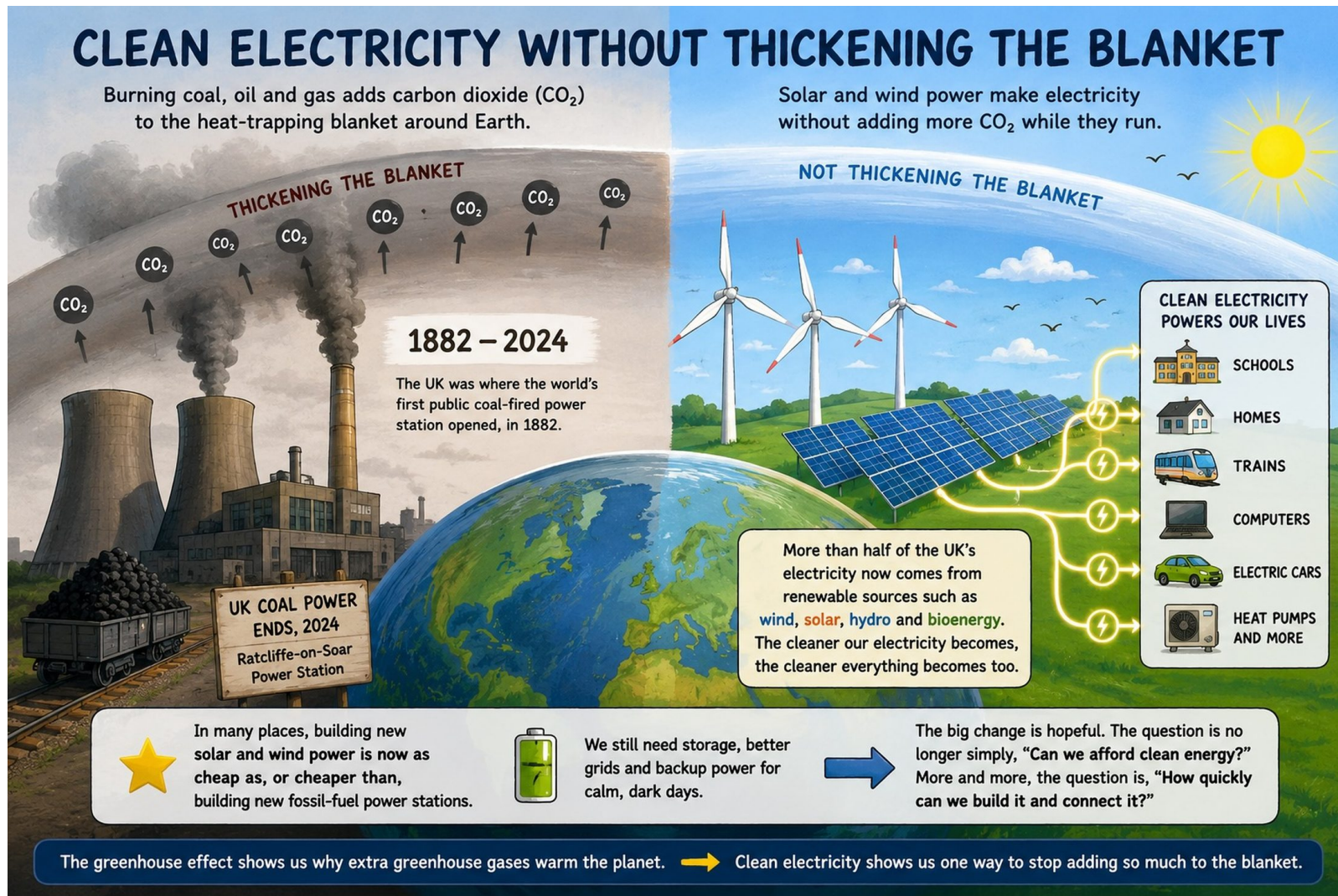


4.4 - Capturing methane for useful energy



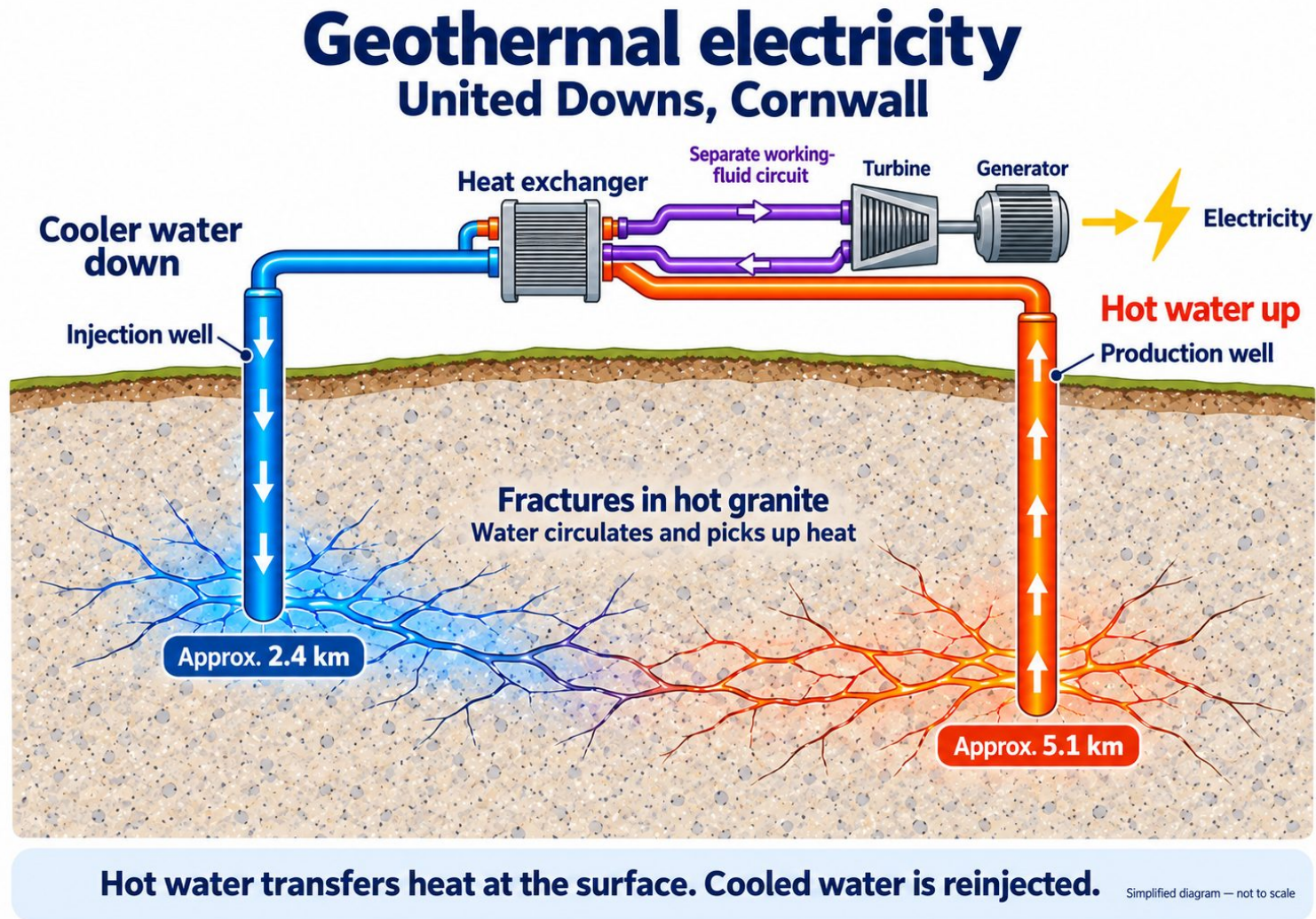
Capturing waste methane can reduce emissions. Burning it still produces CO₂; preventing methane leaks matters.

2.4 - Clean electricity



Solar and wind do not emit CO₂ while generating. Construction and other lifecycle impacts still matter.

S2 E2 new - Geothermal electricity in Cornwall



Deep geothermal heat can generate electricity. This is different from a shallow ground-source heat pump.

Quiz: Clean energy

Name: _____ Date: _____

Circle one answer for each question.

1. Which action is an example of electrification?

- A. Using more petrol in a car.
- B. Replacing a gas boiler with an electric heat pump.
- C. Burning coal instead of gas.

2. What does a heat pump mainly do?

- A. It creates electricity from deep rocks.
- B. It burns gas to warm water.
- C. It uses electricity to move heat from one place to another.

3. Which set helps keep electricity dependable on a calm night?

- A. Storage, connected grids, flexible use and sources that can keep running.
- B. Only solar panels, with no other support.
- C. Batteries that never need charging.

4. What is a battery or pumped-storage scheme doing when it supplies power?

- A. Creating a new primary source of energy.
- B. Returning some energy that was stored earlier.
- C. Producing energy without any losses.

5. At United Downs, what is the original source of the energy used to generate electricity?

- A. Heat in deep rocks.
- B. Sunlight falling on the wells.
- C. Water creating heat from nothing.

6. Why can capturing methane from waste help the climate?

- A. Burning methane produces no CO₂.
- B. It guarantees that no gas ever leaks.
- C. It can prevent methane escaping while providing useful energy.

Talk it through: Name two ways your imaginary town could receive electricity after sunset on a calm day.

Teacher answers & guidance

