Large-Scale Heat Pumps and District Heating



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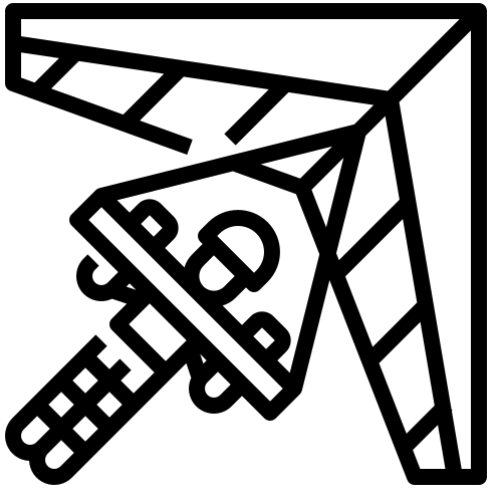
Sweco Denmark

7 years of experience working with:

- Design of Industrial Heat Pumps
- Design of Industrial Refrigeration Plants
- Utilisation of waste heat.

Why Large-Scale Heat Pumps Now?

- Focus on electrifying district heating
- Predicted capacity growth in Denmark 2025 → 2035
  - ➢ 700MW → 4,000MW
- Shift from complementary → base load
- Greater heating-sector integration enables grid stabilisation.
- Utilisation of multiple energy sources & large focus on excess heat
- “We used to look for chimneys – now we look for cooling surfaces”

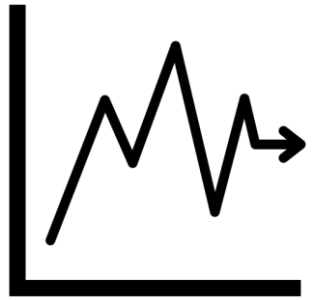


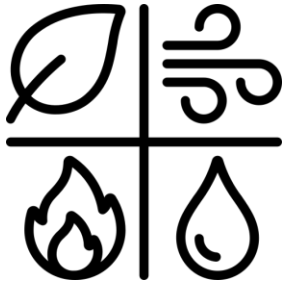
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Heat Pumps in DH: The Big Picture

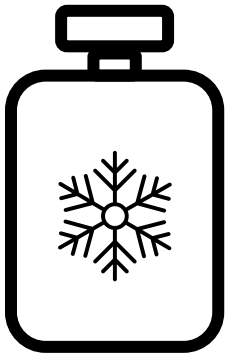
Design Drivers

- Energy Source
- Operating profile (hours, part load, flexibility)
- Optimisation of existing hydraulic systems (Return Temperature)
- Refrigerants









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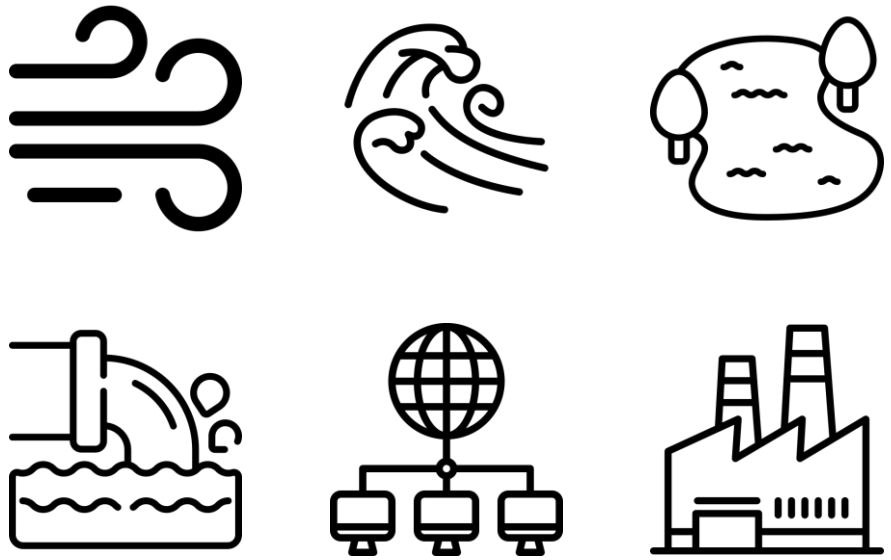
Energy Sources: What Really Matters

