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Energy Recovery: How Do We Fully Use the Resources We Are Currently Consuming

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Which is which?

- Energy Recovery
- **Heat Recovery**
- ENERGY EFFICIENCY
- **ENERGY CONSERVATION**

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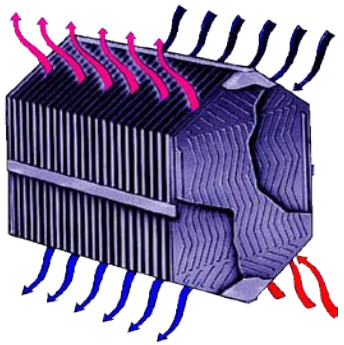
Quick Look

- **Energy Recovery**
  - Any technique or method minimizing input of energy to an overall system by exchanging energy from one sub-system system with another
  - Energy can be in any form, in either subsystem
    - Most energy recovery systems exchange thermal energy in either sensible or latent form

Quick Look



- **Heat Recovery**
  - Example:
    - Heat recovery ventilation (HRV)
      - Provides fresh air and improved climate control, while also saving energy by reducing the heating (or cooling) requirements
    - Energy recovery ventilators (ERVs) are closely related
      - ERVs also transfer the humidity level of exhaust air to intake air

Quick Look

- ENERGY EFFICIENCY
  - Using less energy – providing same level of energy service
    - Example I: insulating allows a building to use less heating and cooling energy to achieve and maintain a comfortable temperature
    - Example II: Installing fluorescent lights and/or skylights instead of incandescent lights to attain the same level of illumination

Quick Look

- **ENERGY CONSERVATION**
  - Efforts made to reduce energy consumption to preserve resources for the future
  - Achieved through increased efficient energy use
    - With decreased energy consumption and/or reduced consumption from conventional energy sources
  - Energy conservation **can** result in:
    - Increased financial capital
    - Environmental quality
    - National security
    - Personal security
    - Human comfort

Ground Source

- Several concepts attached idea of geothermal:
  - Ground Source Heating – methods of using the ground in a heat pump to warm & cool a system close to the average surface temperature of a location
  - Geothermal Power – generation of electricity from rocks much hotter than the average annual temperature.
  - Geothermal Heating – using “rocks” much hotter than the average annual temperature to heat directly

Geothermal

- Under the right circumstances…
- Cost effective, reliable, sustainable, and environmentally friendly
  - Historically been limited to areas near tectonic plate boundaries
  - Recent advances expanded range and size of viable resources

Geothermal and Other Thermal Sources

- O&M, most likely not able to use, but always think of options
  - Especially on retrofits and expansions
    - Wells
    - Heat sinks
    - Trombe wall
    - Thermal mass

Left Over Energy in Chillers

- We send a huge amount of heat energy to the atmosphere through cooling towers

Note: we **send** every BTU collected in buildings

- Also add another 25% in compressor and accessory work
- Must find a way to reclaim that energy and use it

Chillers

- Example: Recovering Energy from Chillers
- Breakdown of typical chiller system
  - Chiller – 38%
  - Pumps – 12%
  - Fans – 48%
  - Towers – 2%

Best Practices for Efficient Operation

- Operate multiple chillers for peak efficiency
- Raise chilled-water temperature
- Establish a chilled-water reset schedule
- Reduce condenser water temperature
- Purge air from refrigerant
- Optimize free cooling
- Verify Performance of hot-gas bypass and unloader
- Maintain refrigerant level
- Maintain daily log

Other Recovery:

