LoT-NET

Low Temperature Heat Recovery &
Distribution Network Technologies

IOR.org.uk
REFRIGERATION AIR CONDITIONING HEAT PUMPS

sirach

Advanced Vapour Compression Heat Pumps

Professor Neil Hewitt, Ulster University

WARWICK
THE UNIVERSITY OF WARWICK
Ulster University
EST 1892 LSBU
Loughborough University

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

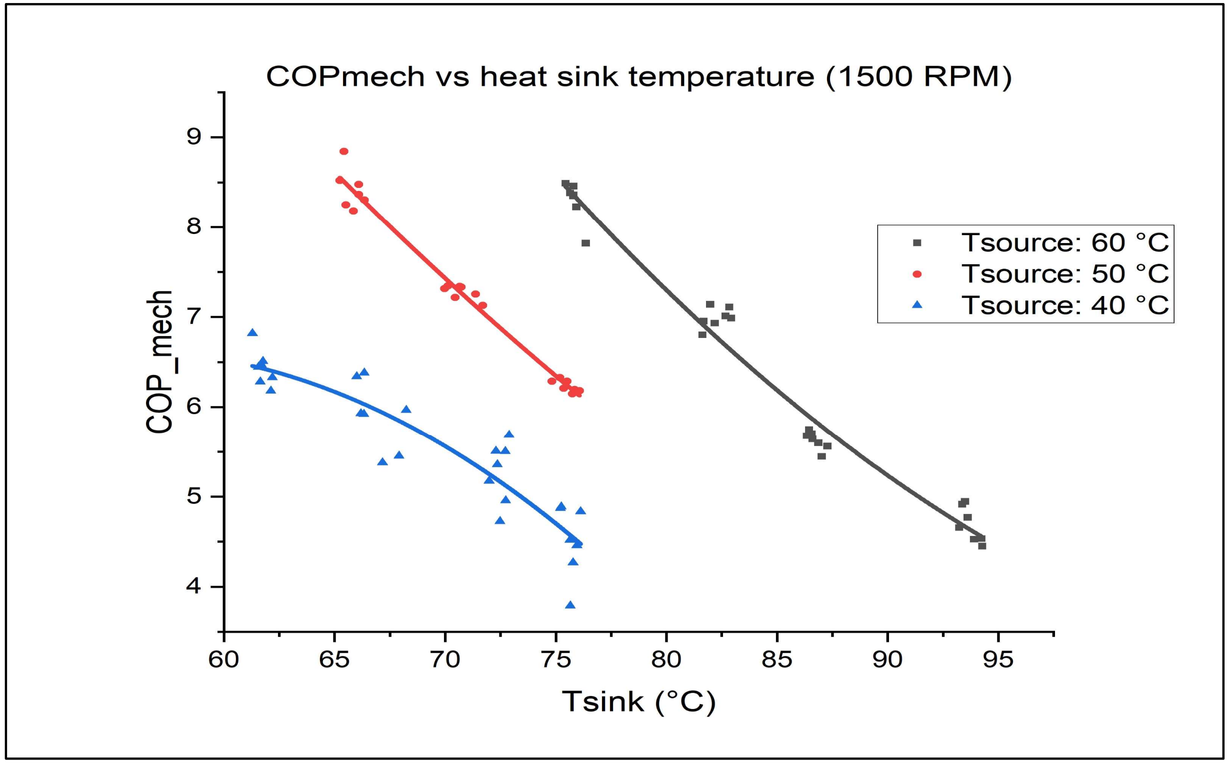
WP3.1: Low temperature lift, high COP VC heat pump to deliver heat from LT network to load (e.g. lift of 20^{o}C with COP>9, enabling network to supply conventional radiator system)

