HOARE LEA

5th International Conference on Smart Energy Systems and 4th Generation District Heating

Thermal Supply Peak Shaving in 5th Generation Balanced Energy Networks

MICHAEL-ALLAN MILLAR

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District Heating

1st to 4th Generation and Beyond

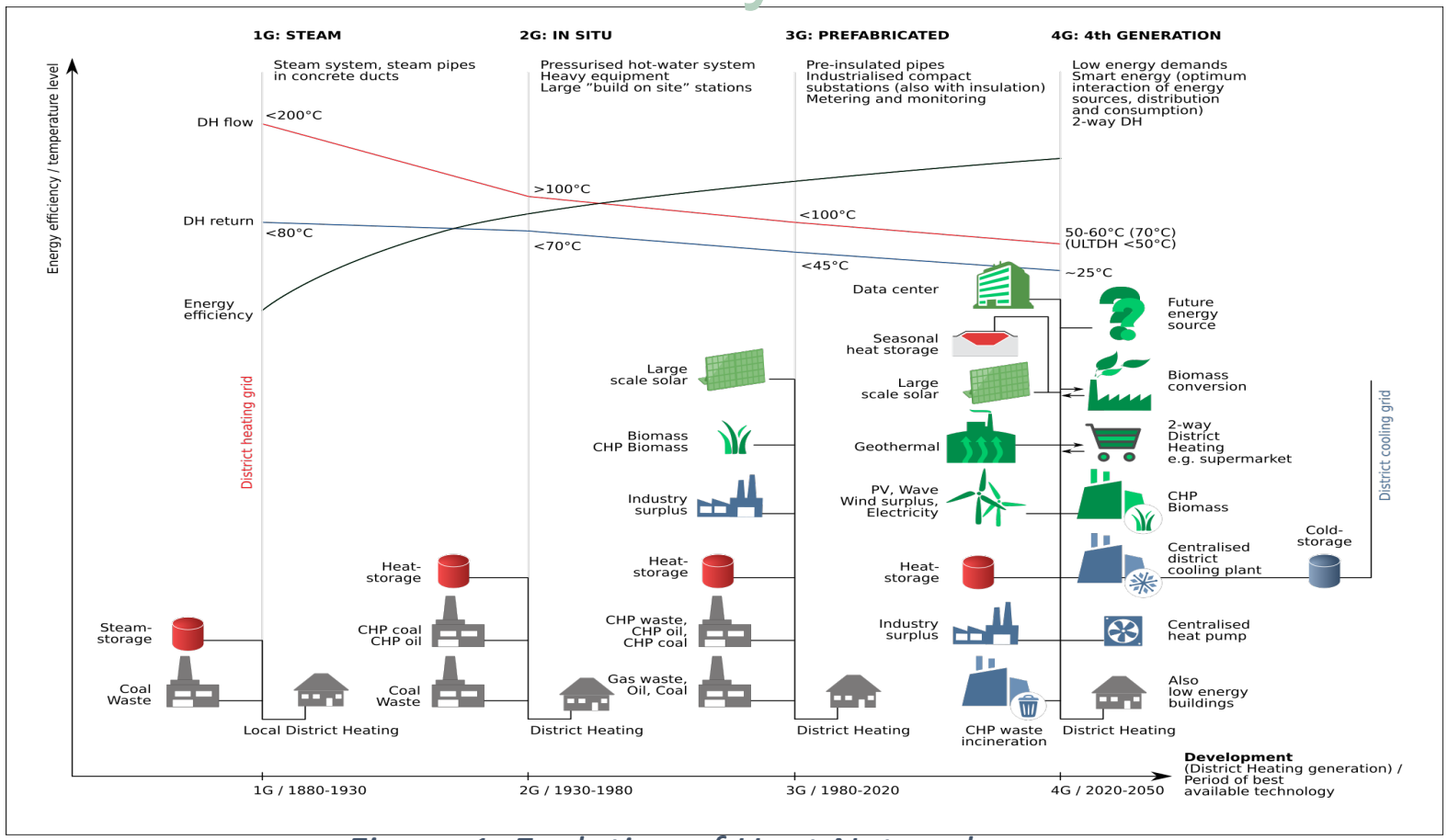

Figure 1. Evolution of Heat Networks

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5th Generation Energy Sharing Networks

The Goal

- Ambient loop distribution circa. 25-40ºC
- Can be used for heating and cooling
- Could be individual heat pumps or sub-stations
- Supplemented by Low/zero Carbon source

