

# Low Temperature Workshop

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**U.S. DEPARTMENT OF ENERGY**

# Issues for Discussion

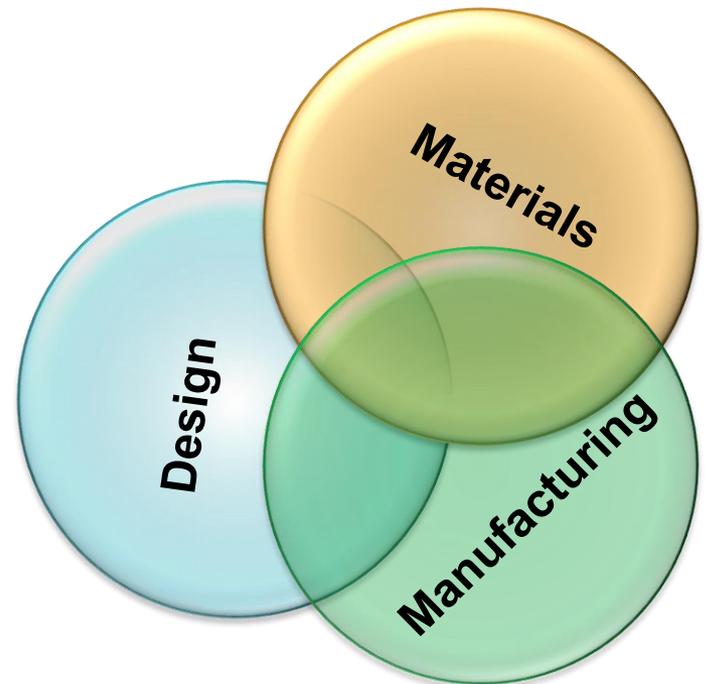
Enabling technologies (Heat exchangers and beyond)

Integration Opportunities in Buildings

Research priorities in low-temperature systems

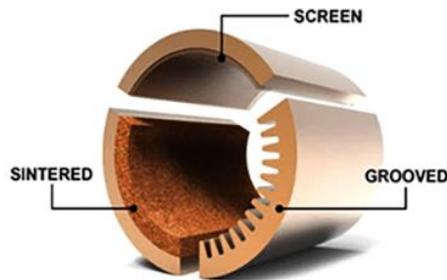
# Heat Exchangers (Enabling Technology)

- Conventional HX approaches are not efficient (MC or BPHX)
- Limited developments in the intermediate temperature range (150 C – 250 C)
- Simultaneous developments in various sectors are required to achieve optimum performance
- High pressure operation
  - Super critical CO<sub>2</sub> operation
- Heat pipes and vapor chambers