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

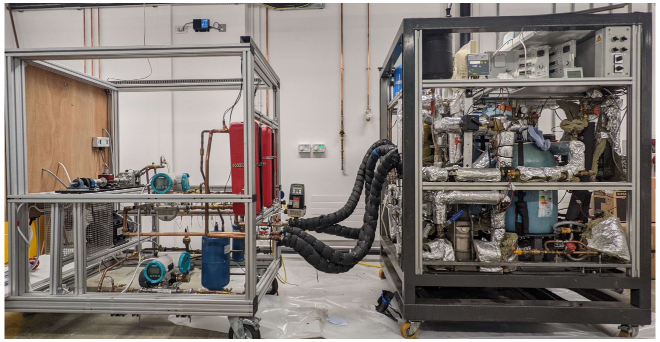
WP3.3: High temperature VC heat pumps from network to process heat in commercial or industrial applications.

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

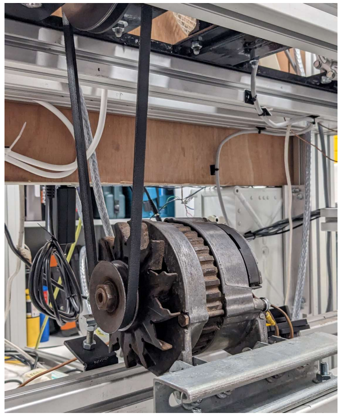
WP 3.1: Low temperature lift, high COP VC heat pump
WP 3.3: High temperature VC heat pump



