



Low Temperature Heat Recovery &
Distribution Network Technologies



Advanced Vapour Compression Heat Pumps

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Heat Pumps and Premature Aging



- 1980's – PhD "The Development of an Alternative Refrigeration Cycle"
- 1990's – Compact Plate Heat Exchangers, CFC Replacements, Scroll Compressors, Ground Source Heat Pumps
- 2000's – Air source heat pumps, integration, end-user engagement, cost reduction versus performance increases
- 2010's – Integration challenges and thermal storage, electrification of heat, smart systems, demand side response and distributed energy management, end-user engagement (And Research Director)
- 2020's – Industrial Heat Pumps (200 deg. C and beyond), waste heat recovery, heat networks, geothermal (And Head of School)



Our Work Packages

WP3.1: Low temperature lift, high COP VC heat pump to deliver heat from LT network to load (e.g. lift of 20°C with COP>9, enabling network to supply conventional radiator system)

WP3.2: VC Heat Pump for Demand Side Management; variable renewable electricity supply will be matched to demands using building/process heating controls in association with variable compressor speed and storage

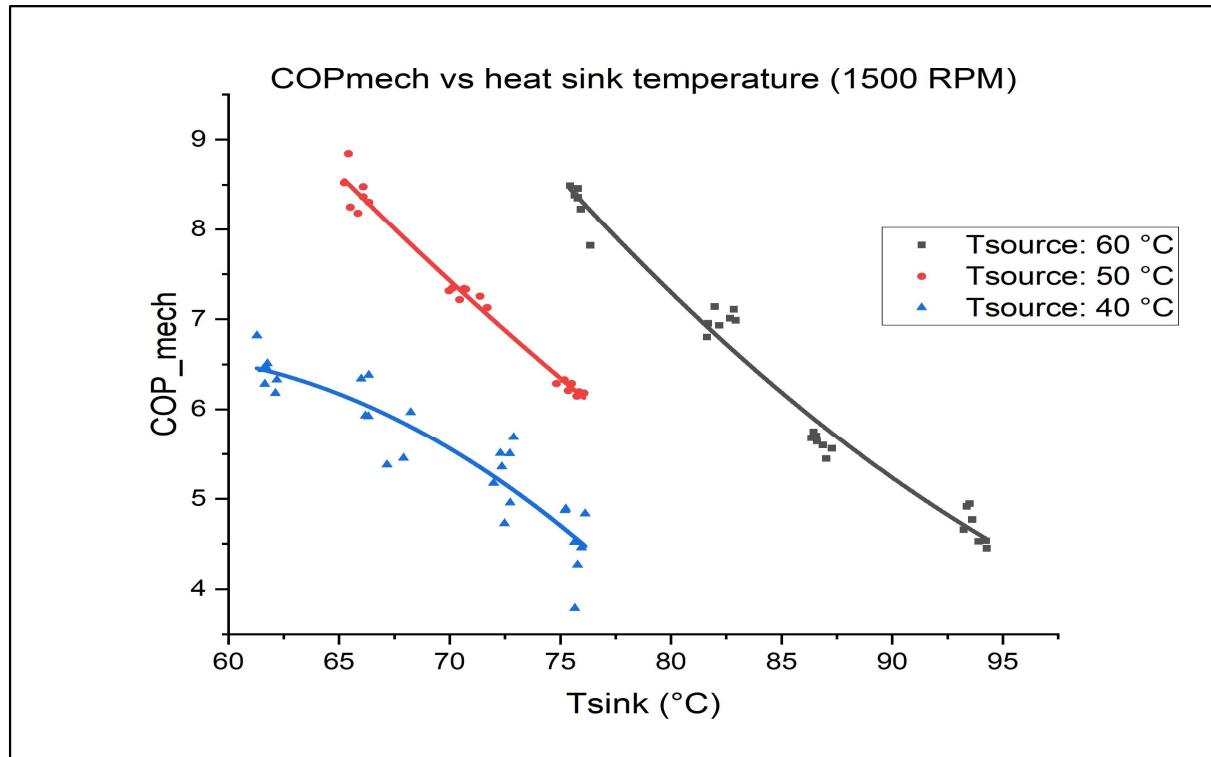
WP3.3: High temperature VC heat pumps from network to process heat in commercial or industrial applications.

