



U.S. DEPARTMENT OF ENERGY  
**SOLAR DECATHLON**

2011

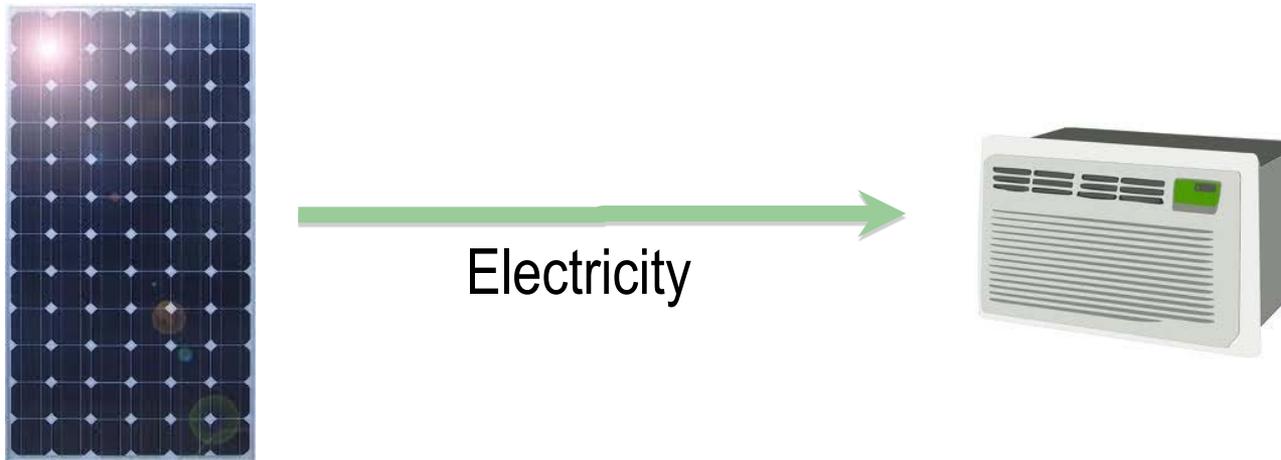
# Solar Cooling

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## Solar powered cooling

- Connect solar **electric** panels to an air conditioner



- Solar **heating** panels can also power air conditioning!



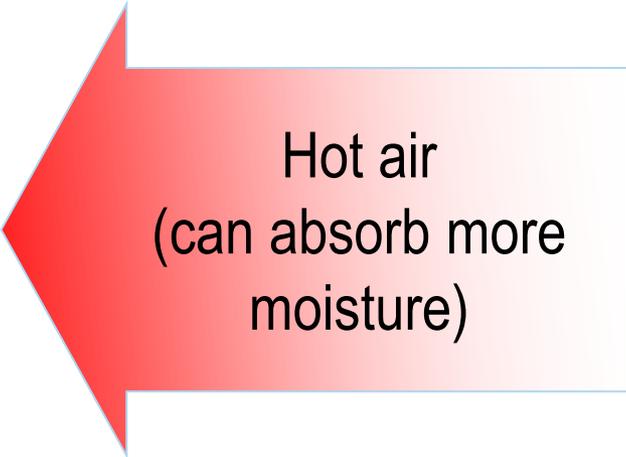
# The importance of [solar] dehumidification

- “Its not the heat, it’s the \_\_\_\_\_”
- Air conditioning cools indoor air by lowering its temperature AND by removing humidity from the air
- Solar dehumidification uses solar generated heat to power a dehumidifier to remove the humidity from indoor air
- This reduces the amount of grid-supplied electricity needed for air conditioning

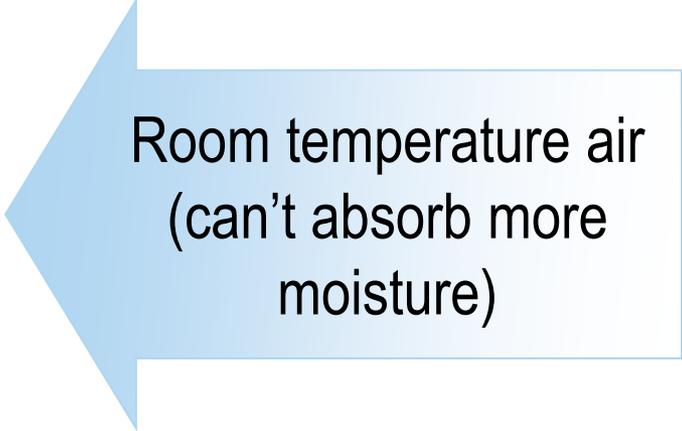


## How solar powered dehumidification works

- Warm air holds more humidity per volume than cool air
- A hair dryer uses heat to dry and “dehumidify” your hair



