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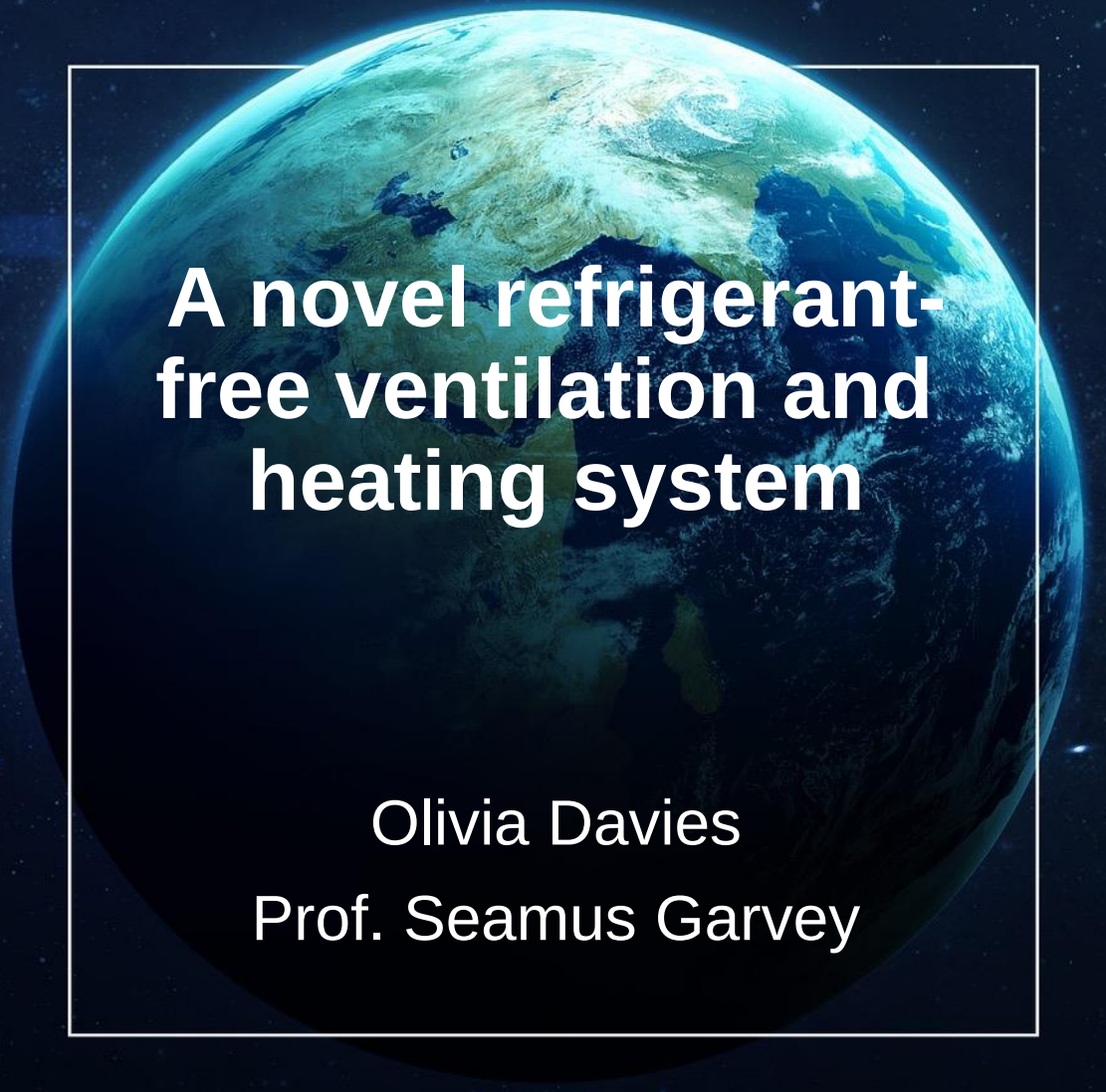