Independent vs. Dependent energy sources

- Independent: seawater, air, geothermal
- Dependent: data centres, industry, wastewater

Focus:

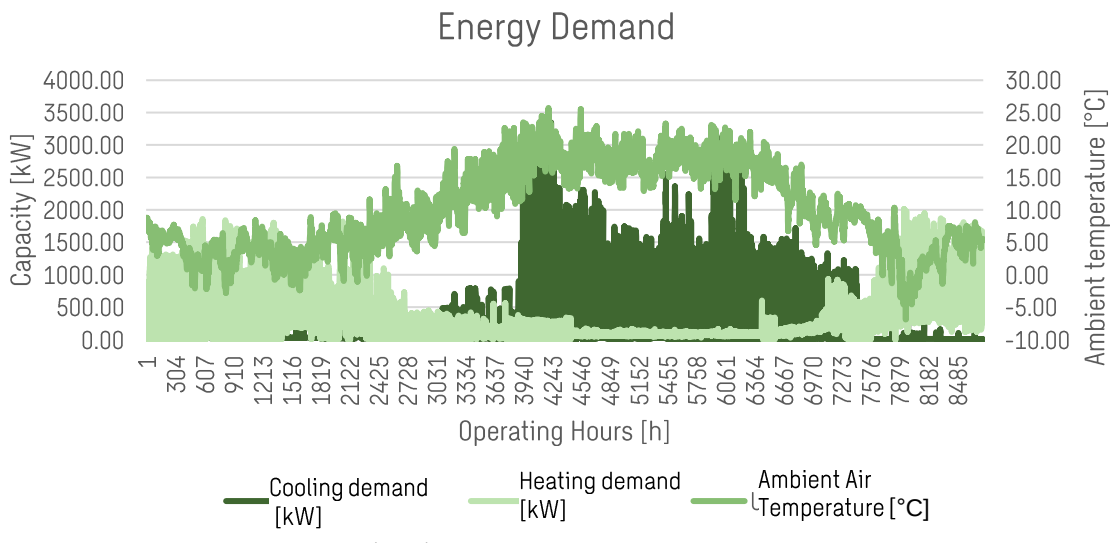
- Availability
- Temperature level
- Annual operating hours

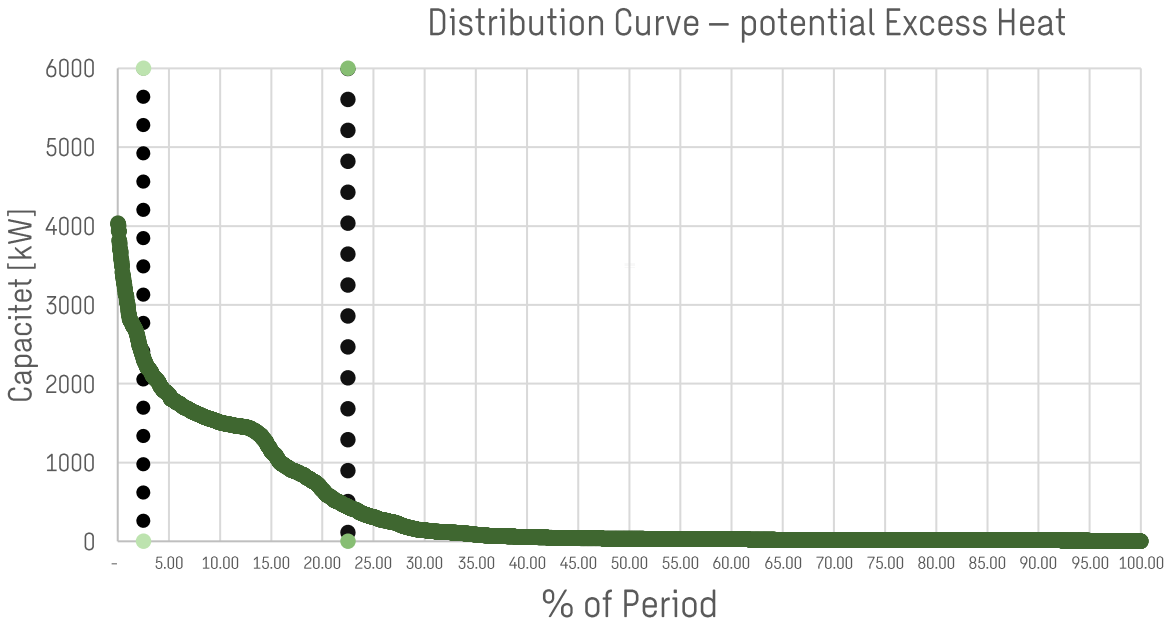


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Excess Heat: When Does it Make Sense?

