Towards a digital society: heating or cooling the climate?

Sustainable Cooling of Data Centres

Presentation by Ray Gluckman

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Gluckman Consulting
specialists in refrigeration and climate change

Presentation Contents

- Cooling efficiency:
  - a step-by-step approach to sustainable cooling of data centres
- Understanding key efficiency issues
  - free cooling and heat load reduction
  - the significant impact of “temperature lift”

Step-by-step journey to minimise cooling energy

Minimise the cooling demand

Free cooling

More efficient IT systems

Minimise the Temperature Lift

Cool at highest possible temperature

Use efficient heat transfer systems

Maximise system efficiency

Cycle design

Better heat exchange

Better compressors, fans, pumps

Good operation and control

Control of IT equipment

Control and maintenance of cooling systems

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Some Key Principles

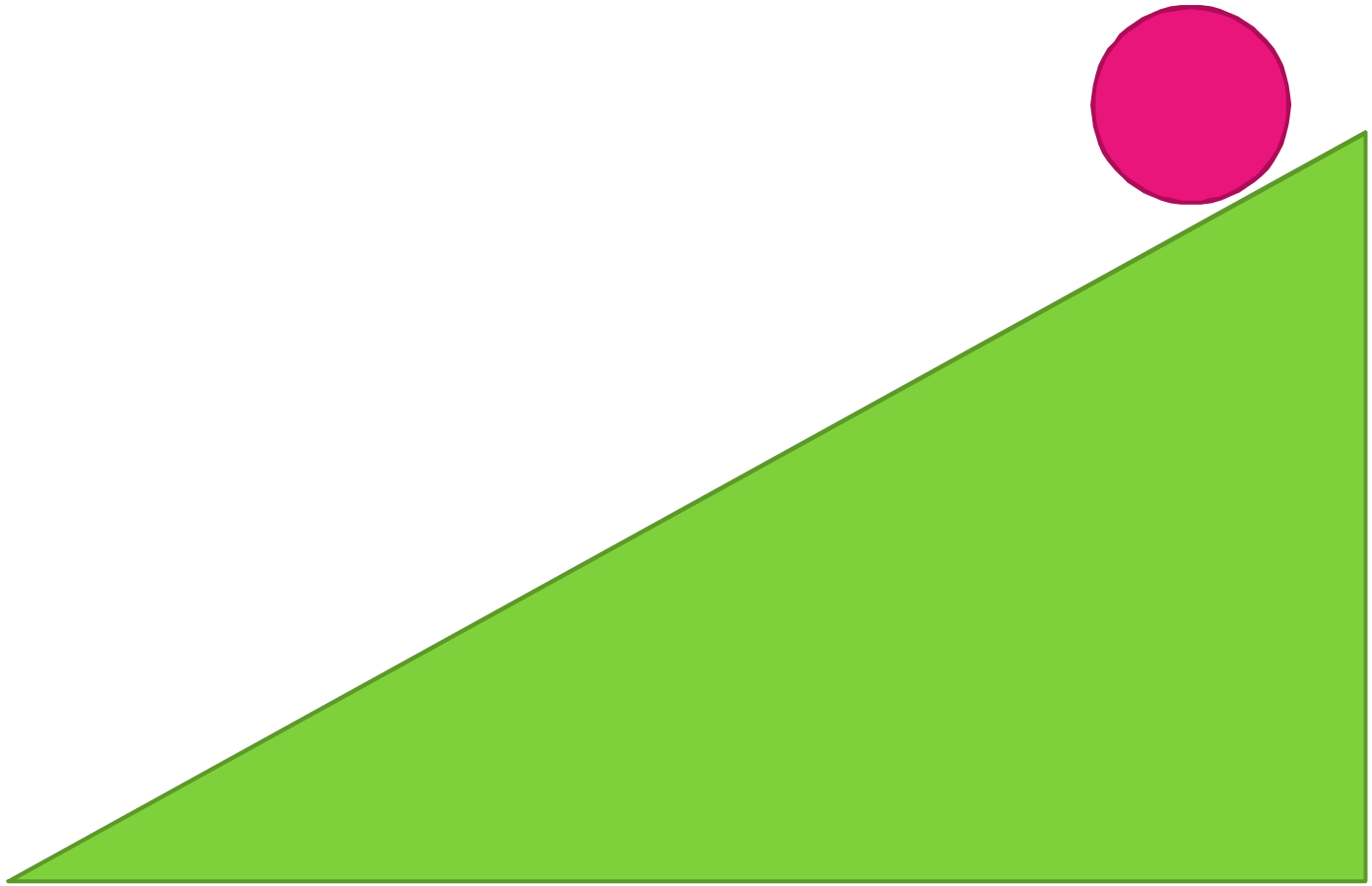
The "Thermodynamic Mountain"