A novel refrigerant-free ventilation and heating system

Olivia Davies

Prof. Seamus Garvey

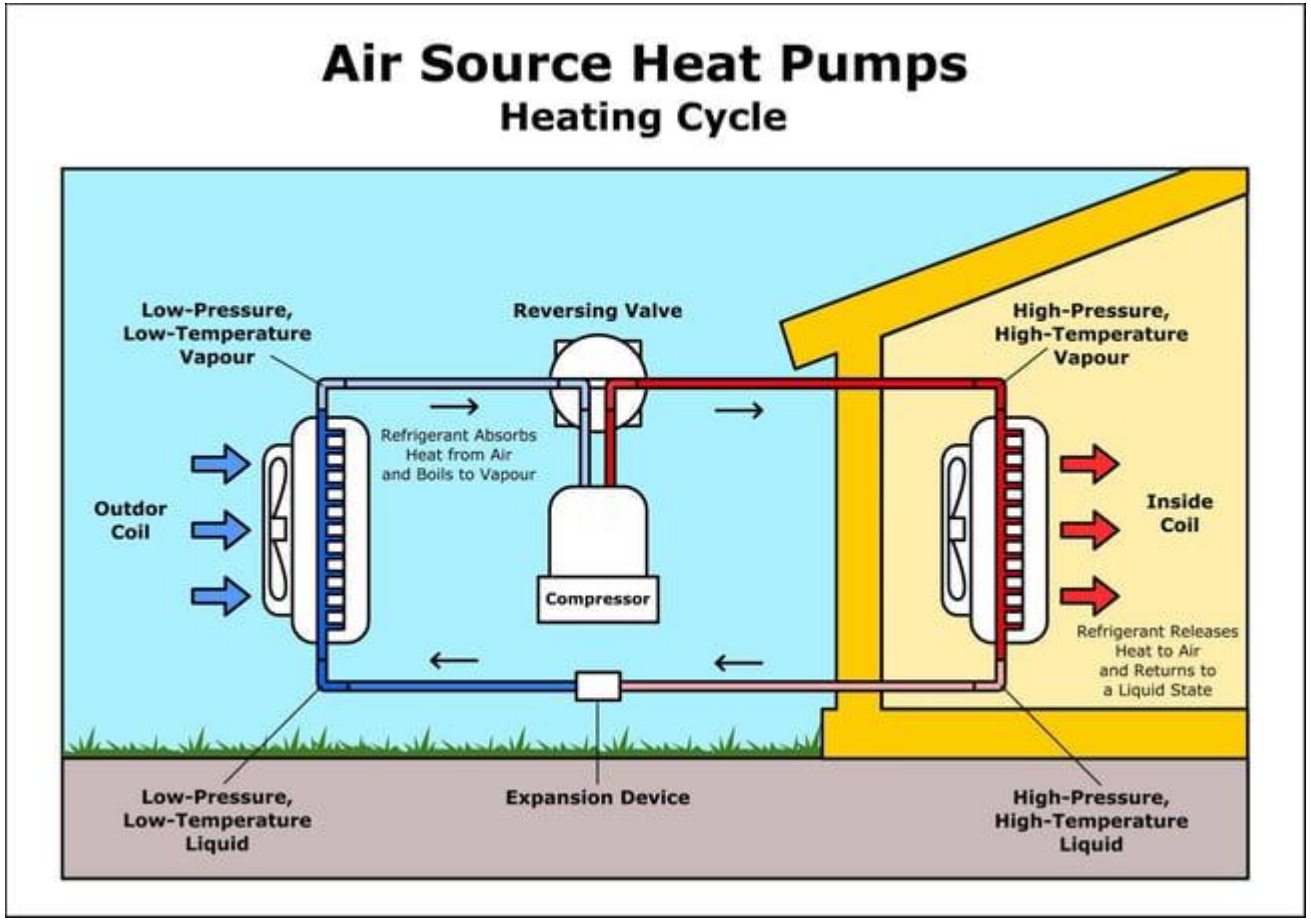
Structure

- Heat pumps
- Historical origins
- Systems thinking
- Calculations
- Challenges
- Proposed Solution

Bellofram Elastomers, Class 3 diaphragm [Class 3 | Bellofram Elastomers]