Rainwater Runoff

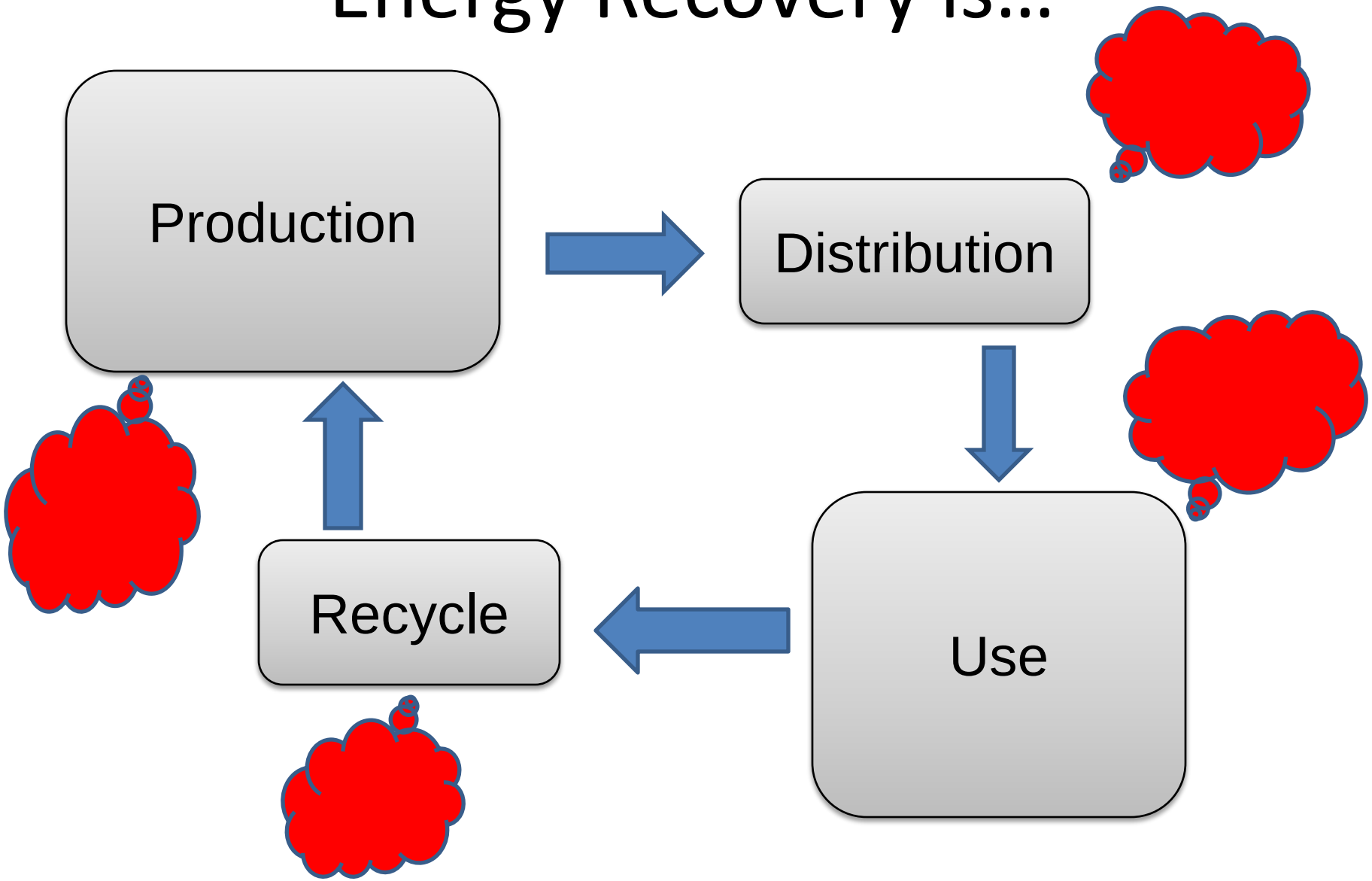
- Surface runoff
- Two savings:
  - Environment – erosion
  - Energy
- Four types of erosion:
  - Splash erosion
  - Gully erosion
  - Sheet erosion
  - Stream bed erosion

Rainwater Runoff-Energy

- Great source of recovered energy
  - Electrical savings – Limited or no pumping
  - Issue of runoff from hardscape
  - Savings – not purchasing water
  - Savings – not processing water to sewer of streams
  - Possible heat sink via storage pond

  - Let's think about this from the facility mangers' perspective…*

Energy Recovery is…



From an O&M perspective…

- Limited Budgets
- No control over capital improvements
- "Just keep it running"