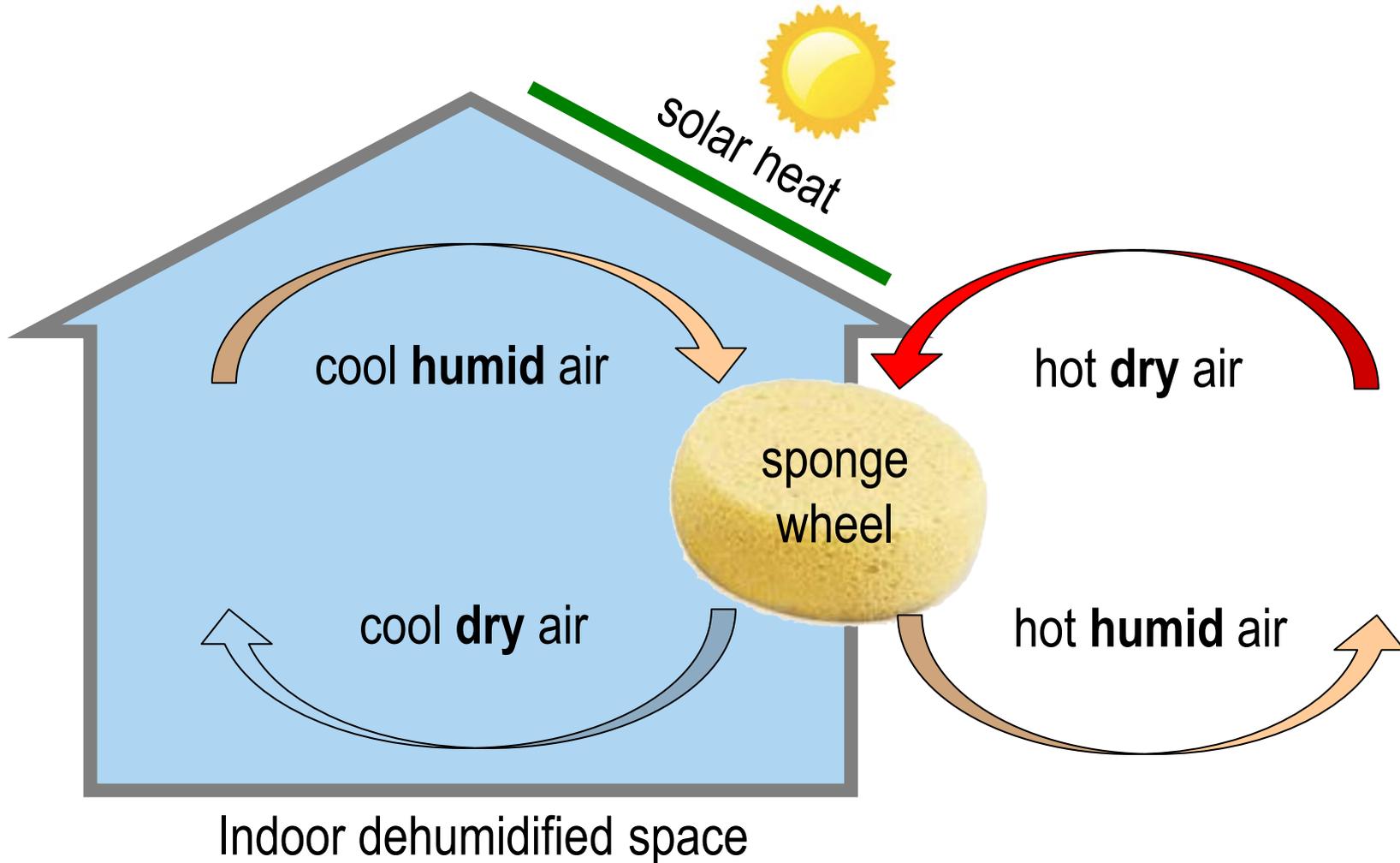
Hot air  
(can absorb more  
moisture)