Free cooling

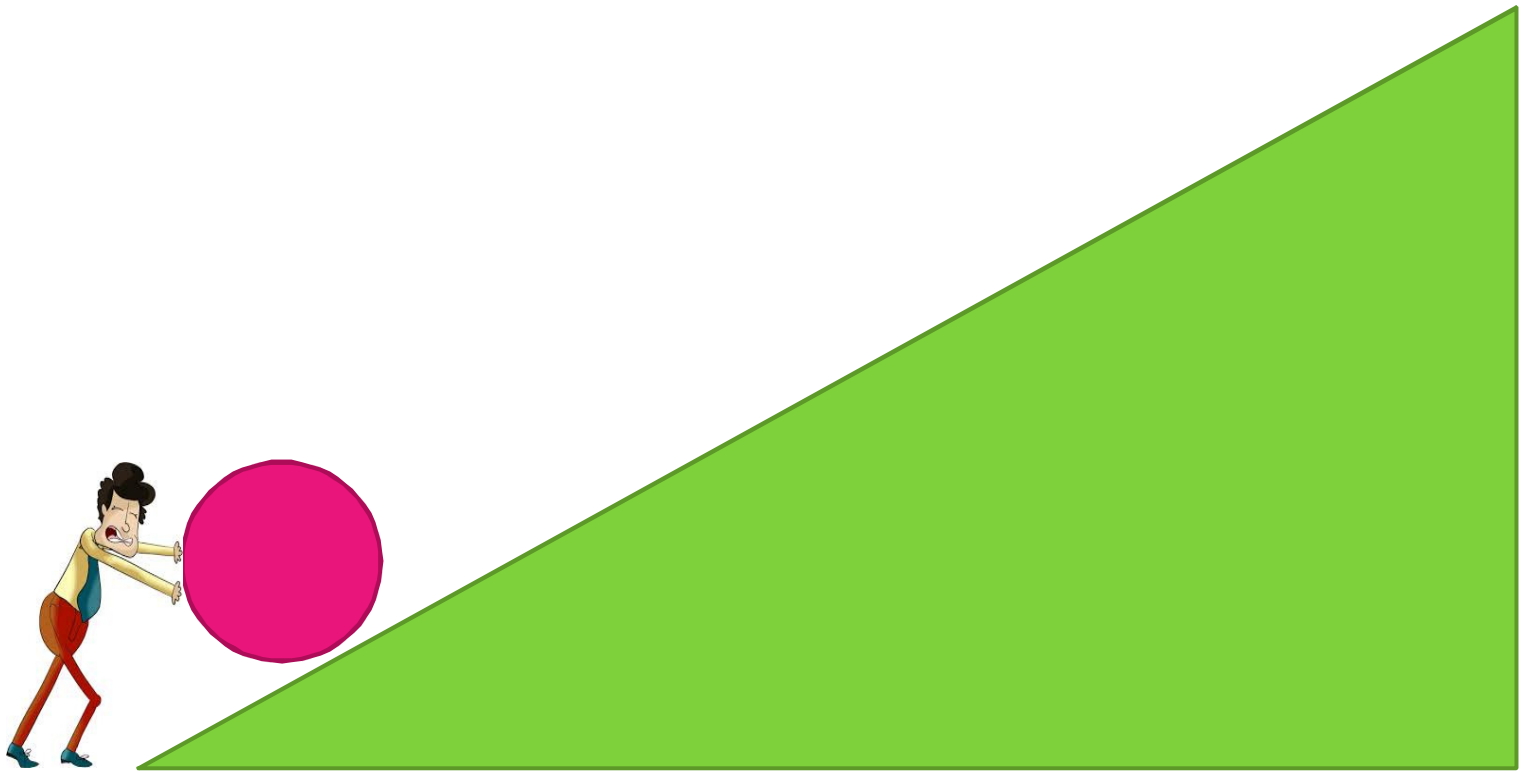
Minimise Heat Load

Minimise Temperature Lift

Moving a weight downhill is easy



Moving it back up the hill requires energy



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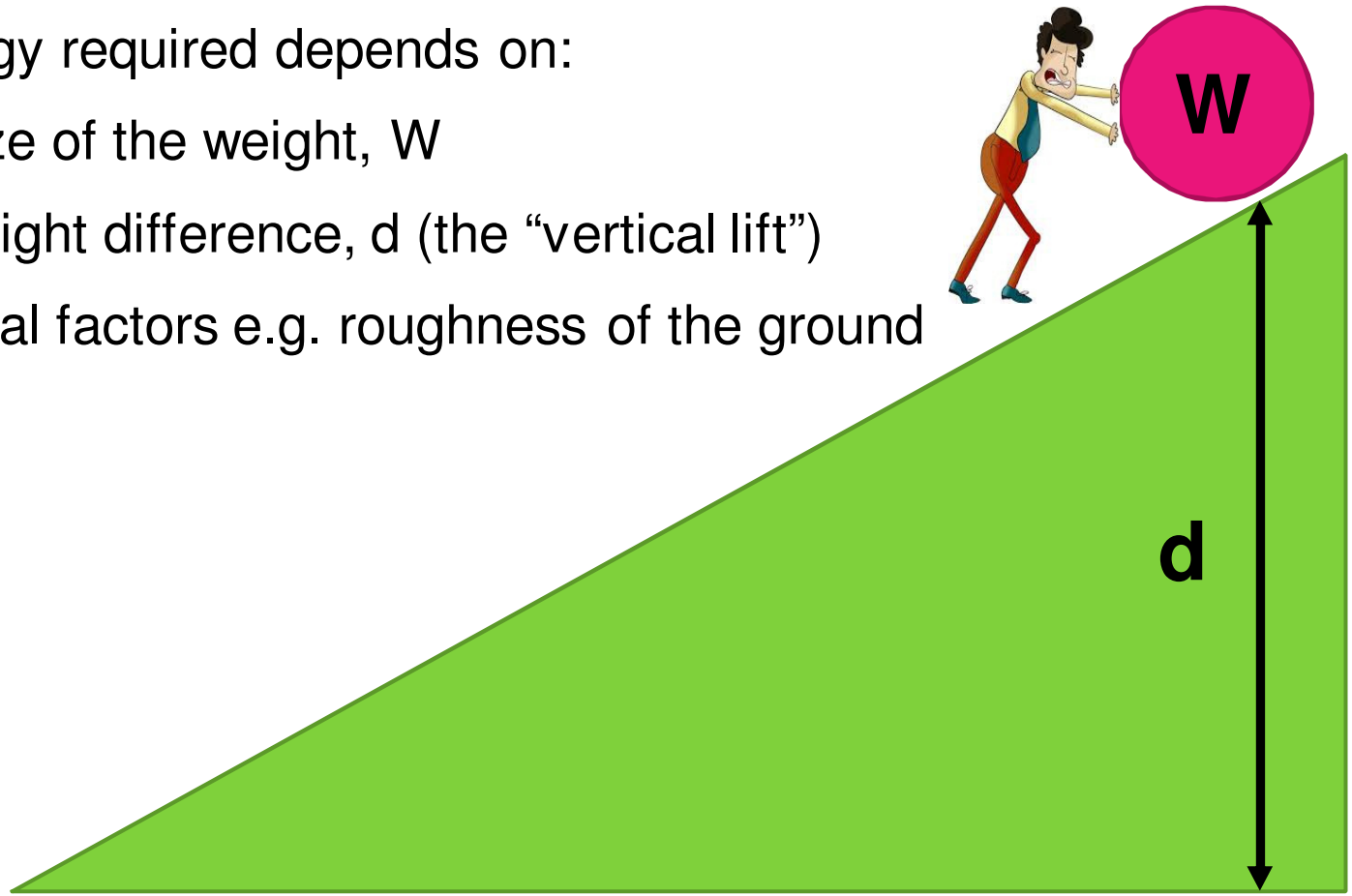
Moving it back up the hill requires energy

The energy required depends on:

1. The size of the weight, W
2. The height difference, d (the “vertical lift”)
3. Practical factors e.g. roughness of the ground