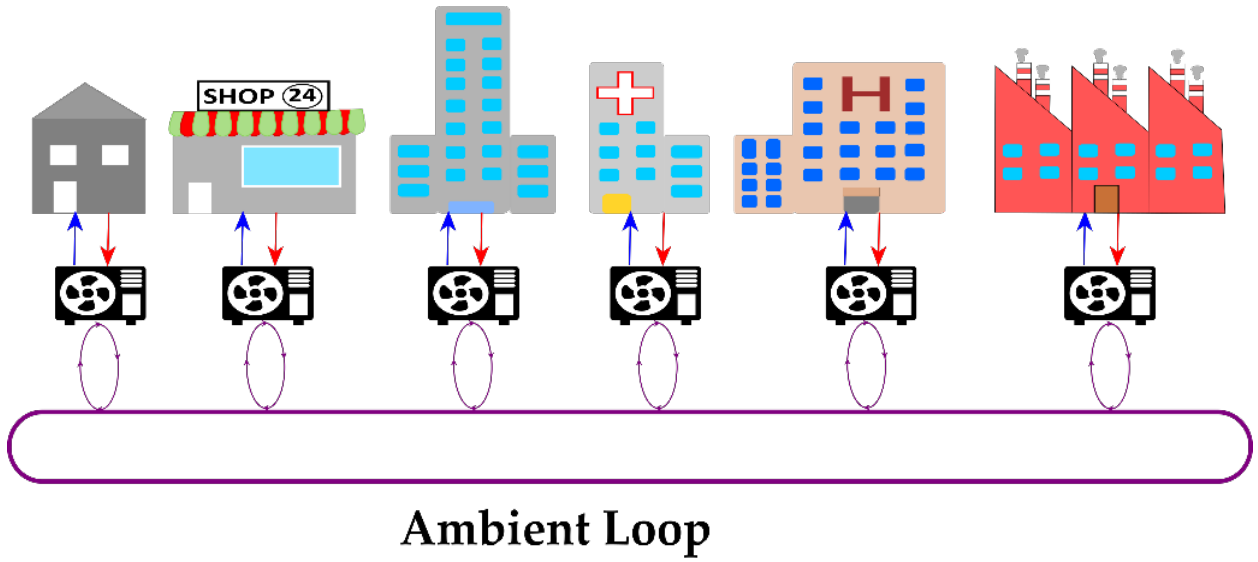

Figure 2. 5G Heat Network with Ambient Loop

District Heating

DECARBONIZATION OF HEAT

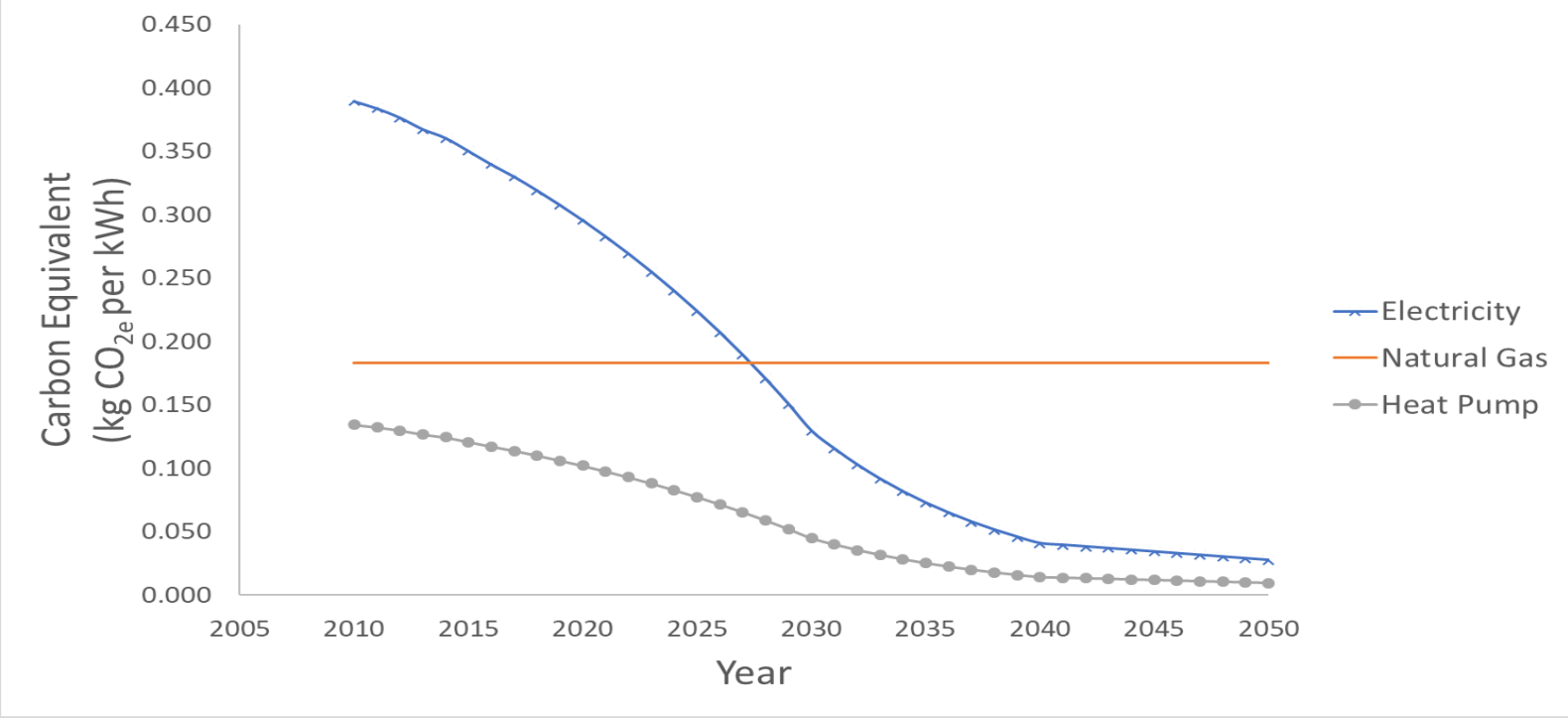

Figure 3. Decarbonization graph of electricity, natural gas and heat pumps.

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The Goal