- Operating hours > Peak capacity
- Internal vs. external utilisation
- ROI driven by utilisation rate
- Load profile limits HP size





Refrigerants & Configurations

- Natural refrigerants: NH3, CO_2, hydrocarbons
- 1-stage vs 2-stage
- Source temperature often defines complexity and achievable COP

Natural Refrigerants (Large Heat Pumps)	NH3	CO2	Hydrocarbons (R600A, R290 etc.)
Capacity	10→20 MW	10→50 MW	10→50MW
Supply temperature	95°C	+95°C	+95°C
Configuration	1-stage & 2-stage	1-stage	1-stage
Key Advantages	• Excellent Thermal Properties • High Efficiency • Proven industrial Technology	• Non-flammable • High single-stage capacity • No requirements to refrigerant charge	• High efficiency • Low operating pressures • Non-toxic
Key Challenges (BS EN378)	• Toxic – strict requirements • Focus on refrigerant charge	• High operating Pressures • Sensitive to return temperatures	• A3 Refrigerant (flammable) – ATEX requirements • Focus on refrigerant charge

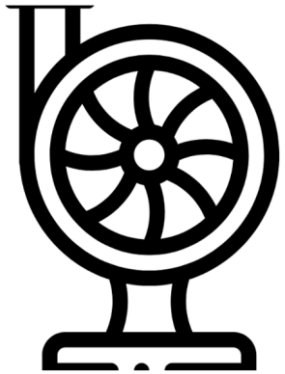
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Compressor Technologies

Piston Compressors: 0.5-4 MW
- High efficiency
- Low capacity
- Short service intervals

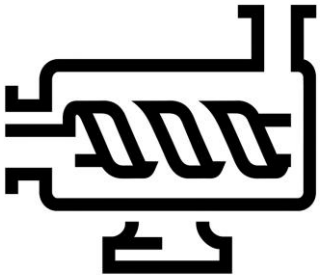


Centrifugal/Turbo Compressors: 5-50 MW
- High capacity
- Lower efficiency
- Long service intervals



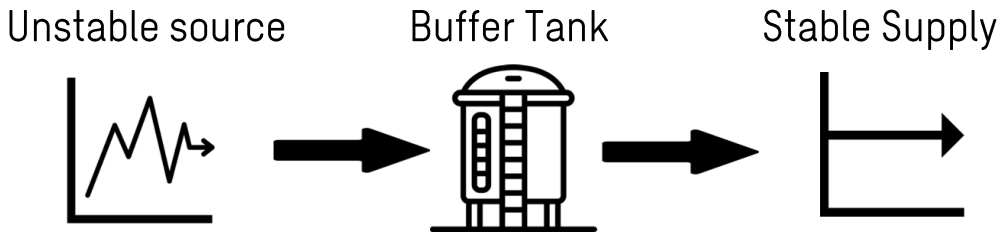


Screw Compressors: 3-20 MW
- High capacity
- High efficiency
- Long service intervals