Room temperature air  
(can't absorb more  
moisture)



# How solar dehumidification works





## Back to solar powered cooling

- **Electricity** from solar panels can power air conditioning



- In reality, **energy** can power air conditioning



- This **energy** can be **heat** energy instead of electricity

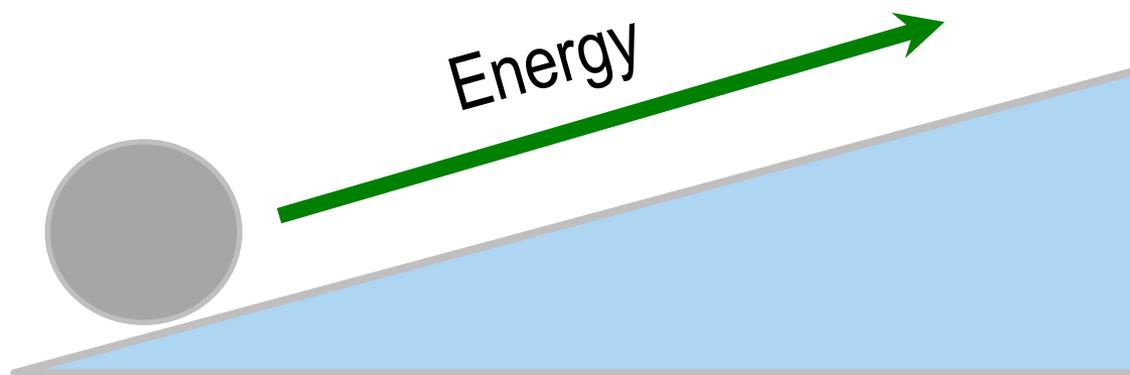


# Brief introduction to Thermodynamics

- The First Law, applied to air conditioning:
  - Energy can be neither created nor destroyed. It can only change forms.
  - An air conditioner doesn't just produce "cooling," it moves heat energy from cooler indoors to warmer outdoors
- The Second Law, applied to air conditioning:
  - Heat energy flows from a hotter object to a colder object
  - An air conditioner requires energy to move heat from cooler indoors to warmer outdoors