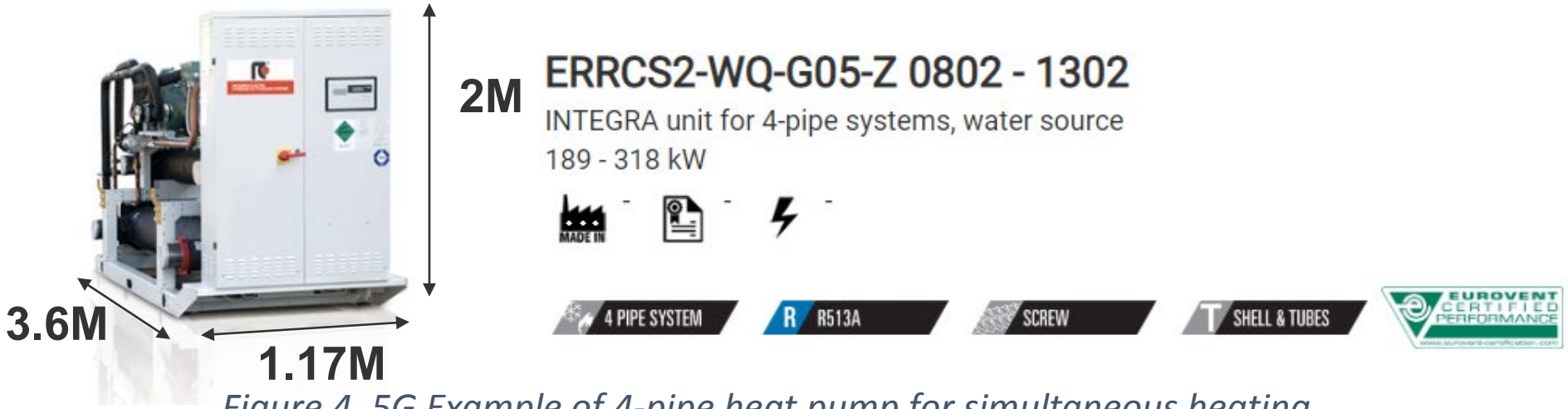

Figure 4. 5G Example of 4-pipe heat pump for simultaneous heating and cooling

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Load Profiles

Load Profiler Tool

- Internal Tool developed by Hoare Lea
- Uses energy modelling data to provide normalized loads