WP3.4: Combined heat pump/ORC for heat to electricity or reverse, allowing maximum flexibility between combined (thermal/electricity) energy systems.



WP 3.1: Low temperature lift, high COP VC heat pump

WP 3.3: High temperature VC heat pump



WP3.4: Combined heat pump/ORC for heat to electricity



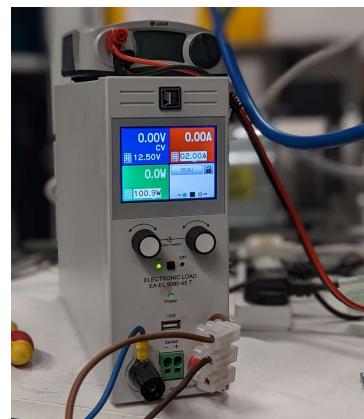
Reversible HP-ORC



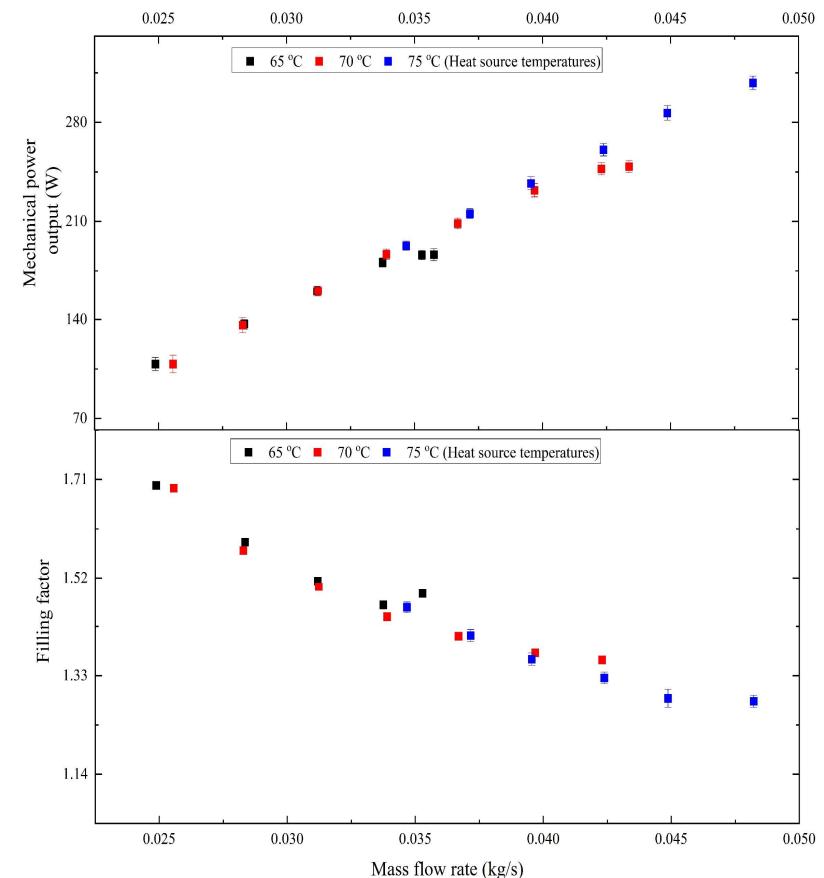
Alternator



Discharge side with the check valve removed



DC electronic load



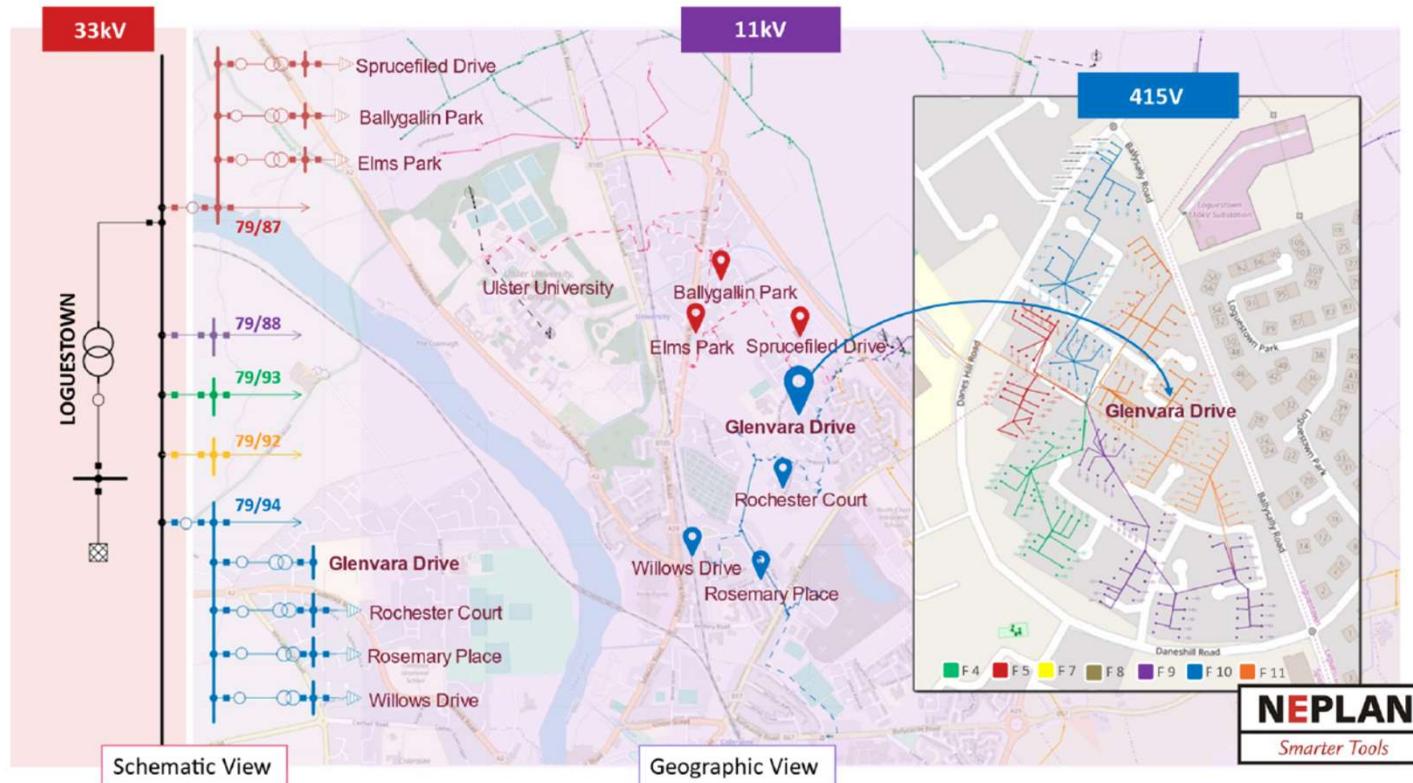
WP 3.1: Low temperature lift, high COP VC heat pump

WP 3.3: High temperature VC heat pump

WP 3.5: The ORC

- The Takeaways....
- Fluid Choice R1233zd(E) will be challenged by PFAS phase outs
 - Water or Gas Cycles for high temperature heat pumps
 - High COPs are very possible
- Organic Rankine Cycle
 - 5% Power return at low temperatures
 - Best use will be as an expansion turbine where 20% power to the compressor will increase the COP

WP 3.2: Demand Side Management



Osaru Agbonaye, Patrick Keatley, Ye Huang, Oluwasola O. Ademulegun, Neil Hewitt (2021) Mapping demand flexibility: A spatio-temporal assessment of flexibility needs, opportunities and response potential, Applied Energy, Volume 295