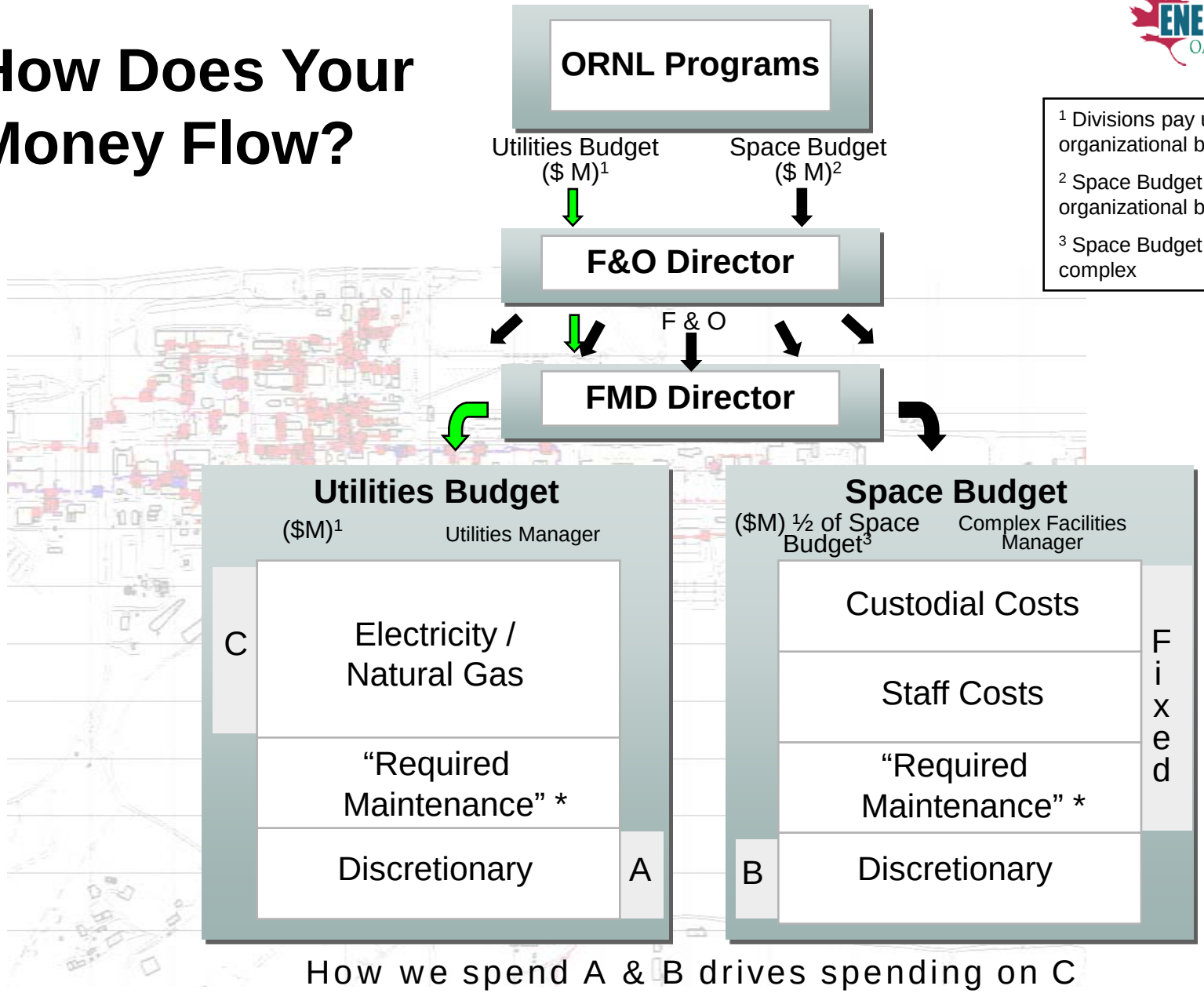
- Reliable or Efficient – Choose?

- What's in it for me?

Commissioning

- New Buildings – Commissioning Agent
- Older Buildings – Recommissioned or RetroCommissioned?
- Are your systems working as intended?
- Are your systems working TOGETHER?

How Does Your Money Flow?