Heat pump – and what really matters

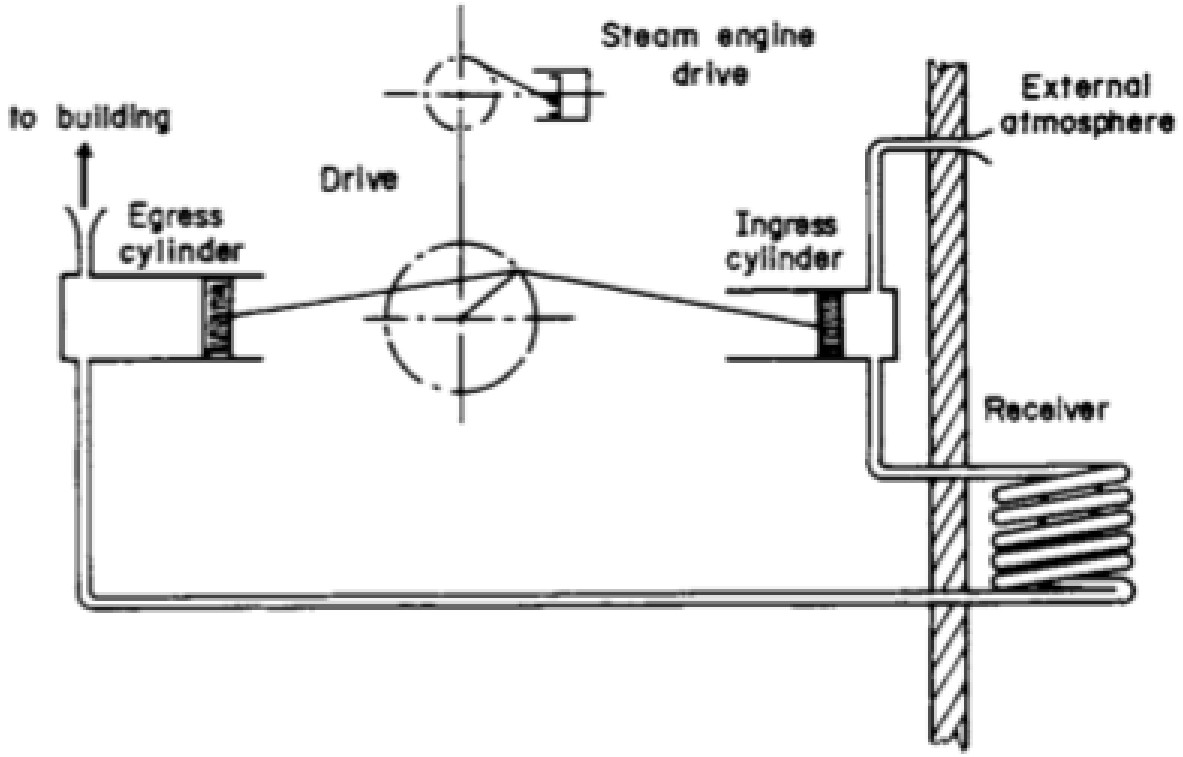
- What is a heat pump?
- What matters most …
  <u>COP in cold weather</u>