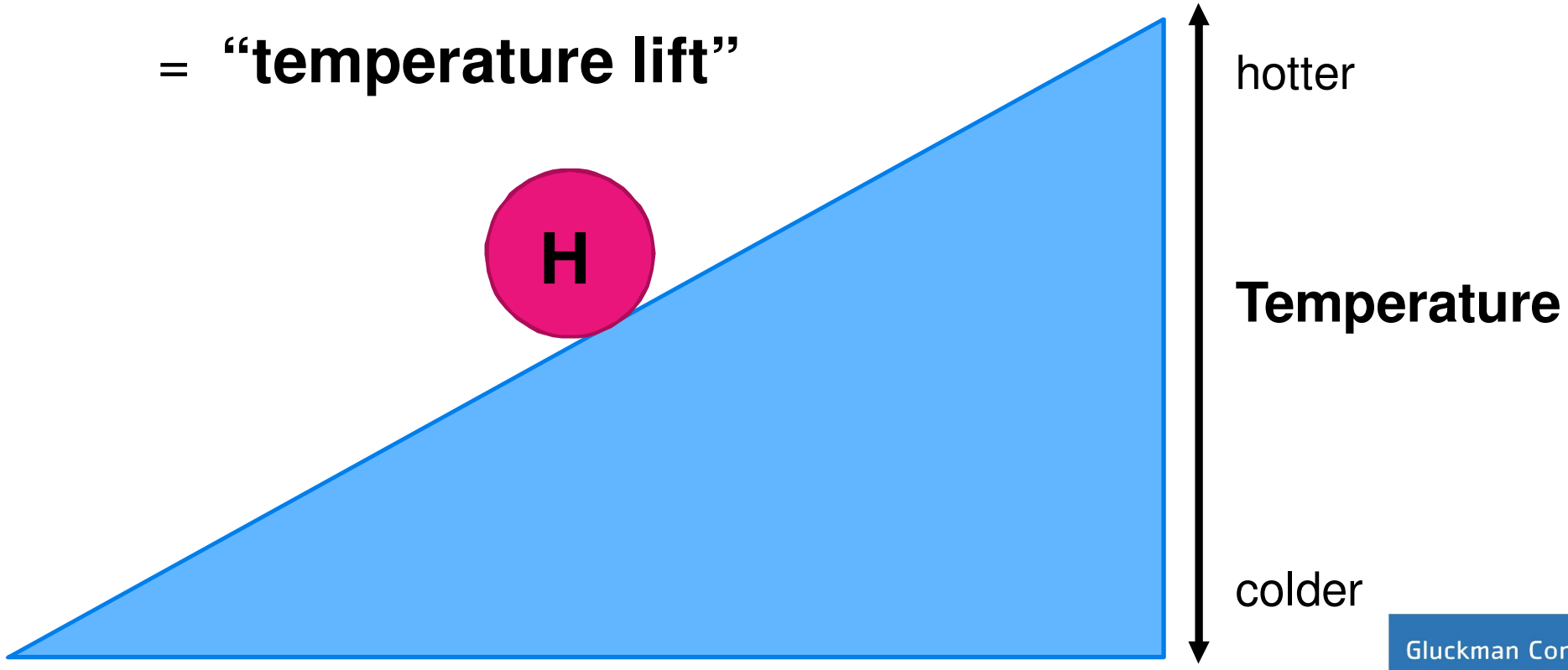


Refrigeration: moving heat on a “thermodynamic mountain”

Weight = a quantity of heat we need to move

Vertical lift = temperature we need to move it through

= **“temperature lift”**



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If a colder heat sink is available, cooling is free (heat “rolls downhill”)

e.g. tow an iceberg to a warm city for air-conditioning

- not realistic or sustainable for many cooling requirements
- but important in data centres

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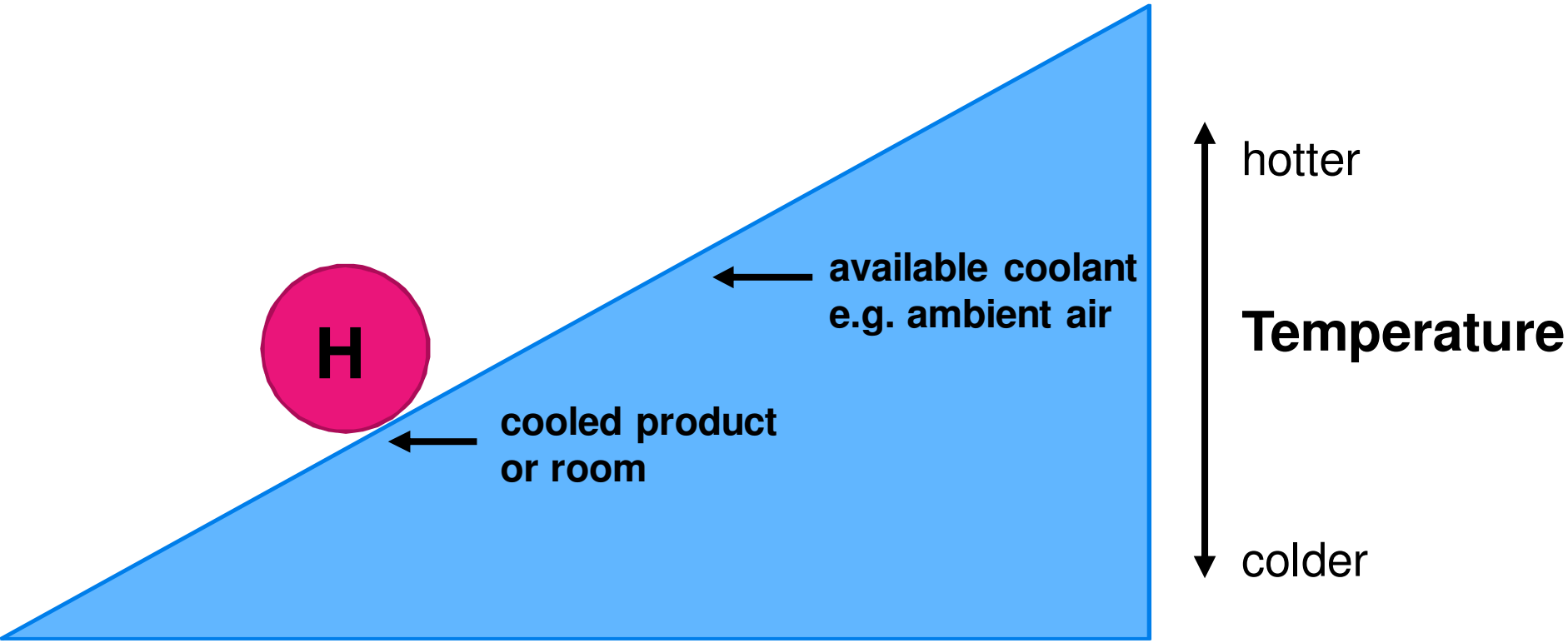
Must maximise “free cooling” opportunity