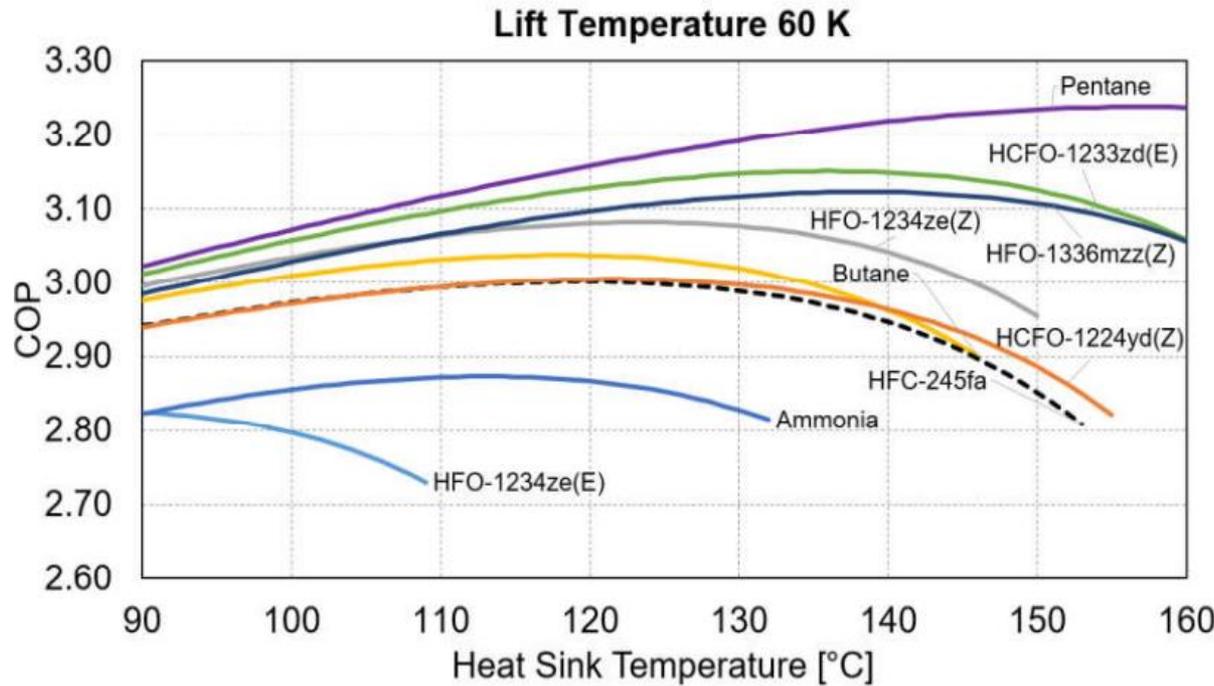


# Heat Exchangers (Enabling Technology)

- Non-metallic solutions
  - Lower thermal conductivity issues can be resolved
  - Additive and subtractive manufacturing processes
- Augmentation techniques for multi-phase flow
  - Boiling and condensation
- Fouling, corrosion and erosion are classical problems
  - Alternative materials (ceramics, polymers)
  - Alteration of surface morphology
    - Durable and scalable



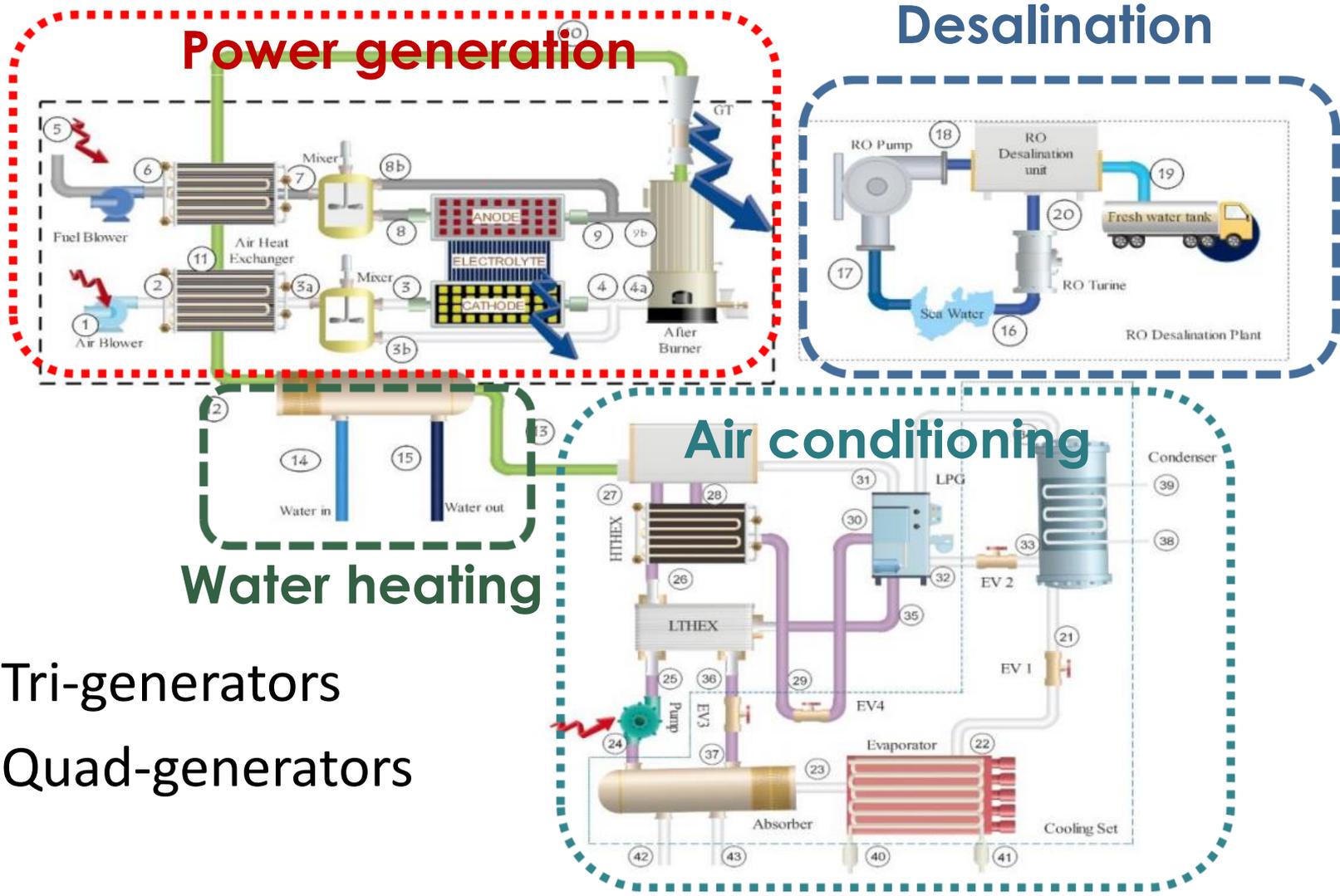
# Compressors & Working Fluids (Enabling Technology)



- Compatibility with higher temperature (electrochemical compression)
- Environmental and safety concerns
- Natural refrigerants

GWP is a reasonable metric or not??