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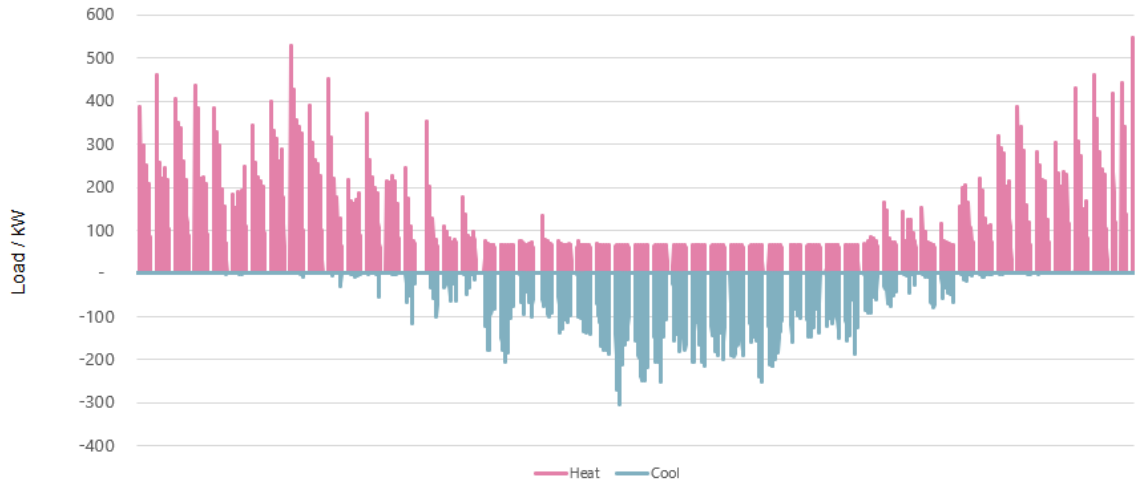
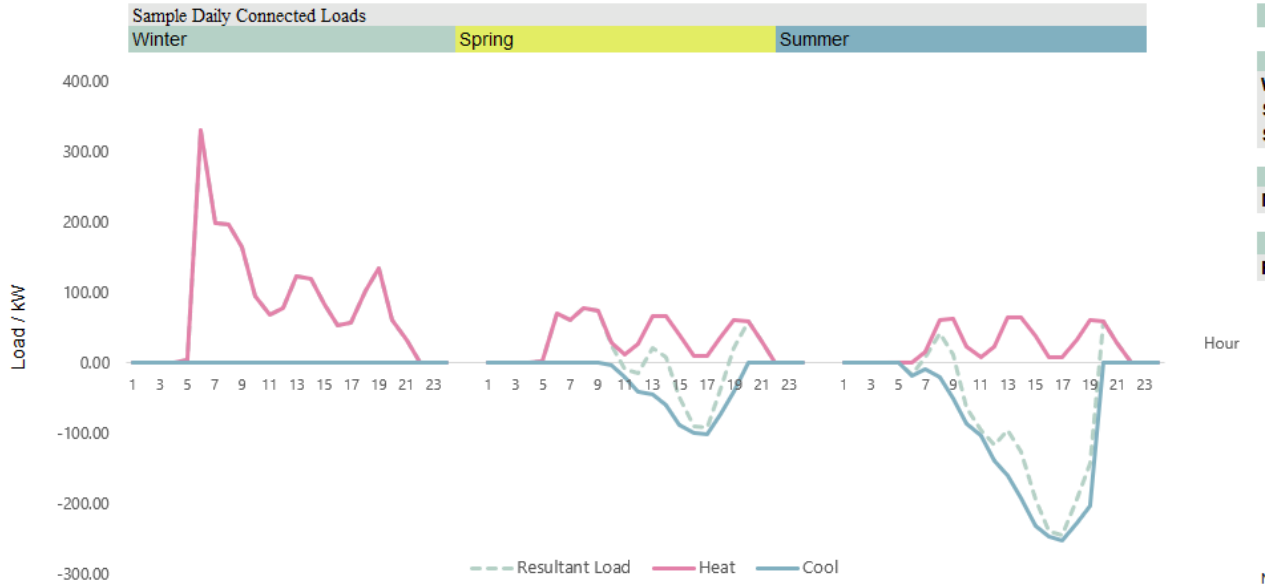
Load Profiles