- using ambient air for free cooling
- data centres in cold climates
  - ambient air cold enough all of the year
- data centres in warm climates
  - conventional designs: is ambient air too warm?
- BUT, we are cooling IT equipment (not comfort cooling the staff)
  - operate at a higher temperature – more free cooling

Many cooling applications – heat has to move “uphill”



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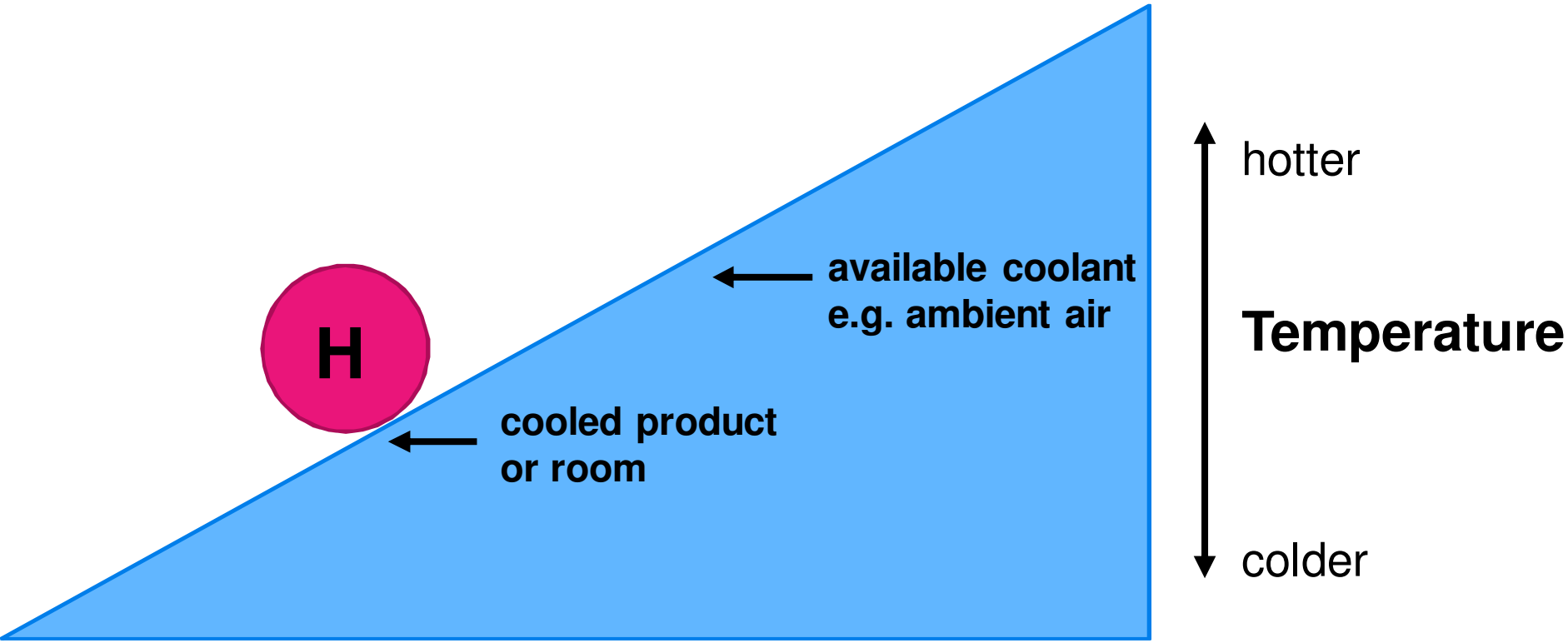
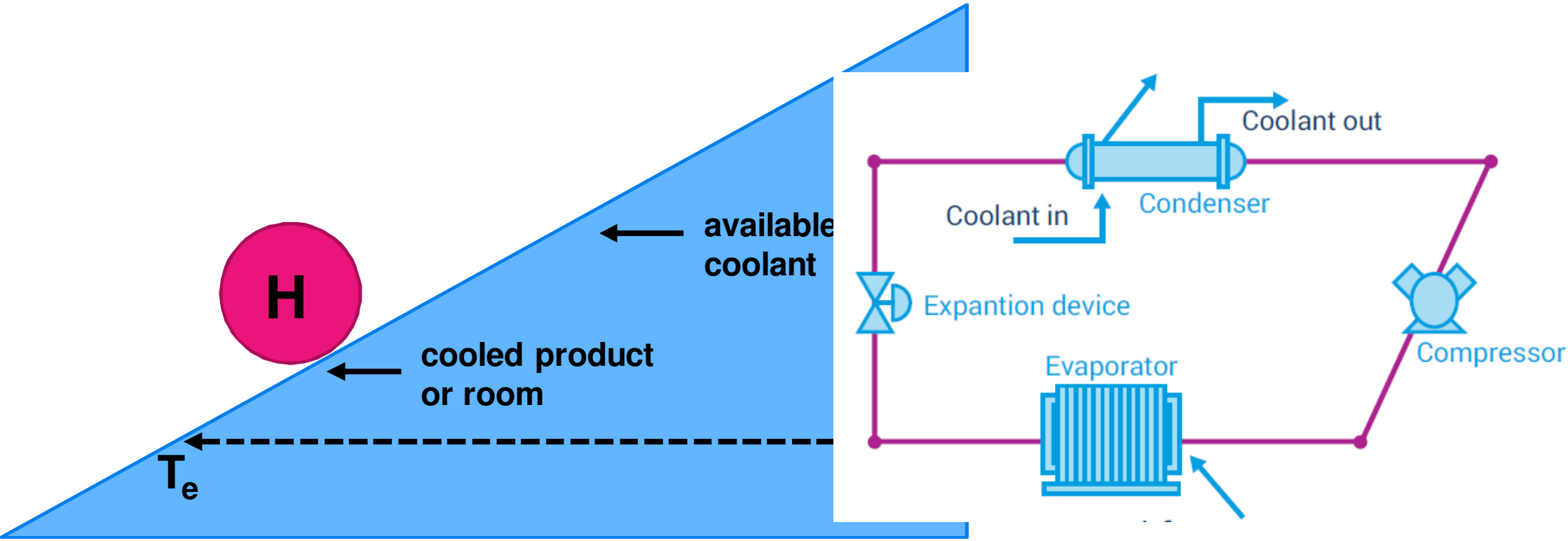