# Integration Opportunities in Buildings

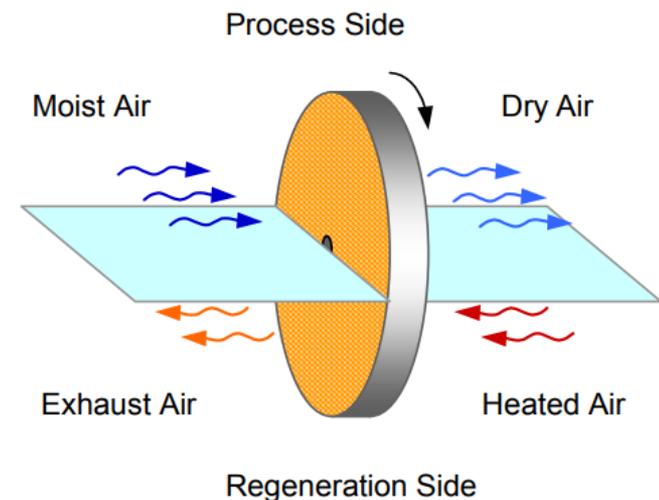


- Tri-generators
- Quad-generators

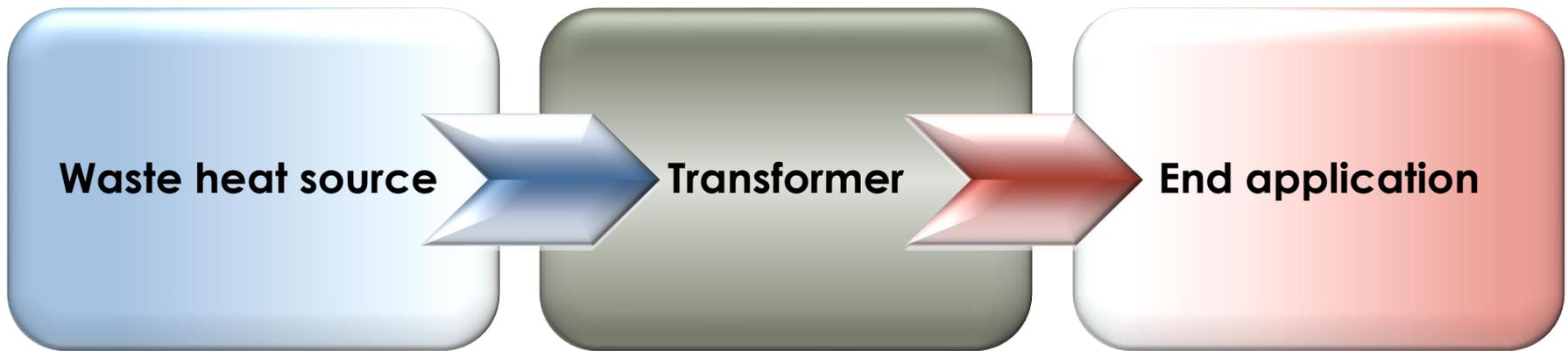
Cost-effectiveness is a major barrier!!

# Integration Opportunities in Buildings

- Waste heat recovery devices
  - Sensible energy recovery devices (Sensible ERVs)
  - Latent energy recovery devices (Latent ERVs)
- Exhaust from gas-fired equipment's (Furnaces, boilers)
- Condenser heat
- Development of compatible solutions
  - Solid desiccants
  - Liquid desiccants
  - Membrane based solution



# Research priorities in low-temperature systems



- Fundamental studies leading to applications
- Thermodynamic analysis
- Components based process optimization
- Techno-economic analysis
- *Efficiency vs. carbon footprints*
- Process integration and renewables

# Research priorities in low-temperature systems

- What if source and sink are not synchronized??
- Solar energy is a prime example of transient source
- *Development of storage solutions is critical*
- Can waste heat recovery system lead to effective decarbonization??
  - Multifunctional equipment technologies
  - On-site utilization