Heat Pump Basics: How Heat Pumps Work & Common Types | The Super Blog

Historical Origins

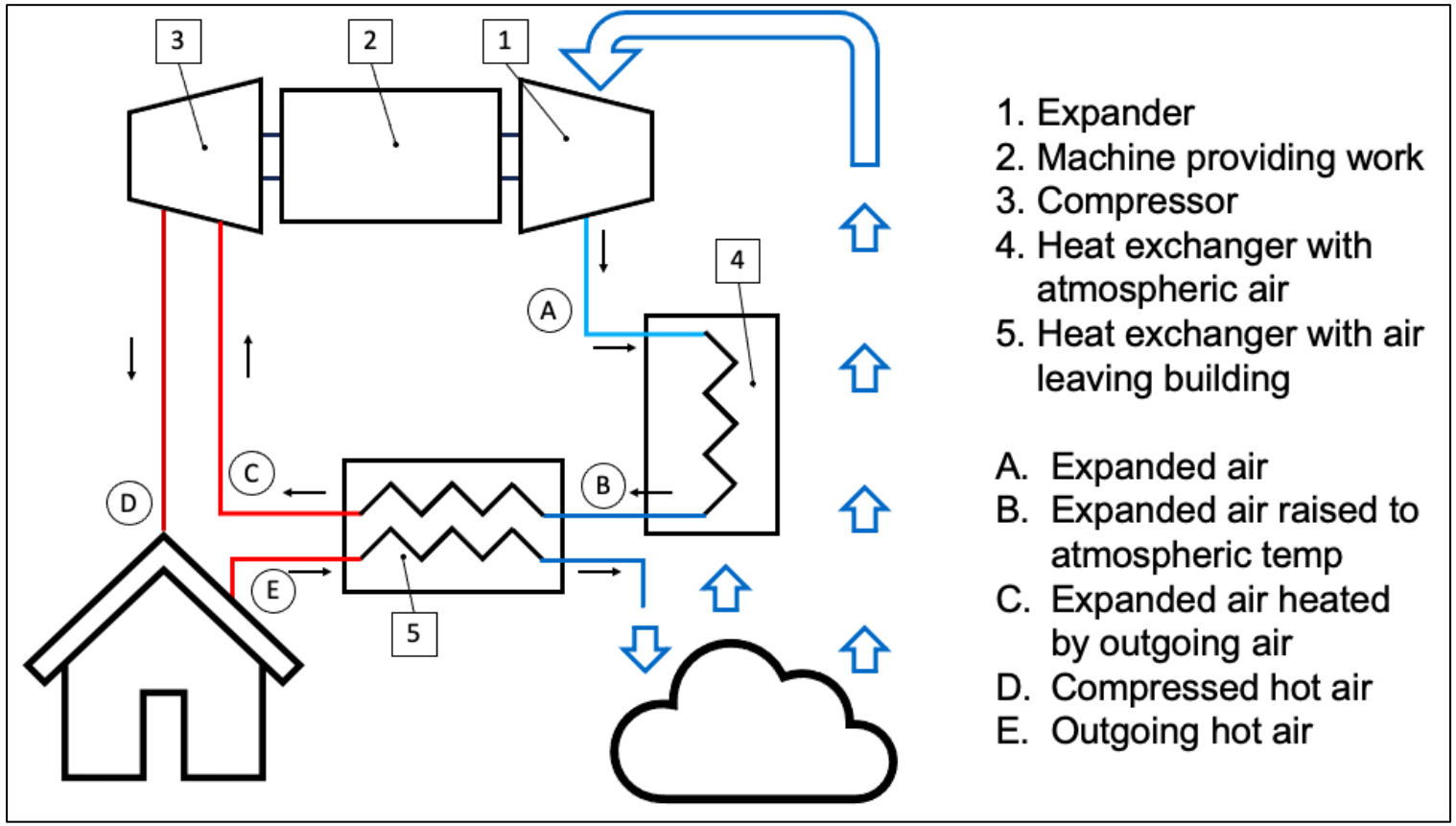
- Lord Kelvin
- Heat powered heat pump
- Heats space directly by injecting warm air



Kelvin's proposed concept- 'Heat Multiplier' patent 1852.

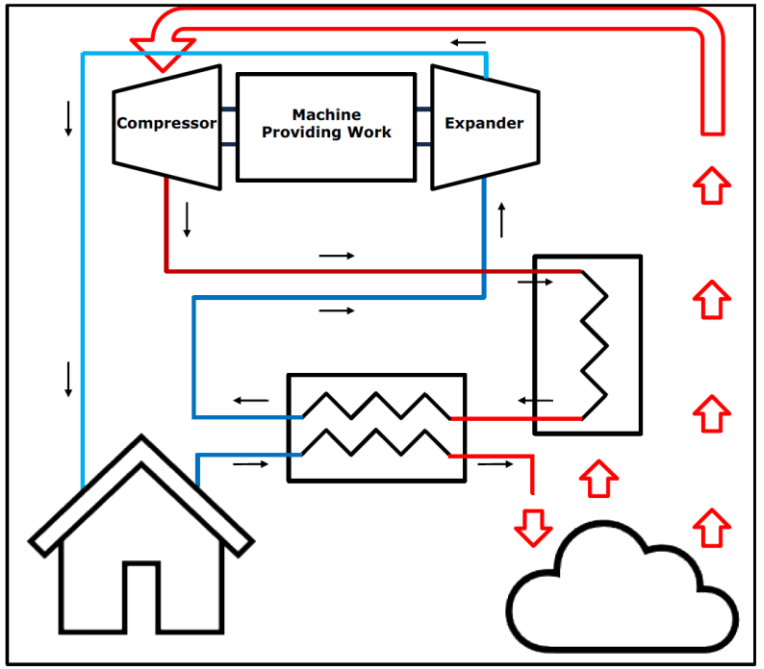
Systems thinking

- Combining the compressor and expander systems



1. Expander
2. Machine providing work
3. Compressor
4. Heat exchanger with atmospheric air
5. Heat exchanger with air leaving building