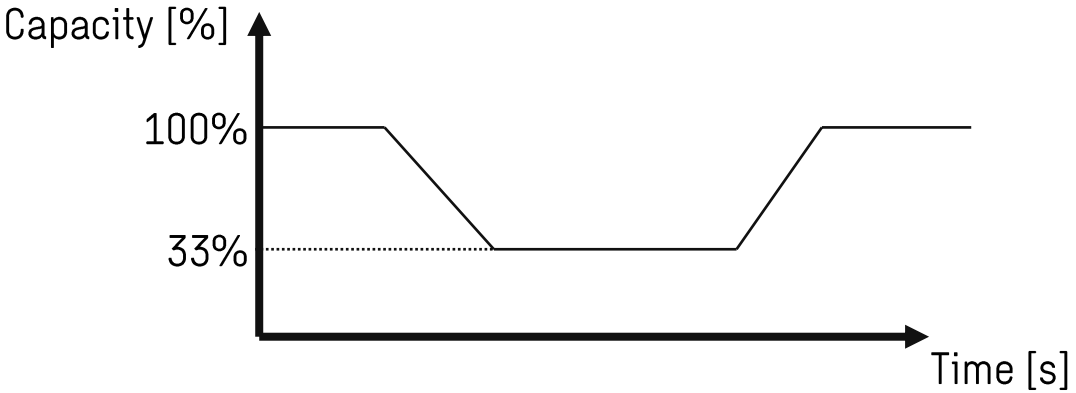
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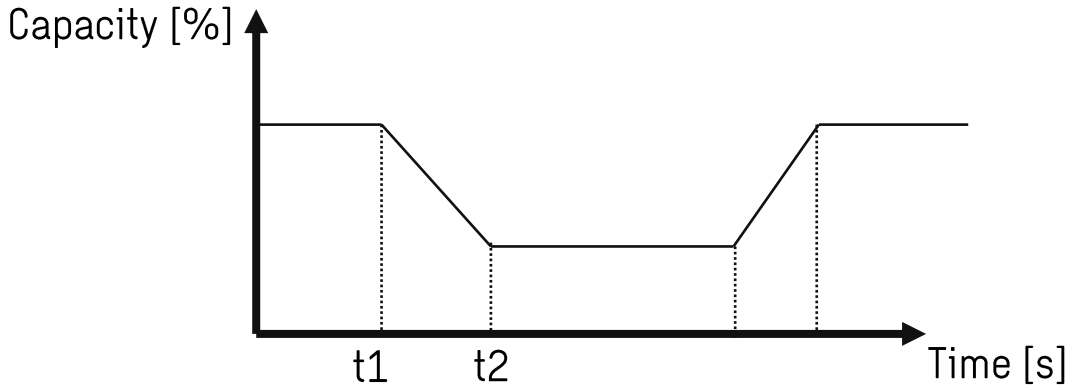
Design Pitfalls



Where things often go wrong

- Temperature & flow fluctuations
  - ➢ Need a buffer tank?
  - ➢ Correct dimensioned hydraulic systems
- External effects
- Start/stop frequency (and response time)
- Part-load operations (and response time)