How is the heat moved “uphill”?



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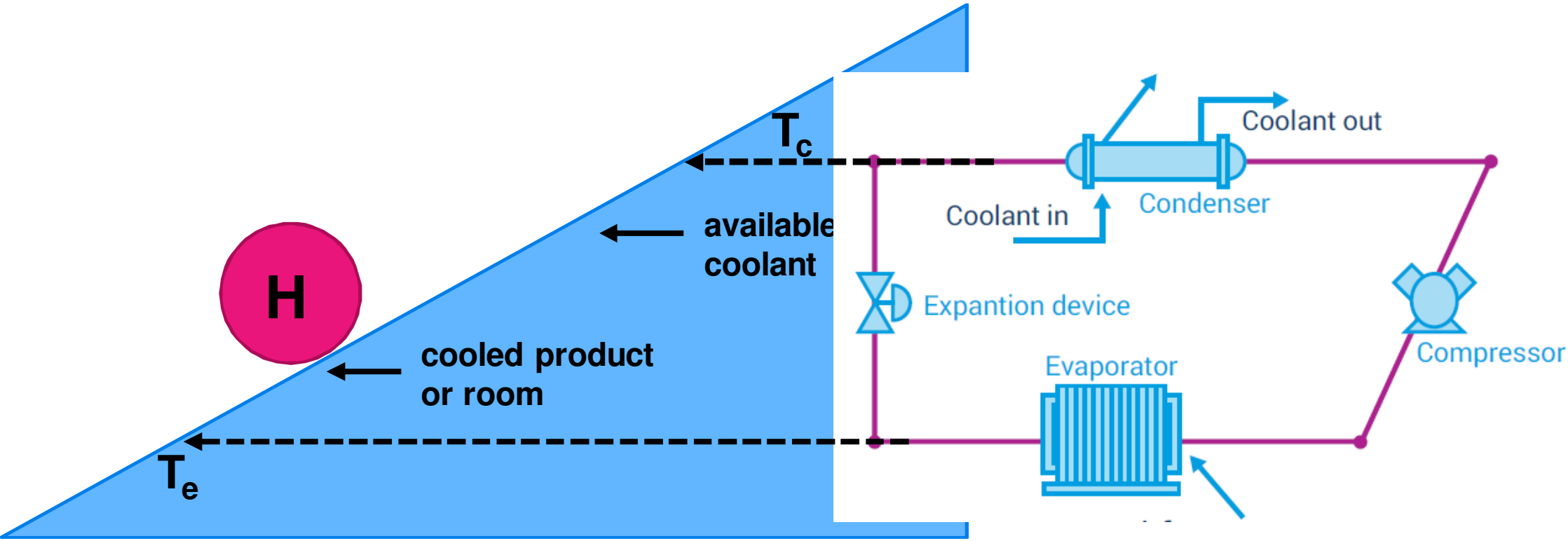