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

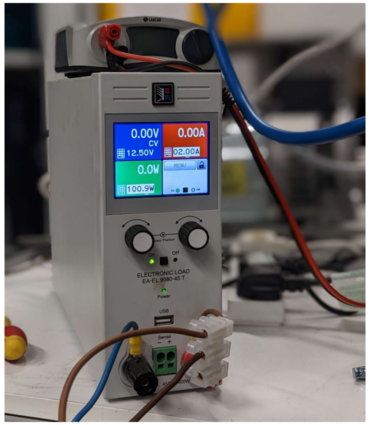


Reversible HP-ORC

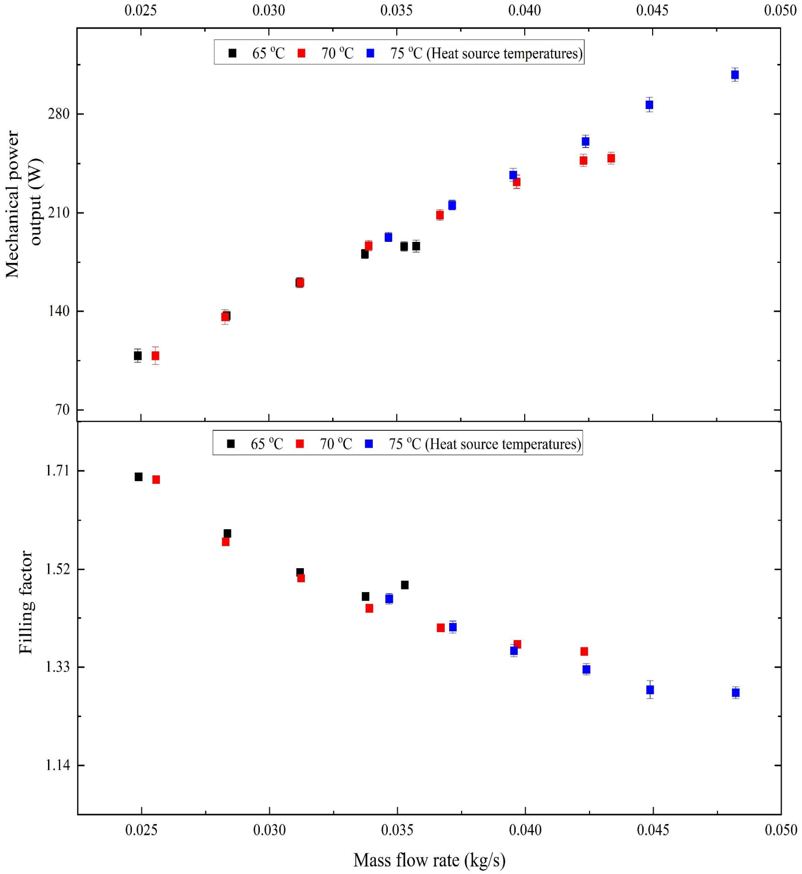


Alternator

Discharge side with the check valve removed



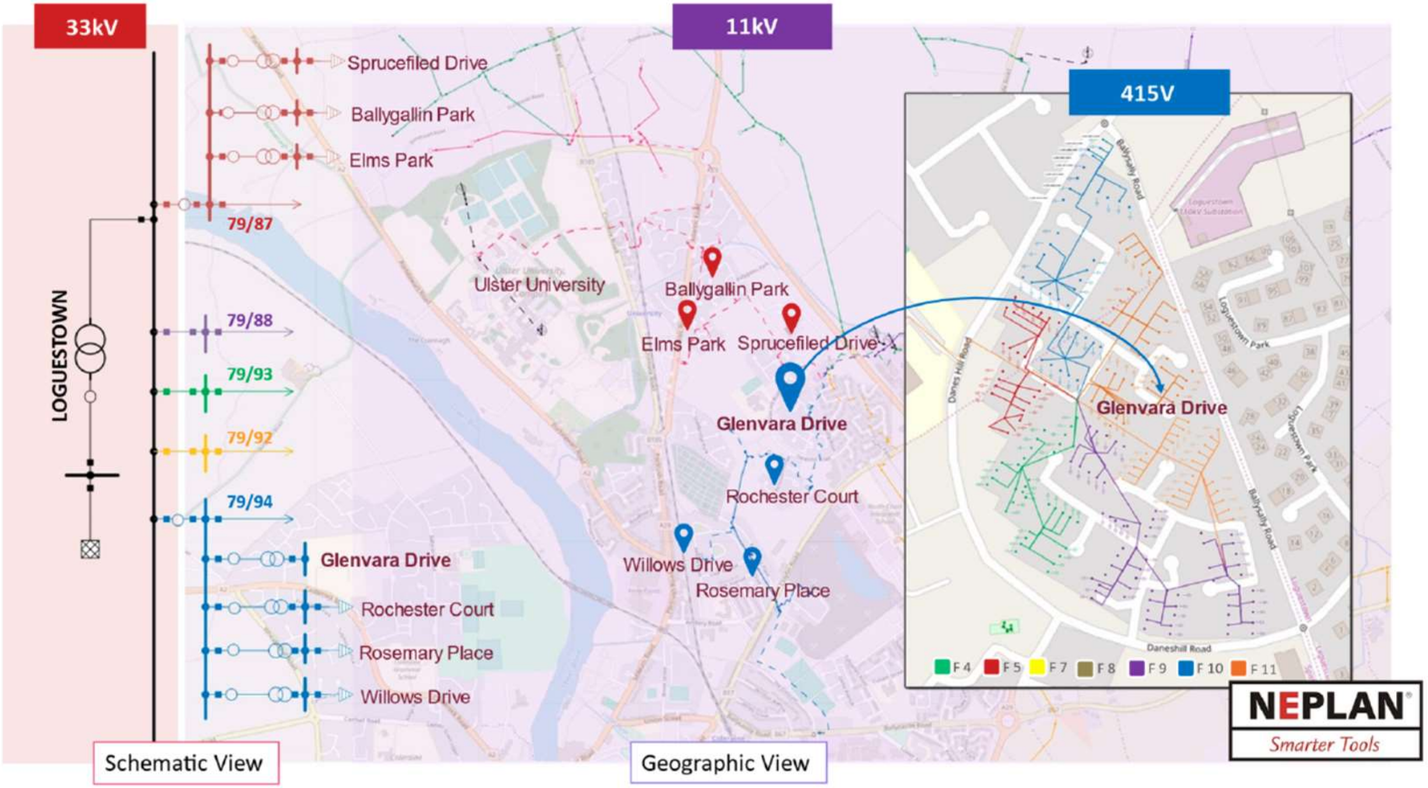
DC electronic load