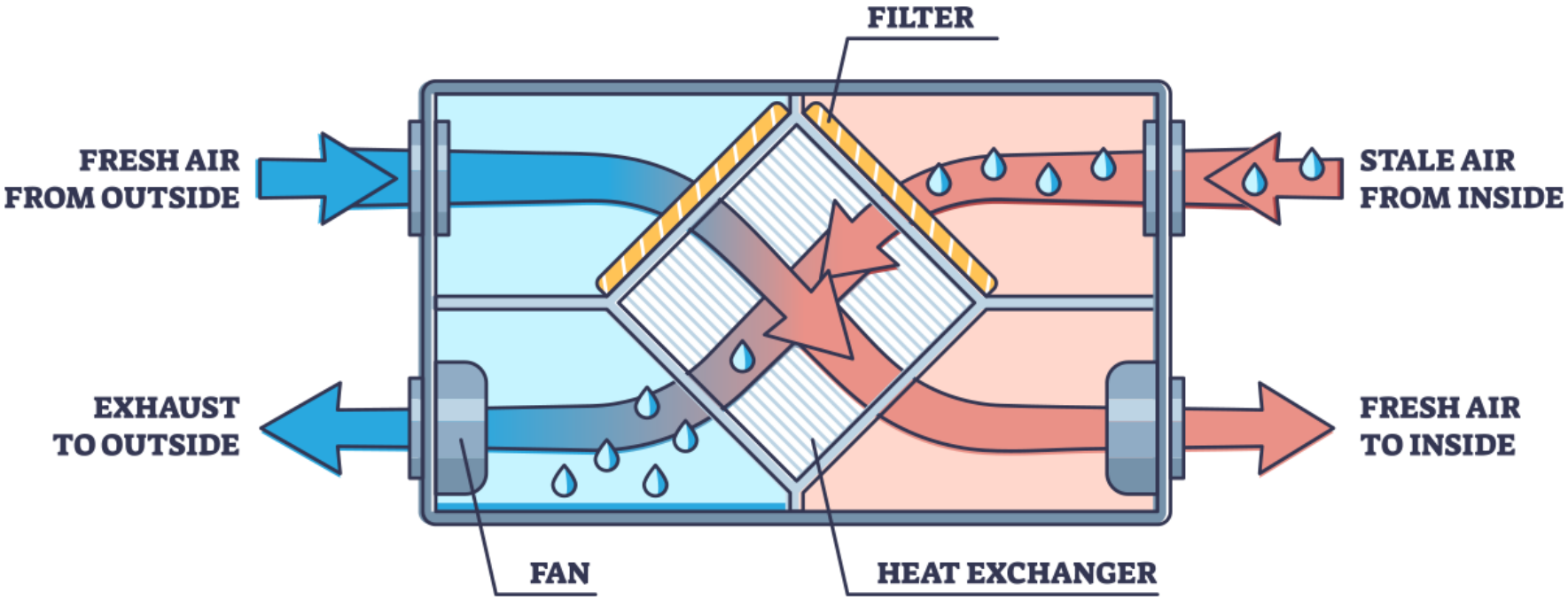
A. Expanded air
B. Expanded air raised to atmospheric temp
C. Expanded air heated by outgoing air
D. Compressed hot air
E. Outgoing hot air