WP 3.2: Demand Side Management



WP 3.2: Demand Side Management



With Project Rulet and Dr Patrick Keatley

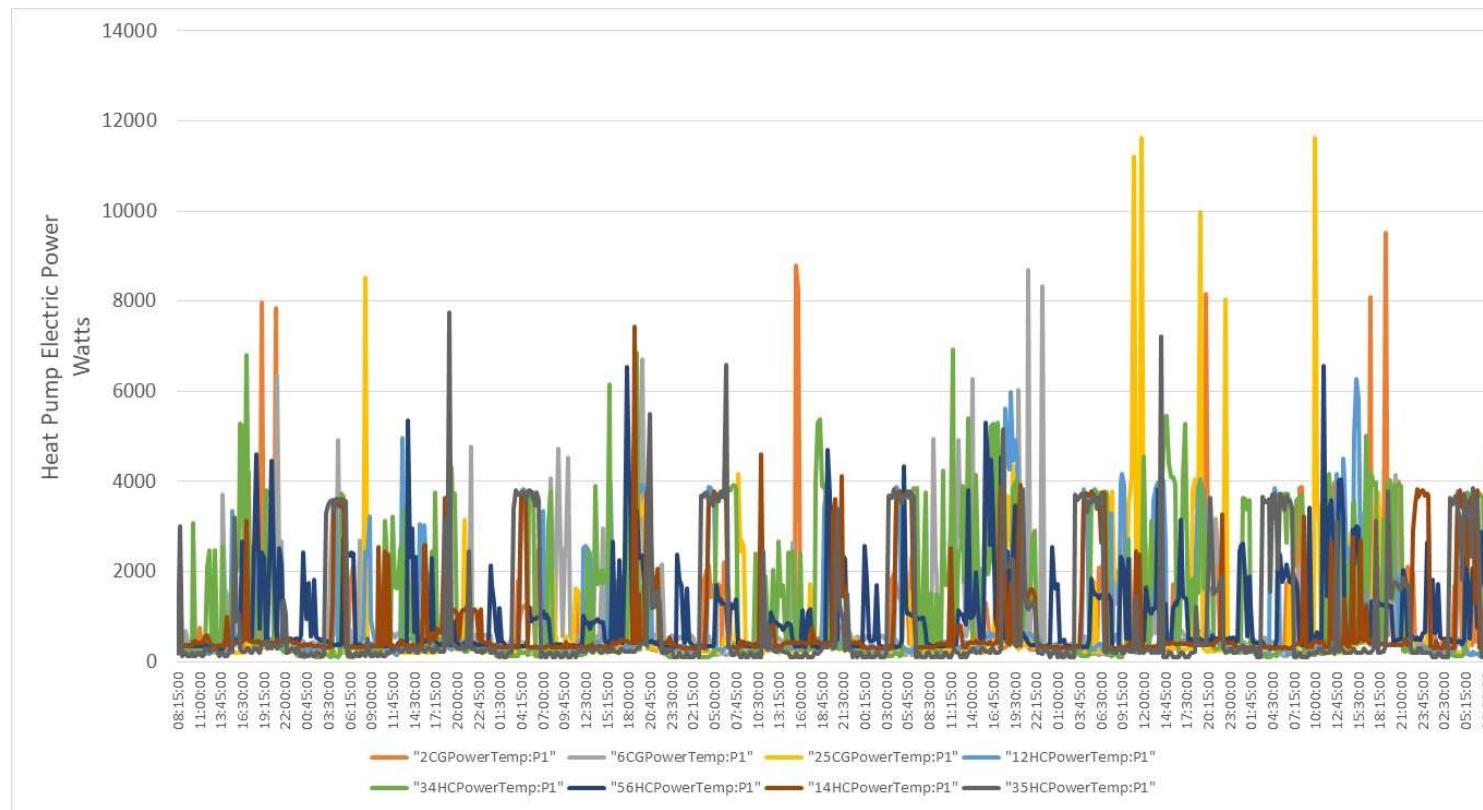
WP 3.2: Demand Side Management

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Green = Trial (plus network costs, etc) cheaper than E7; white is when E7 = Trial; pink is when Trial > E7; red is when Trial >20p more expensive than E7.