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



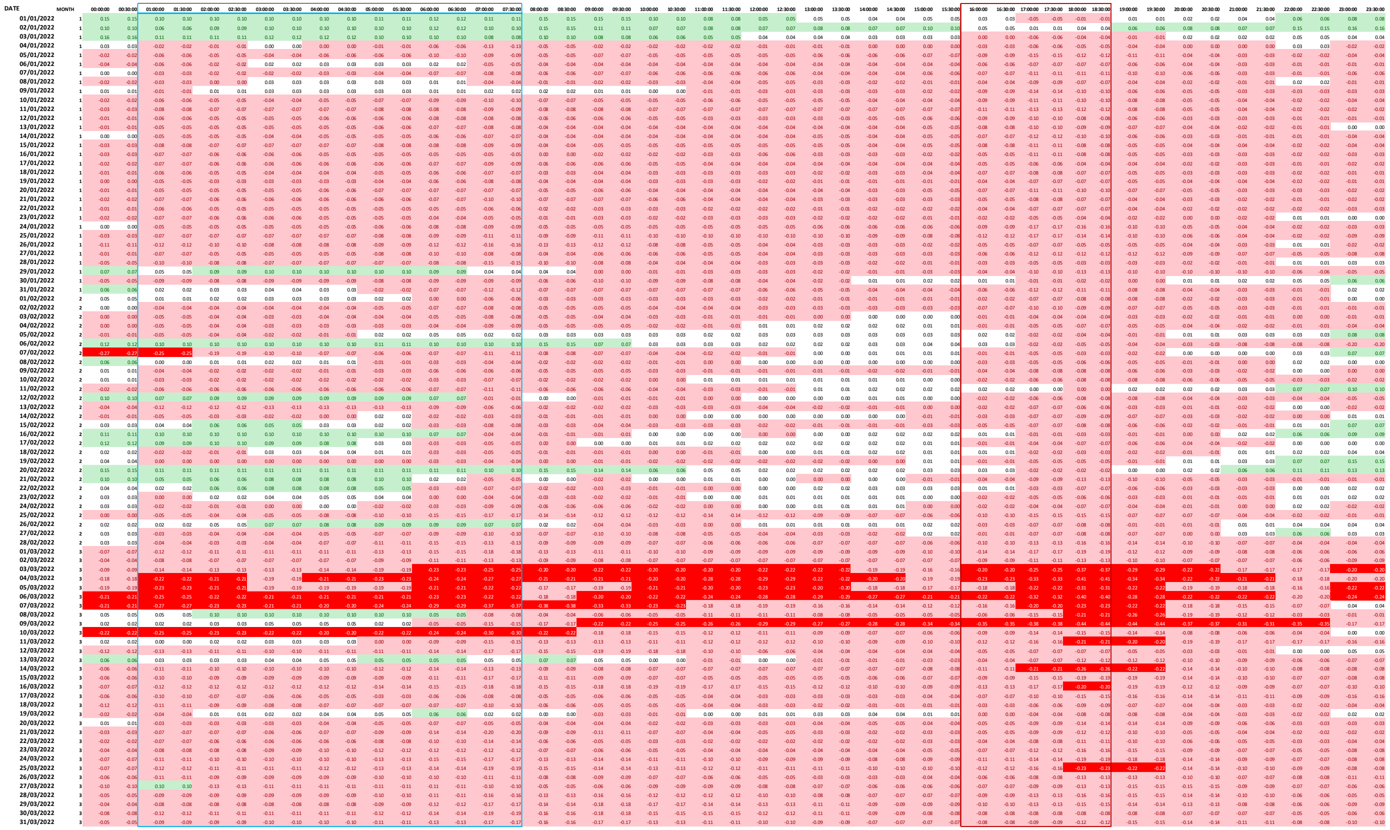
Osaru Agbonaye, Patrick Keatley, Ye Huang, Oluwasola O. Ademulegun, Neil Hewitt (2021) Mapping demand flexibility: A spatio-temporal assessment of flexibility needs, opportunities and response potential, Applied Energy, Volume 295