J. Fleming Report- schematic system

Systems thinking

- Heat recovery units
  - MVHR



Domestic MVHR Units | Clean air at home| Mitsubishi Electric

Mechanical Ventilation Heat Recovery (MVHR) | BioSun Energy

Calculations

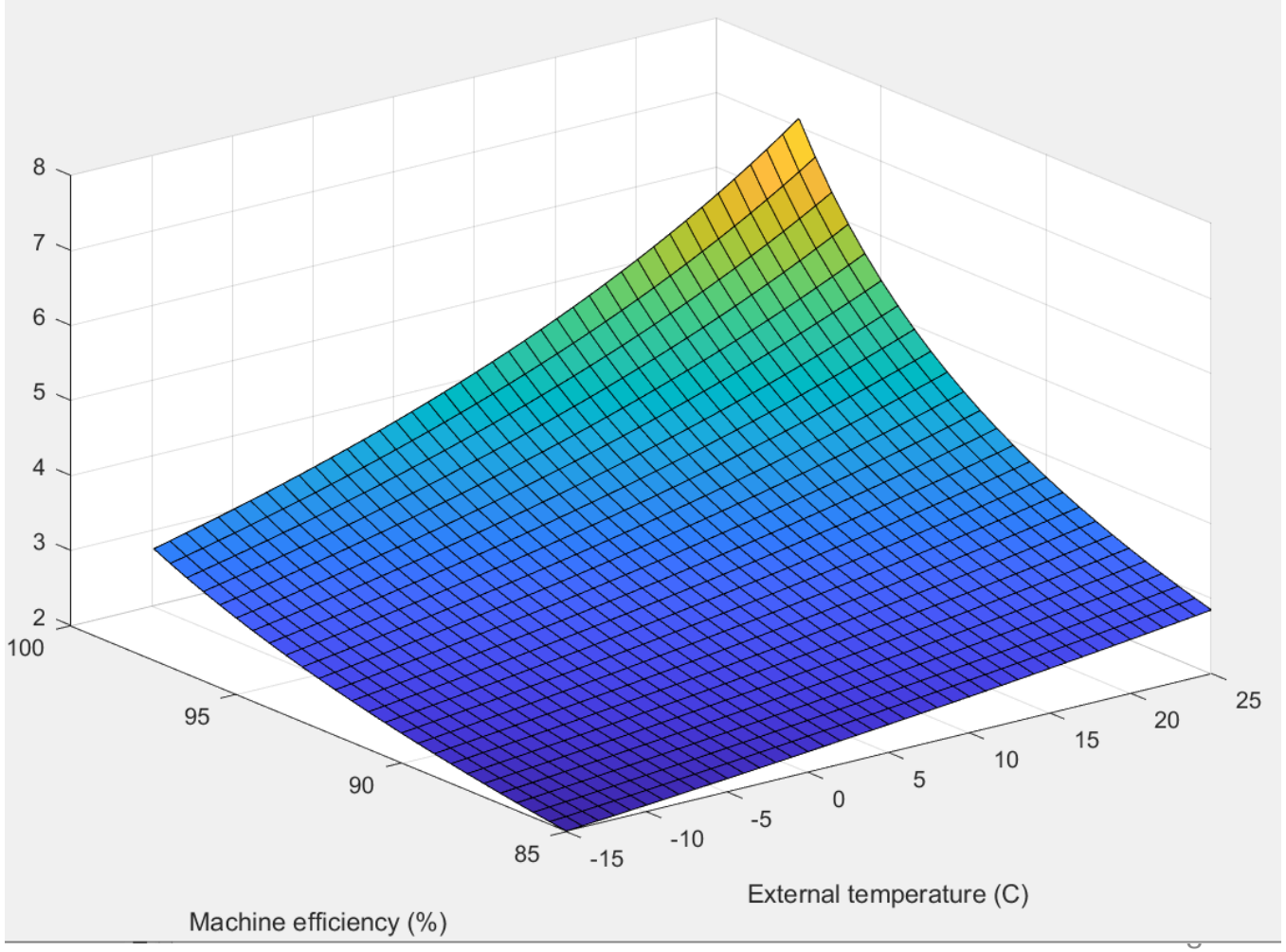
- Temperature and pressure ratios
- $\frac{T_2}{T_1} = \frac{p_2}{p_1}^{\frac{\gamma-1}{\gamma}}$

$$\gamma = 1.4 \; for \; air$$
$$\frac{p_2}{p_1} = 0.85$$
$$Temperature_{ratio} = 0.955$$
$$(1 - T_{ratio}) \times 273 = 12.4 \; ℃$$