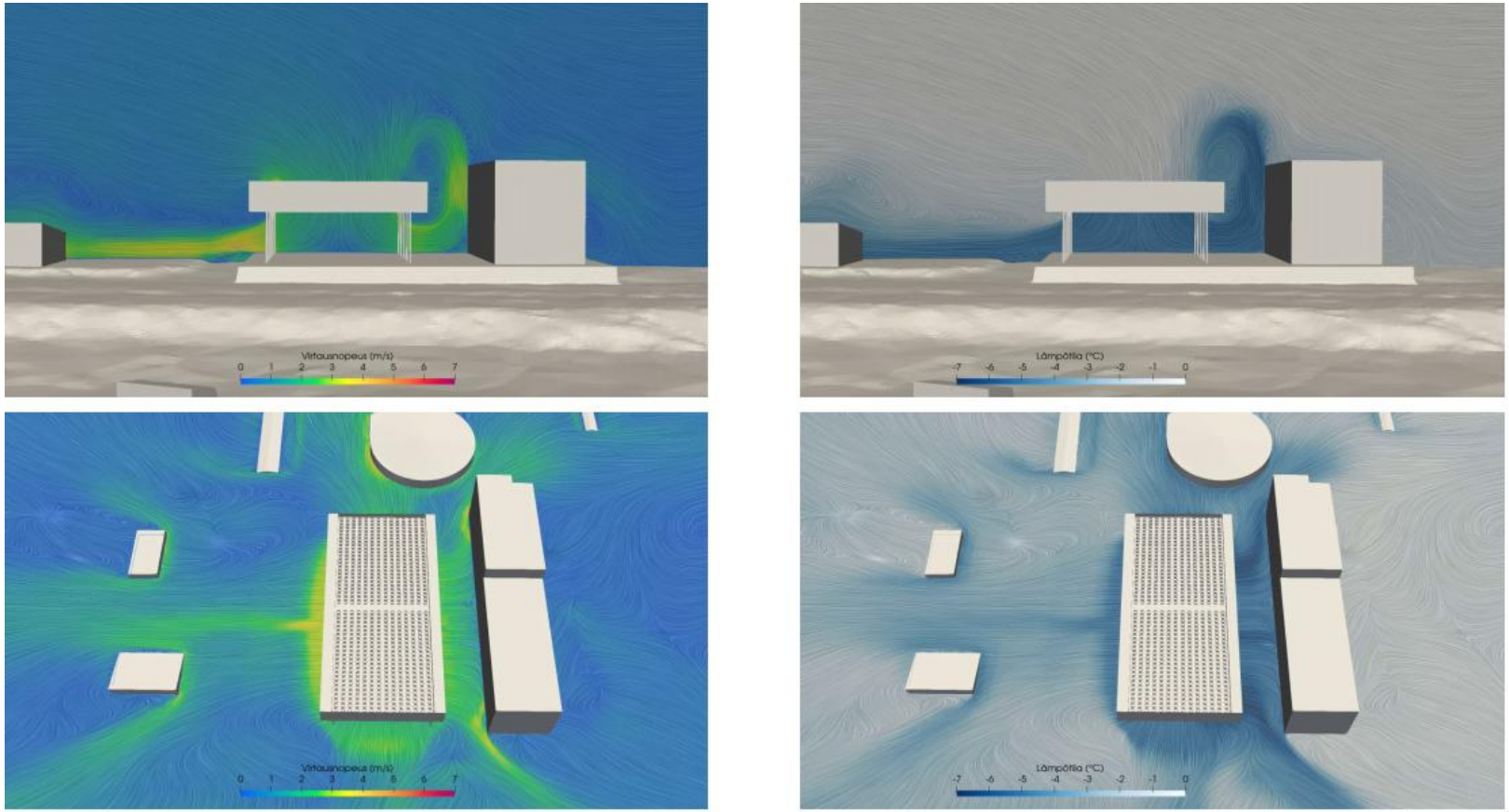




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Example of External Effects: Air Recirculation

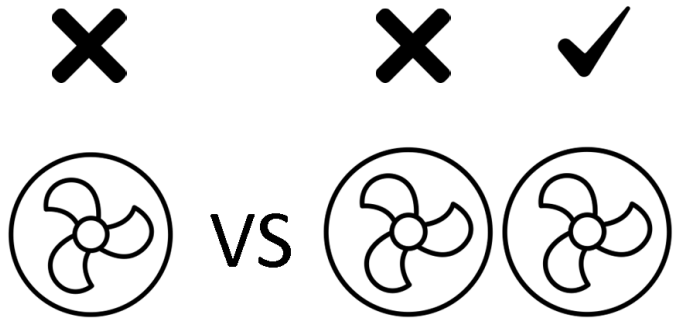
- Massive impact on COP and capacity
- CFD early = cheap insurance
- Layout matters more than people think