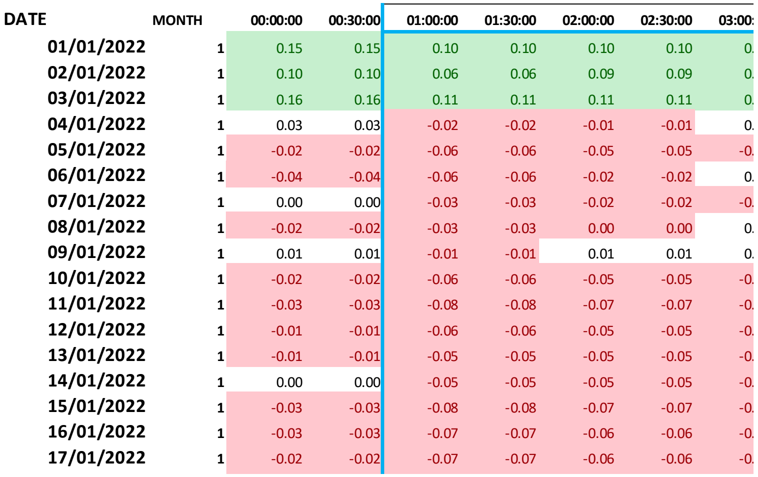
WP 3.2: Demand Side Management

WP 3.2: Demand Side Management

With Project Rulet and Dr Patrick Keatley

WP 3.2: Demand Side Management

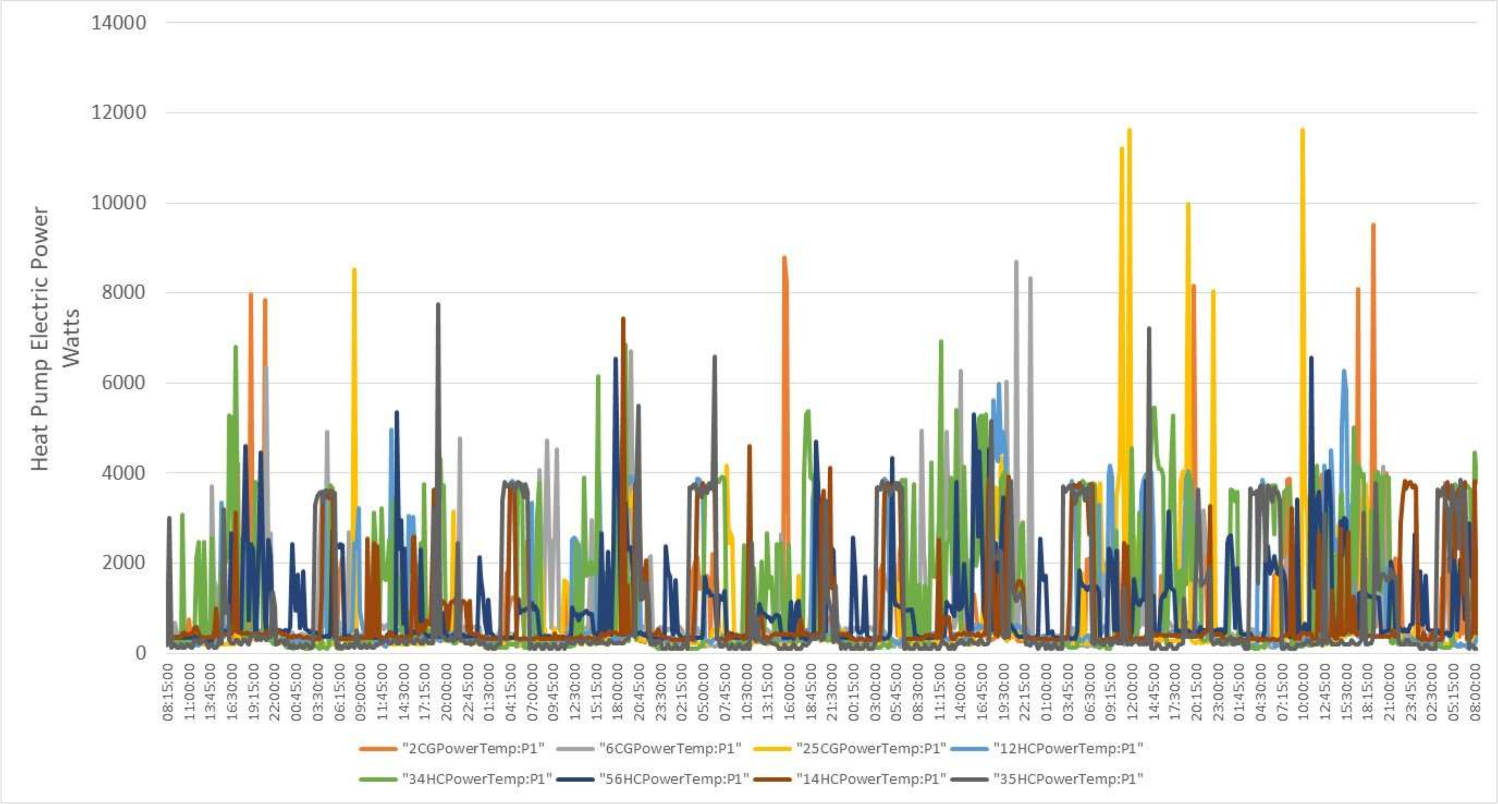




DATE	MONTH	00:00:00	00:30:00	01:00:00	01:30:00	02:00:00	02:30:00	03:00:
01/01/2022	1	0.15	0.15	0.10	0.10	0.10	0.10	0.
02/01/2022	1	0.10	0.10	0.06	0.06	0.09	0.09	0.
03/01/2022	1	0.16	0.16	0.11	0.11	0.11	0.11	0.
04/01/2022	1	0.03	0.03	-0.02	-0.02	-0.01	-0.01	0.
05/01/2022	1	-0.02	-0.02	-0.06	-0.06	-0.05	-0.05	-0.
06/01/2022	1	-0.04	-0.04	-0.06	-0.06	-0.02	-0.02	0.
07/01/2022	1	0.00	0.00	-0.03	-0.03	-0.02	-0.02	-0.
08/01/2022	1	-0.02	-0.02	-0.03	-0.03	0.00	0.00	0.
09/01/2022	1	0.01	0.01	-0.01	-0.01	0.01	0.01	0.
10/01/2022	1	-0.02	-0.02	-0.06	-0.06	-0.05	-0.05	-0.
11/01/2022	1	-0.03	-0.03	-0.08	-0.08	-0.07	-0.07	-0.
12/01/2022	1	-0.01	-0.01	-0.06	-0.06	-0.05	-0.05	-0.
13/01/2022	1	-0.01	-0.01	-0.05	-0.05	-0.05	-0.05	-0.
14/01/2022	1	0.00	0.00	-0.05	-0.05	-0.05	-0.05	-0.
15/01/2022	1	-0.03	-0.03	-0.08	-0.08	-0.07	-0.07	-0.
16/01/2022	1	-0.03	-0.03	-0.07	-0.07	-0.06	-0.06	-0.
17/01/2022	1	-0.02	-0.02	-0.07	-0.07	-0.06	-0.06	-0.