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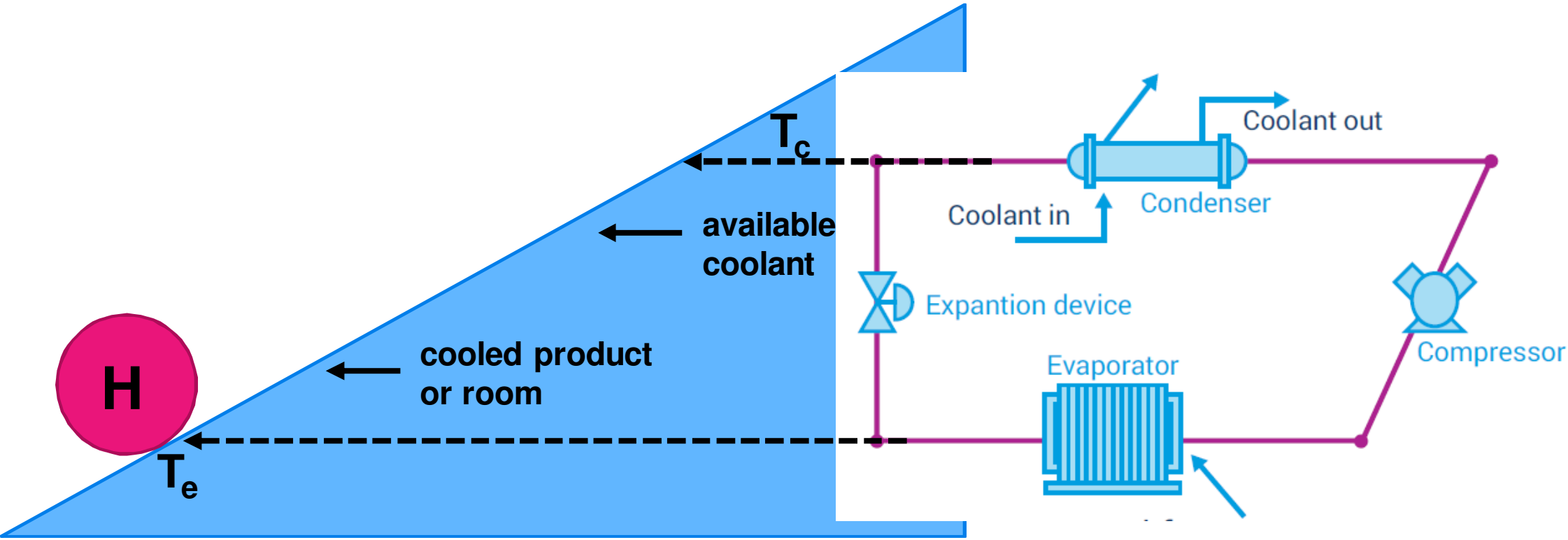