- Coefficient of Performance
- $CoP = \frac{heat \; in}{electrical \; power}$

Challenges

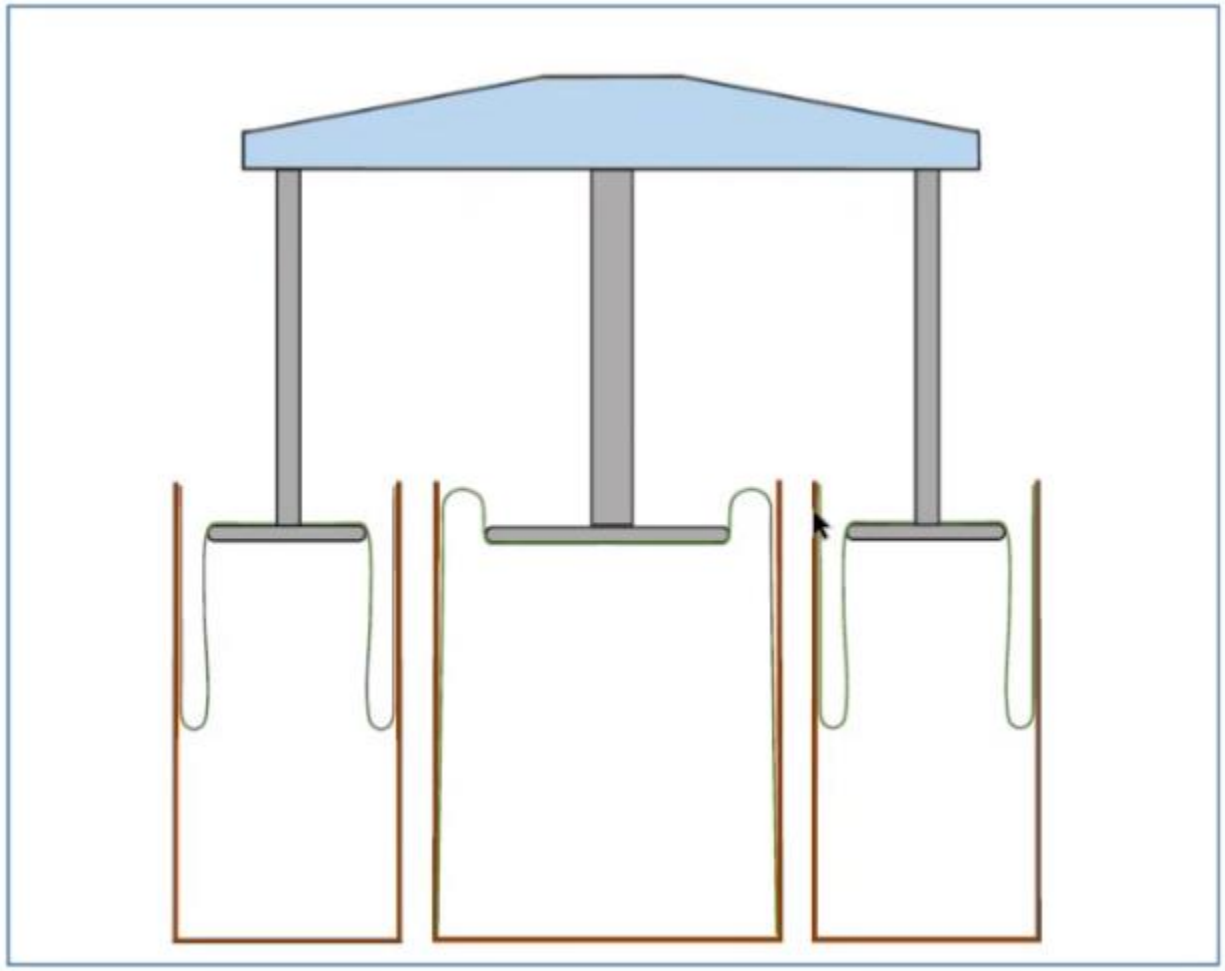
- **Need to** have high efficiencies in both compressor and expander
  - Equivalent to >95% individually to make it feasible
- Pressure ratios close to 1
- Coefficient of Performance
  - Matters most when external temperatures are low