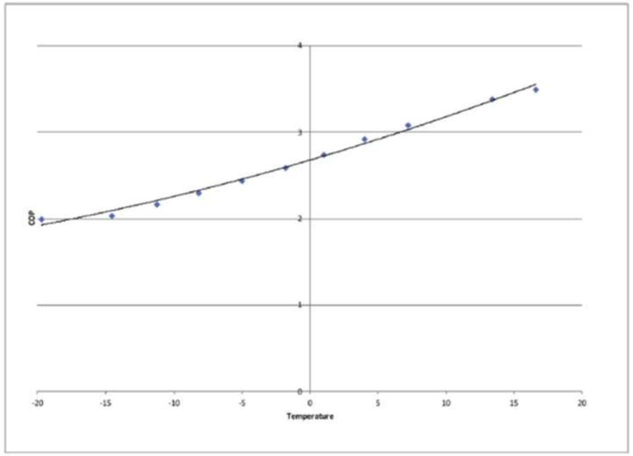
Green = Trial (plus network costs, etc) cheaper than E7; white is when E7 = Trial; pink is when Trial > E7; red is when Trial >20p more expensive than E7.

WP 3.2: Demand Side Management

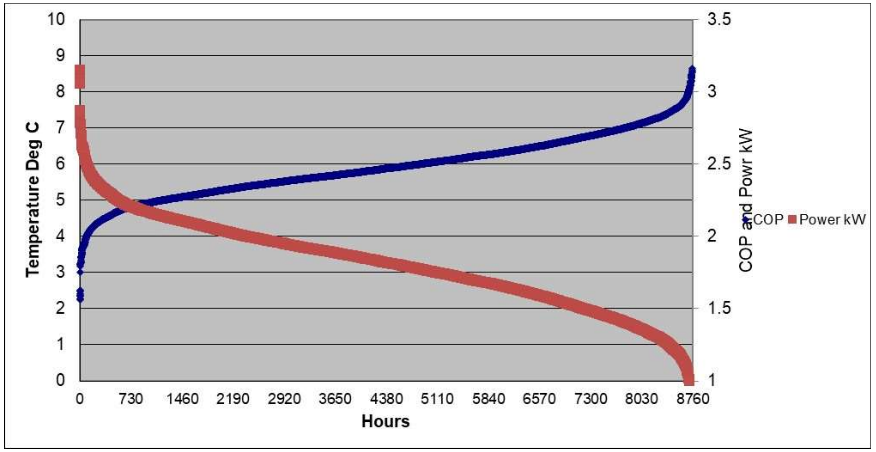


WP 3.2: Demand Side Management

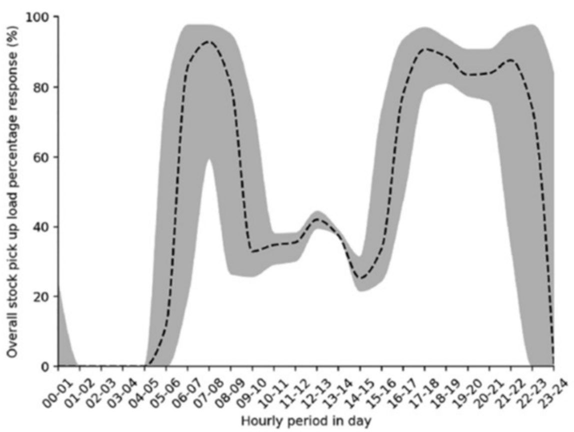
Numerous authors consider After Diversity Maximum Demand (community types, social etc.)
A range of UK values is typically from 1.3 kW to 1.93 kW per household per heat pump.



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….

sirach LoT-NET IOR.org.uk REFRIGERATION AIR CONDITIONING HEAT PUMPS

LoT-NET

Low Temperature Heat Recovery &
Distribution Network Technologies

Questions?