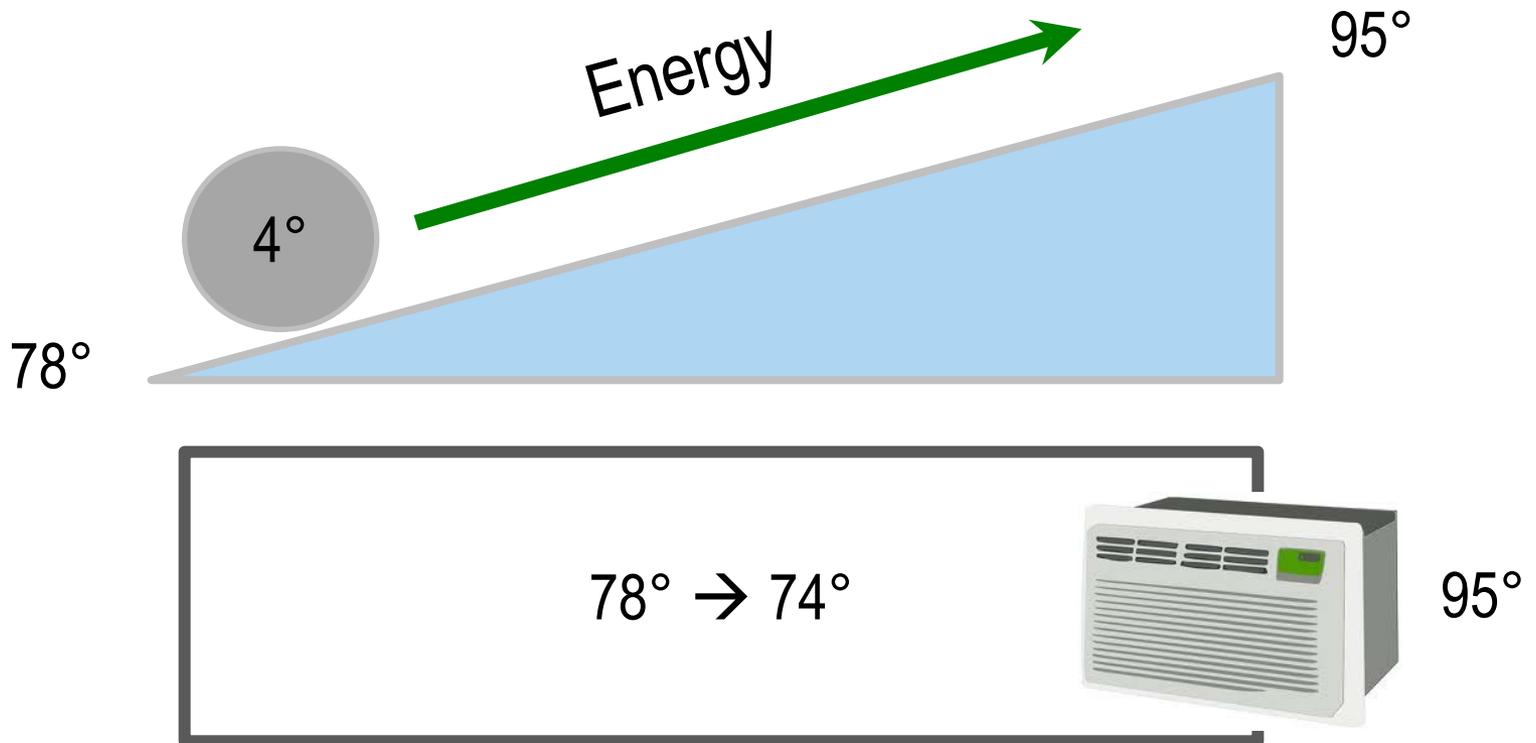
## It's like gravity



**Energy** is required to move a ball up a hill



## It's like gravity



Moving heat from a cool room to the warmer outdoors is like rolling a “heat ball” uphill – it takes **energy**.



## How do we move the 'heat ball' uphill?

- We take advantage of how a liquid absorbs heat when it changes into a gas, and releases heat when it changes back to a liquid
- A can of compressed air gets cold when you spray it
  - The “air” inside is actual a liquid
  - When you spray air out the **pressure** in the can drops and some liquid **evaporates** into a gas
  - This **absorbs** heat, making the can **colder**
  - This is how the **evaporator** in an air conditioner works





# How do we move the 'heat ball' uphill?

A bike pump gets hot as you pump up a bike tire

- As air is compressed it gets **hotter** and its **pressure** gets higher
- Compression requires **energy**
- If the air were pumped to high enough **pressure**, and then allowed to **release** heat and **cool off**, some of the air **condenses** into a liquid
- This is how the **compressor** and **condenser** in an air conditioner work



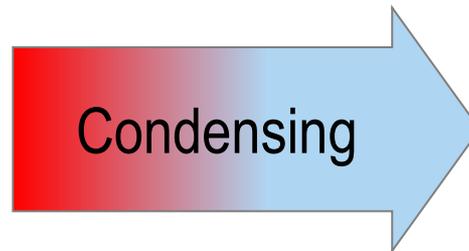


## How do we move the 'heat ball' uphill?

- We take advantage of how a liquid absorbs heat when it changes into a gas, and releases heat when it changes back to a liquid
- Now we put both processes together