J. Fleming report- CoP vs temperature and efficiency

Proposed Solution

- Compander with rolling membranes
- All pistons to move in unison
  - Work out of expander goes straight to work into compressor
- Downstroke:
  - Compressor- increases pressure of air and then discharges this into desired space
  - Expander- at ambient pressure and allows air out through valve
- Upstroke:
  - Compressor- takes air into chamber
  - Expander- valve closes before it reaches the top to expand air



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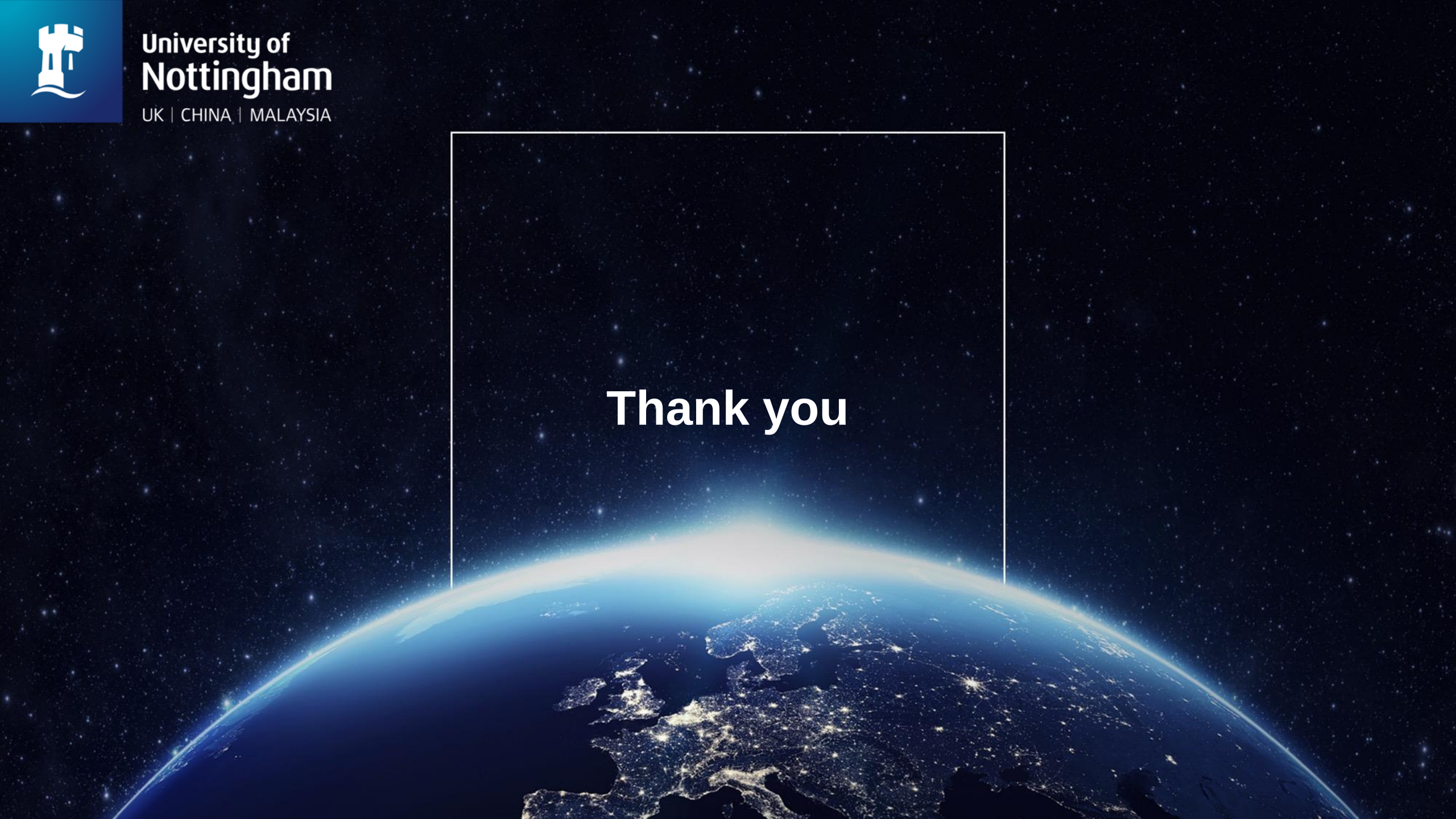

Thank you