[1] Divisions pay utilities in organizational burden

[2] Space Budget to organizational burden

[3] Space Budget divided by complex

How we spend A & B drives spending on C

Project Justification

- “All Costs are Real Costs”
- Who’s pocket has the money?
- Figure simple savings
- Get Buy-in from the Money People

*

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Steam-left over heat

- Steam usually generated for one of two reasons:
  - To produce electrical power, for example in power stations or co-generation plants
  - To supply heat for heating and process systems

Steam and left over heat

- Kilogram of steam condenses completely
- Kilogram of condensate formed at same pressure and temperature (Figure 1)

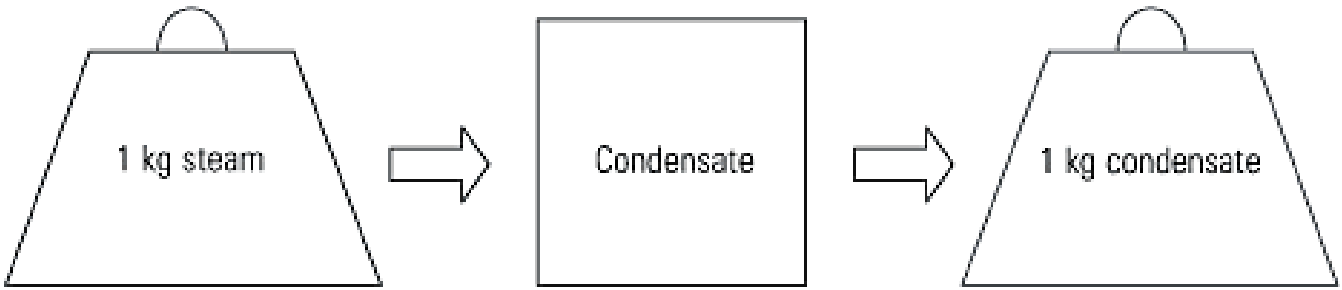

Figure 1—1 kg of steam condenses completely to 1 kg of condensate

Steam-left over heat

- An efficient steam system will reuse this condensate
- Failure to reclaim and reuse condensate makes no financial, technical or environmental sense

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Steam-left over heat

- Saturated steam used for heat gives up its latent heat (enthalpy of evaporation), which is a large proportion of the total heat it contains.
- Remainder of heat in steam is retained in condensate as sensible heat
  - Enthalpy of water (Figure 2)

Steam-left over heat

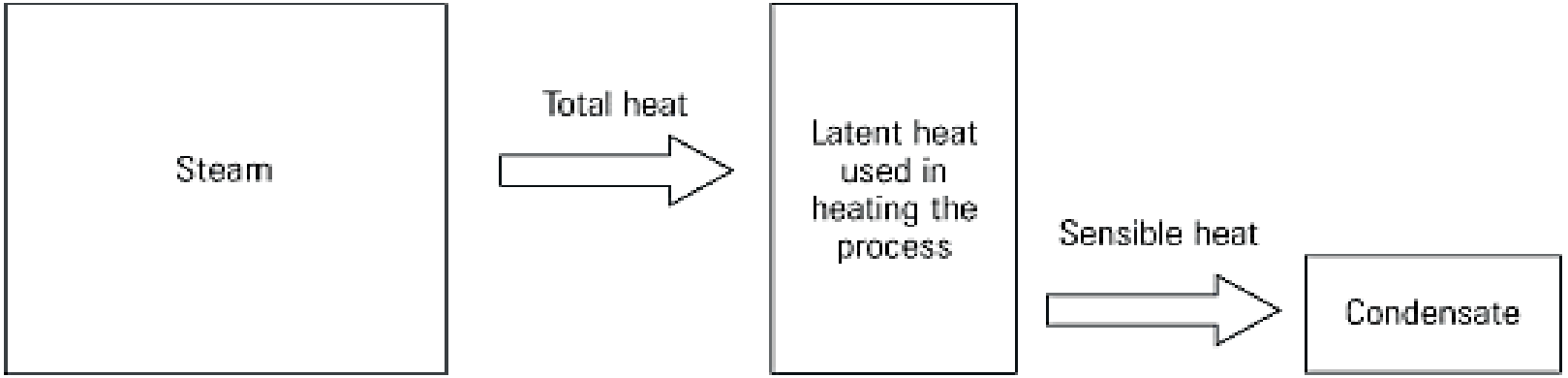


Figure 2

- After giving up its latent heat to heat the process, steam turns to water containing only sensible heat

Steam-left over heat

- When a liquid evaporates its go through a process where
  - Liquid heats up to evaporation temperature
  - Liquid evaporates at evaporation temperature by changing state from fluid to gas
  - Vapor heats above evaporation temperature - superheating

Steam-left over heat

- As well as having heat content, the condensate is basically distilled water, which is ideal for use as boiler feedwater.
- An efficient steam system will collect this condensate and:
  - Return it to a deaerator
  - Return it to a boiler feedtank
  - Use it in another process

* Use in justifying condensate return system

Condensate: When NOT to use it

- **Only** when there is a real risk of contamination should condensate not be returned to the boiler
- Note:
  - Even then may be possible to collect condensate and:
    - Use it as hot process water
    - Pass it through heat exchanger

  where its heat content can be recovered before discharging the water mass to drain.