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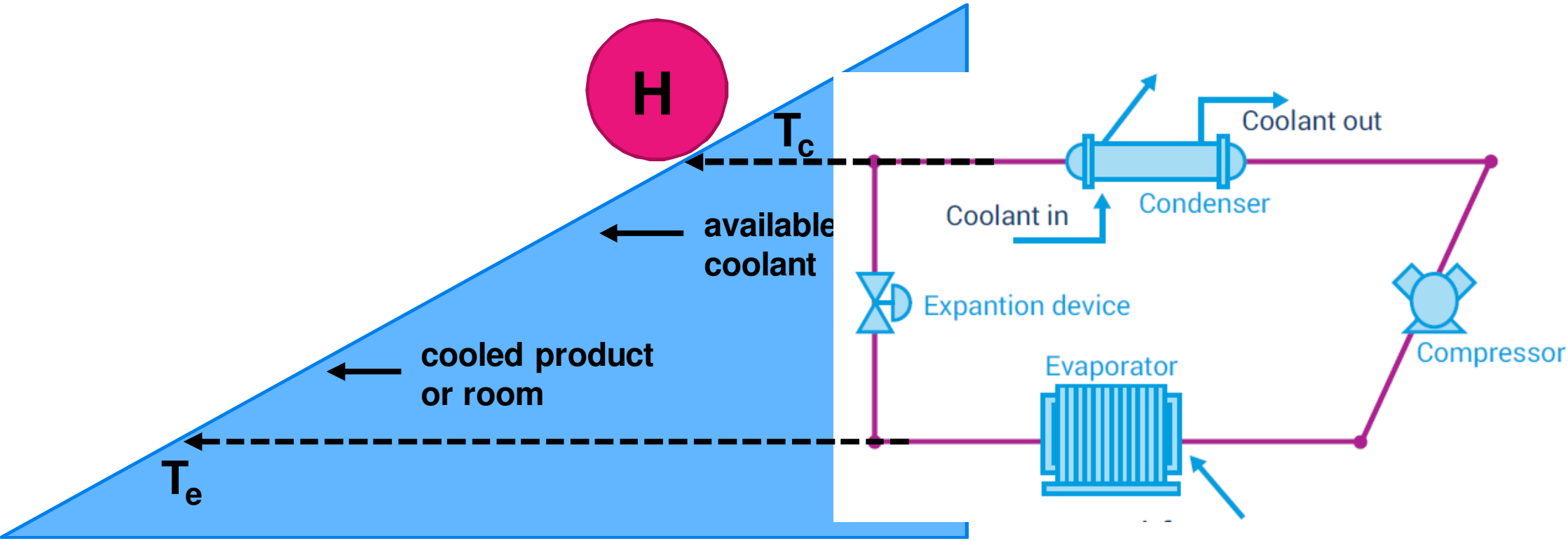
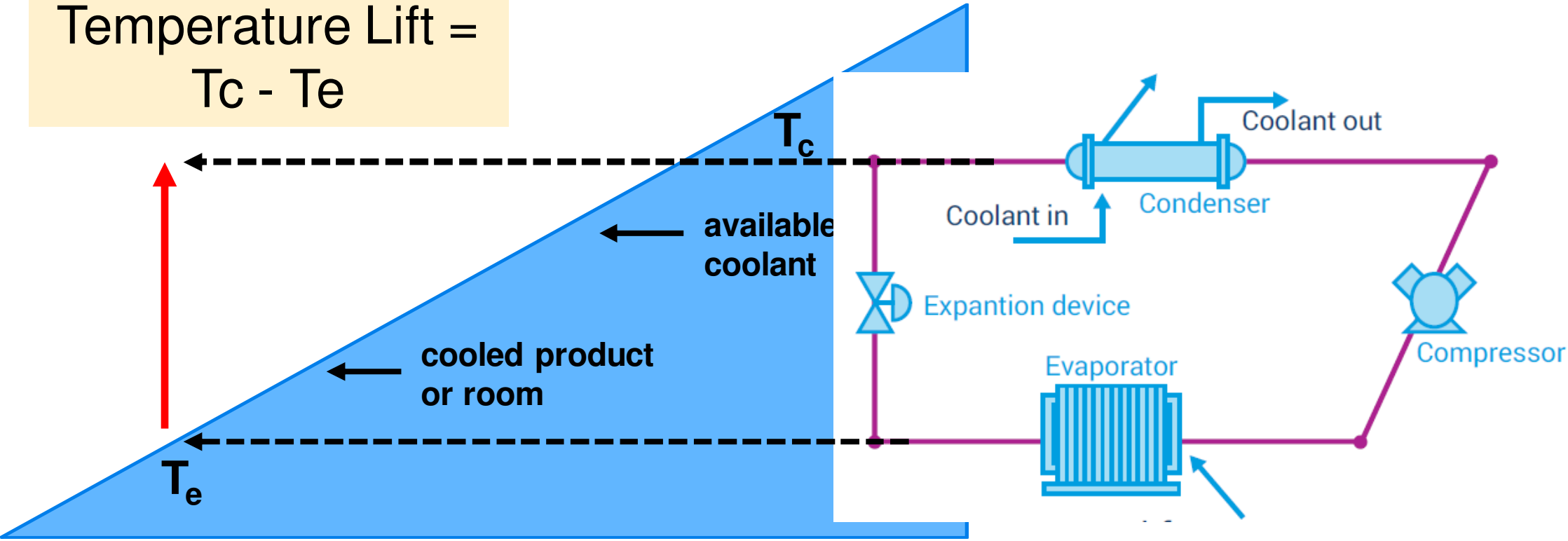


How is the heat moved “uphill”?

Temperature Lift =
Tc - Te



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Why is temperature lift so important?

- Cooling efficiency is VERY sensitive to temperature lift
- just 1 degree C of extra lift:
  - leads to 3% to 5% increase in data centre cooling energy consumption
- it is very easy to create many degrees C of unnecessary temperature lift
  - through poor design
  - through poor operation
  - incorrect control settings

Steps to Minimise Cooling Energy Consumption

1. **Minimise the heat load** e.g.
   - free cooling
2. **Minimise the temperature lift** e.g.
   - operate at a higher temperature
   - minimise heat exchanger temperature differences
3. **Maximise system efficiency** e.g.
   - cycle design, component design
4. **Good operation and control** e.g.
   - IT system control
   - cooling system control and maintenance

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