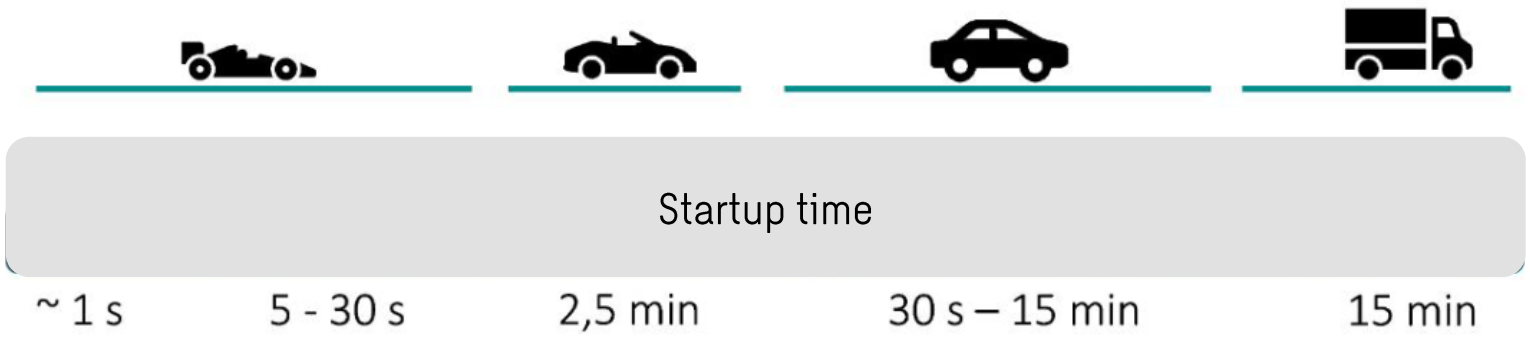


Strategic Perspective

COP vs Uptime

- Base load vs flexible operation
- Redundancy levels
- Integration with electrical boilers and buffer tanks
  - ➢ Stability and Flexibility
- Balancing the electrical grid





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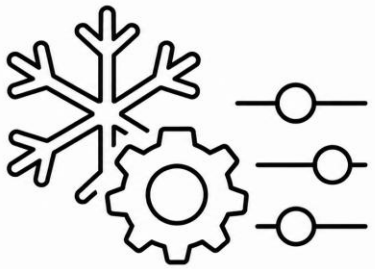
Key Takeaways

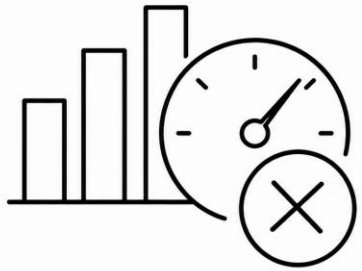
Good planning provides good results

- Design for real operation, not nominal data
- Consider refrigerants and configuration early
- Maximise operating hours
- COP is irrelevant without uptime



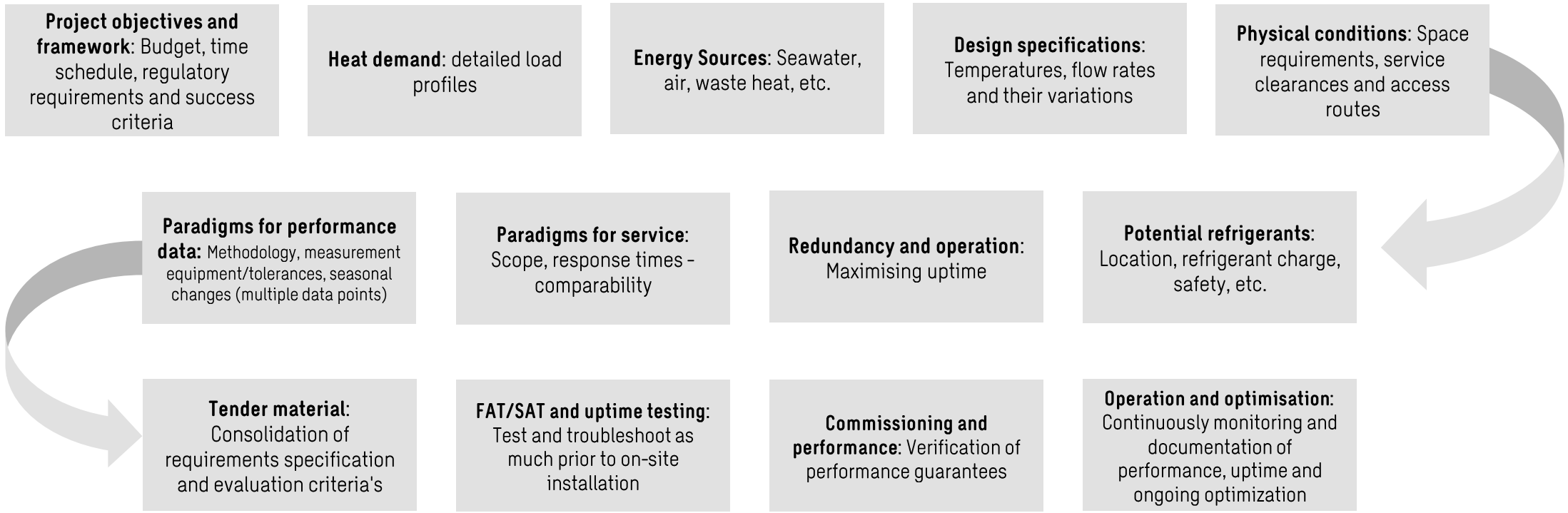






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Planners Guide – From Idea to Execution (Extra)



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