Steam-left over heat: Condensate return

- Effective condensate recovery system
  - Collecting hot condensate from steam using equipment and returning it to boiler feed system, can pay for itself in a remarkably short period of time.
- Figure 4 shows a simple steam and condensate circuit, with condensate returning to boiler feedtank

Steam-left over heat: Condensate return

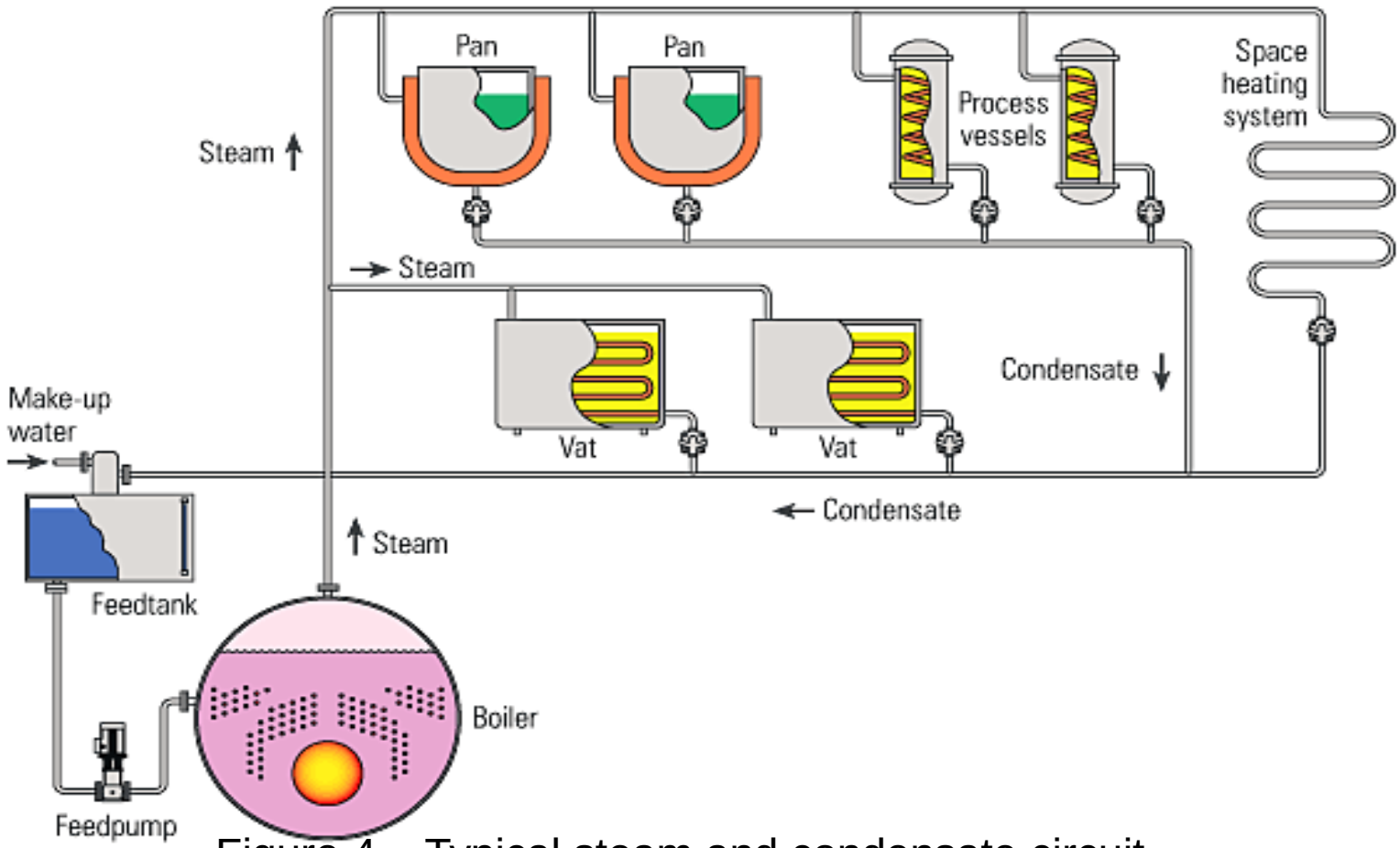


Figure 4 – Typical steam and condensate circuit

Why return and reuse condensate?