- 1. B.** Electrification replaces a job done by burning fuel with a job done using electricity. Lower-carbon electricity increases the climate benefit.
- 2. C.** A heat pump moves existing heat. The electricity powers its compressor and other components.
- 3. A.** These four approaches work together. No single option removes every reliability challenge.
- 4. B.** Storage shifts energy through time. It has limited capacity and loses some energy during the process.
- 5. A.** Hot geothermal water carries underground heat to the surface. A heat exchanger transfers it to a separate working-fluid circuit.
- 6. C.** Methane is a powerful greenhouse gas. Capture can reduce releases, but burning it makes CO₂ and leakage must be controlled.

Using the illustrations. Compare moving heat (heat pump), recovering energy from waste methane, generating low-carbon electricity and using deep geothermal heat. Ask pupils to identify which diagrams involve burning a gas and which do not.

Keep the distinctions clear. The supplied book illustration is simplified: the ground liquid stays liquid; a separate refrigerant evaporates and condenses inside the heat pump. Ground temperatures and efficiency vary. Methane capture is not emission-free; the geothermal chart also simplifies machinery.

Challenge answer. Possible answers: a charged battery; pumped storage with water available; imports from another region; suitable hydro, nuclear or geothermal generation. Safely delaying flexible electricity use can also help.

Sources & artwork

IEA: Energy Efficiency 2024

IPCC AR6 WGIII: Energy Systems

GEL Energy: United Downs Geothermal Powerplant

Illustrations 2.4 and 4.4 are extracted from Book Layout v8 - FINAL MASTER. The heat-pump image is the Chapter 15 artwork supplied by Graham Davies. The geothermal chart is derived from the Series 2 Episode 2 video poster. Artwork prepared with OpenAI tools under Graham Davies's direction; episode content follows the Series 2 script PDFs.