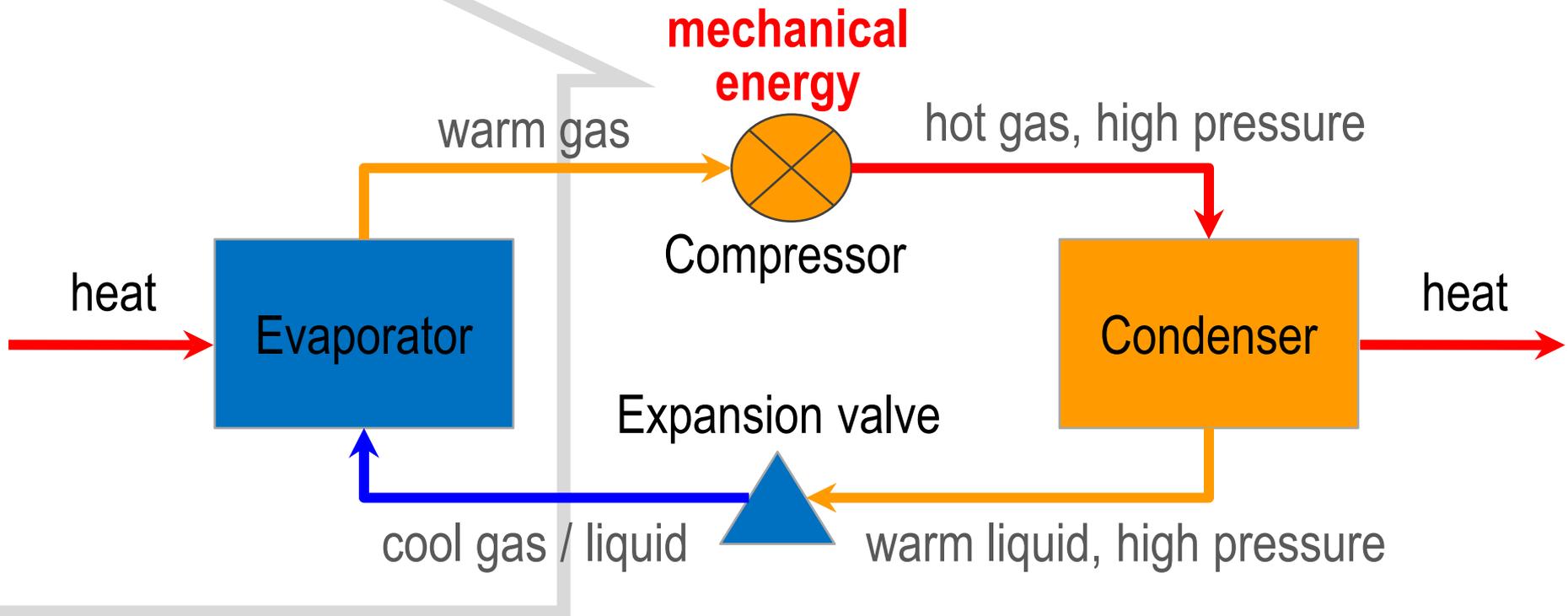
Compressing  
(needs energy)



Evaporating



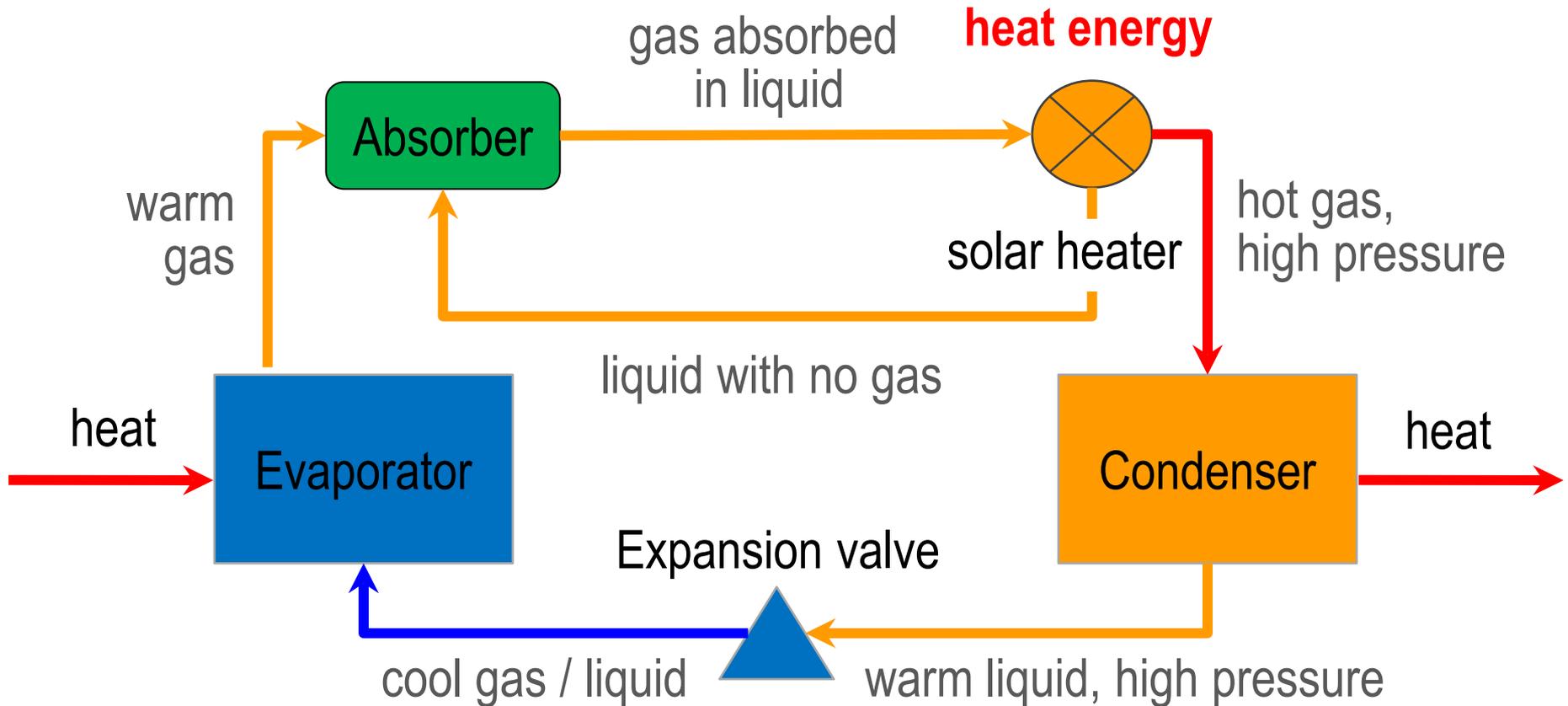
# Air conditioners use mechanical energy to move the 'heat ball' uphill