- Water charges are reduced
- Effluent charges and possible cooling costs are reduced
- Fuel costs reduced
- Boiler blowdown reduced
  - Less energy is lost from boiler
- Chemical treatment of raw make-up water reduced

Waste Recovery

- There are many ways we can capture excess energy – waste
  - Must look for it
  - Must be relentless in the pursuit of waste

*

Steam Systems

- Insulation
- Traps
- Pressure Reducing Stations
- Condensate Recovery

Insulation Issues

- Is the pipe really insulated or is it just covered?
- Weatherproof?
- Enough?

- IR imaging

Steam Traps

- Are they the right type?
- Are they sized correctly?

- Trap surveys are a must!
- Who does the survey?

- Who's got the money?

Lighting

- Daylighting
- Task Lighting
- Setbacks
- Controls

- How much?
- Where?
- When?

Electrical Systems

- Transformers
- Speed control for pumps and fans

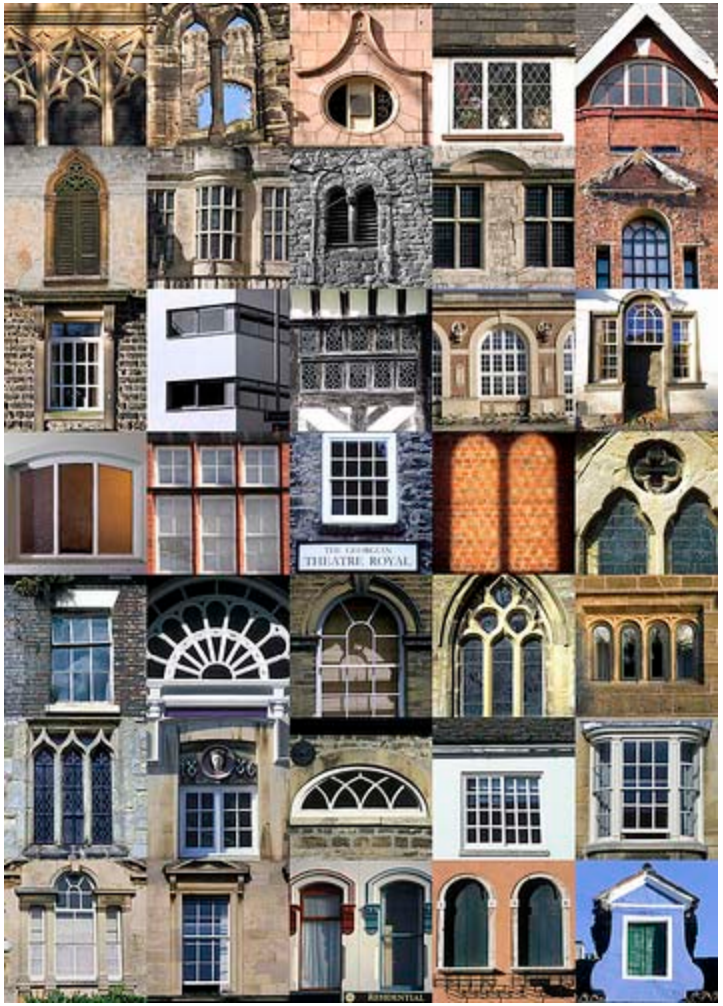
Roofing

- Cool Roofs
  - White Roofs
    - Green Roofs
- Thatched Roofs?!?!
- It’s all about insulation and reflection

What the heck is fenestration?

- Windows
- Doorways

- Air Infiltration
- Heat movement



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HVAC

- Supply Fans
- Exhaust Fans
- Chillers and Boilers
- Mixing Boxes
- Balance
- Building Automation Systems

HVAC Thoughts

- Constant Volume versus Variable Volume
- Variable Frequency Drives
- Simultaneous Heating and Cooling
- Filter Changes

Remember

- Understand the money system
- Everything works together – it's a process
- Have both a short term and a long term plan

Questions?