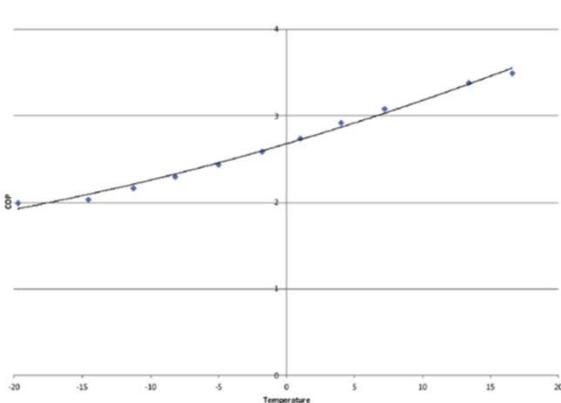
WP 3.2: Demand Side Management



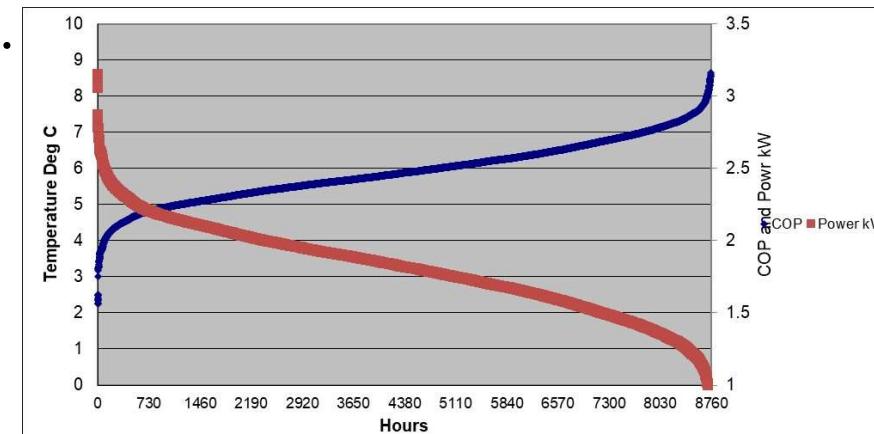
WP 3.2: Demand Side Management

Numerous authors consider After Diversity Maximum Demand (community types, social etc.)

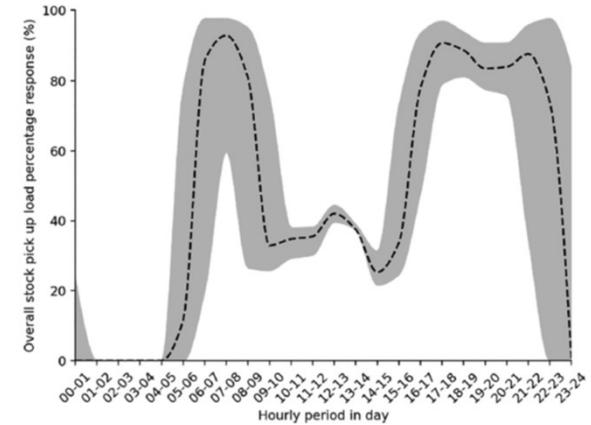
A range of UK values is typically from 1.3 kW to 1.93 kW per household per heat pump.



1. COP can be a lot lower



2. ASHP COP is affected by Air Temperature



3. Time of Day is important

WP 3.2: Demand Side Management

- **The Takeaways**
- Air Source Heat Pumps will decarbonise space heating (with decarbonised electricity)
- Thermal storage is a must for diversity on a daily basis
- Diversity decreases with time of day (thus thermal storage)
- Diversity decreases with temperature (smart load controls)
- Don't charge the EV when the heat pump is running....





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Questions?



EST 1892
LSBU