The expansion valve causes the warm **liquid** to change into a mix of cool **gas** and **liquid** by reducing the **pressure** of the warm **liquid**



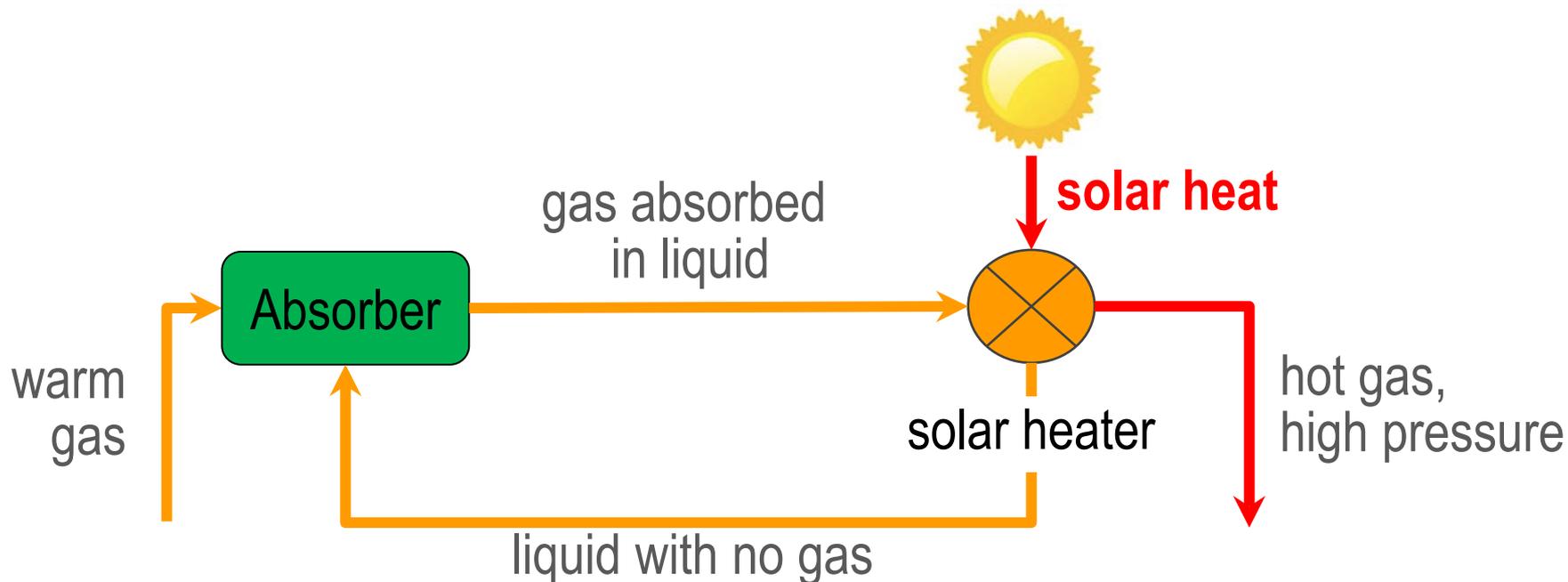
# How do we power air conditioning with heat?



Replace the **compressor** with an **absorber** and **heater**



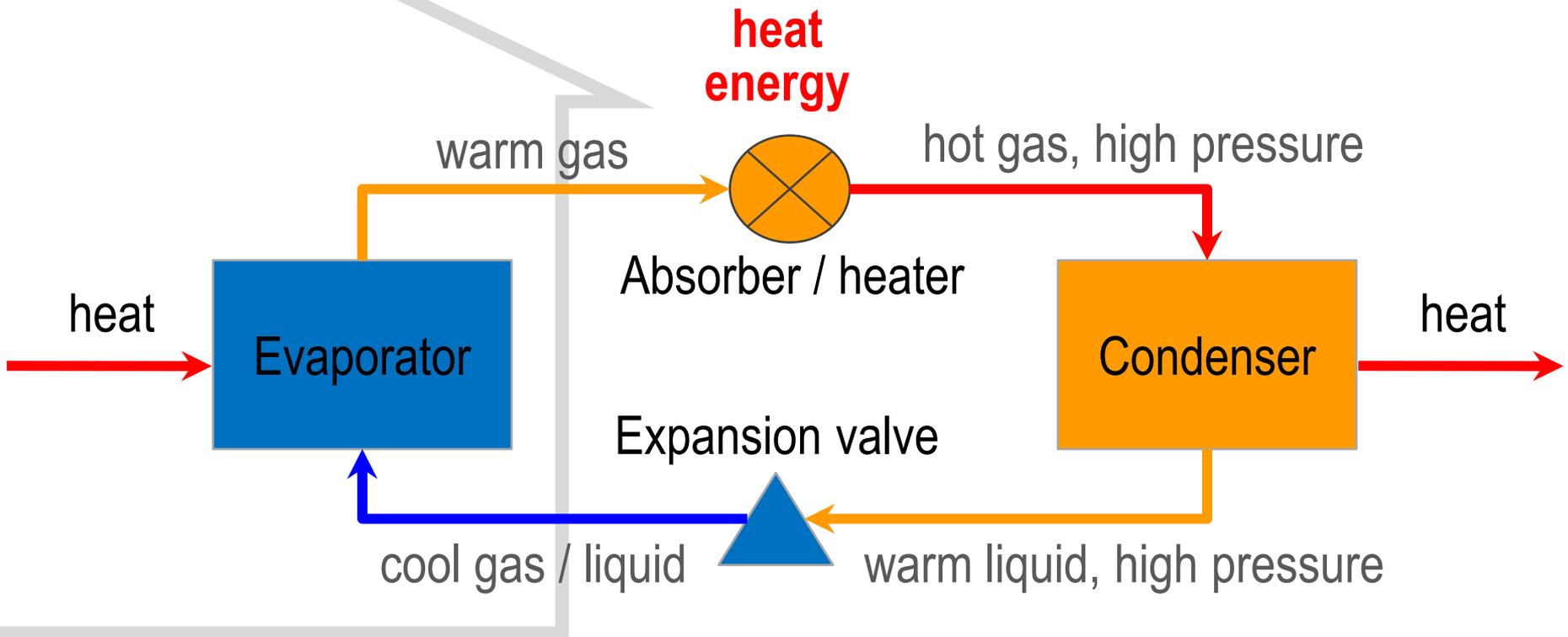
# How do we power air conditioning with heat?



The absorber is like a “liquid sponge” that absorbs gas – the solar heater “boils” the gas out of the liquid similarly to how a warm soda goes flat quickly



# How do we power air conditioning with heat?



The **compressor** is replaced by the **absorber/heater**, which uses **heat energy**



## Solar cooling benefits

- Solar cooling, when integrated into a solar water heating system, provides both efficient hot water and air conditioning
- Solar dehumidification can help reduce the load on electrical air conditioners
- Solar energy is available during times of peak air conditioning demand



# Thank You

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