Office Space

- 10’000m^2 office space
- 254MWh heating
- 131MWh cooling





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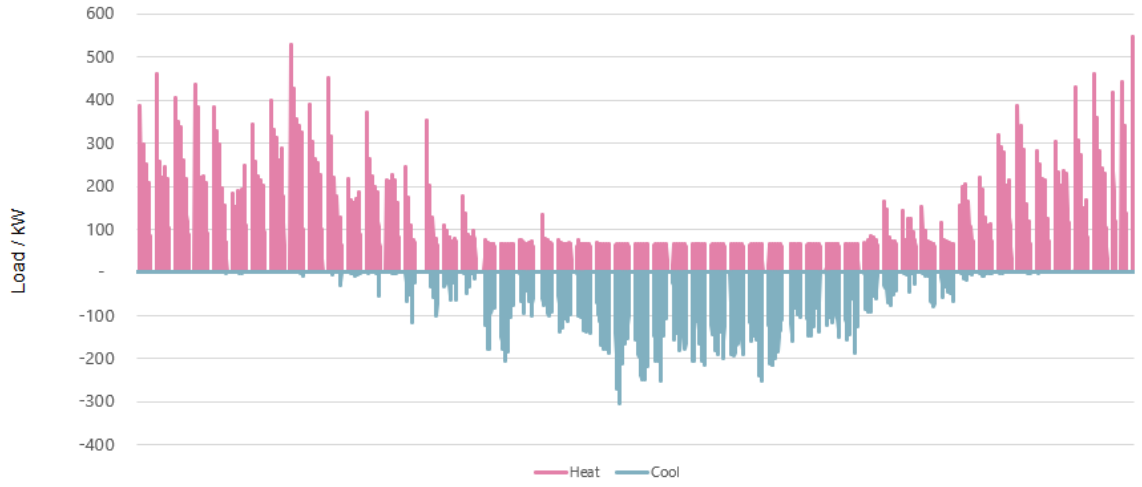
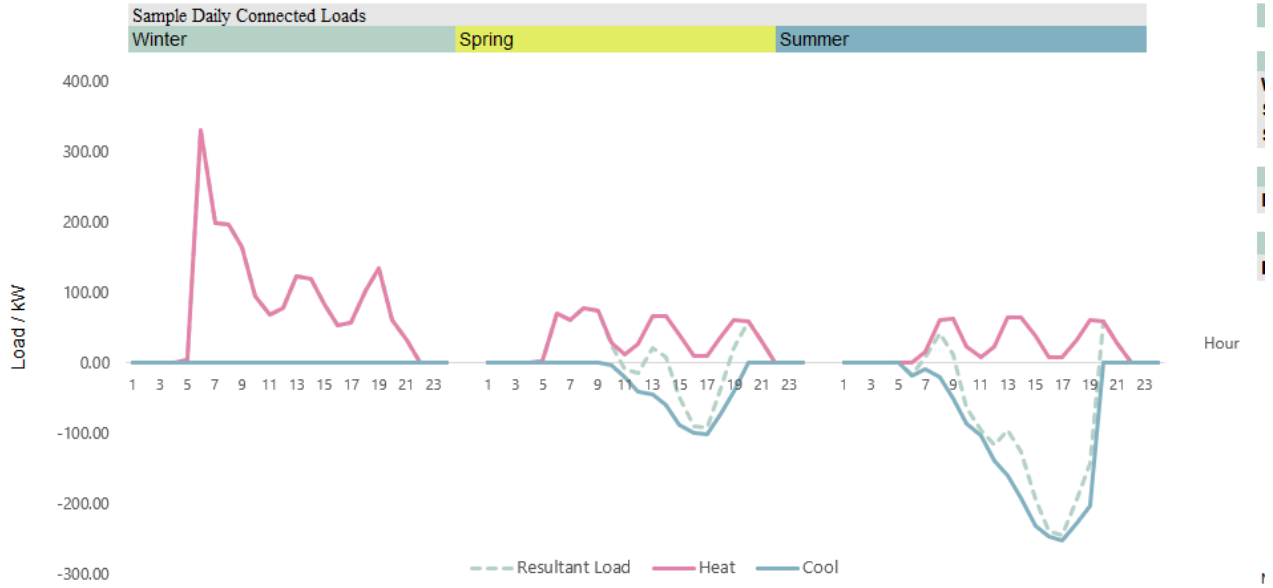
Load Profiles

Retail

- 200m² retail space
- 0.9MWh heating
- 16MWh cooling
- Does not include refrigeration cooling
- Includes heating effect from refrigerators





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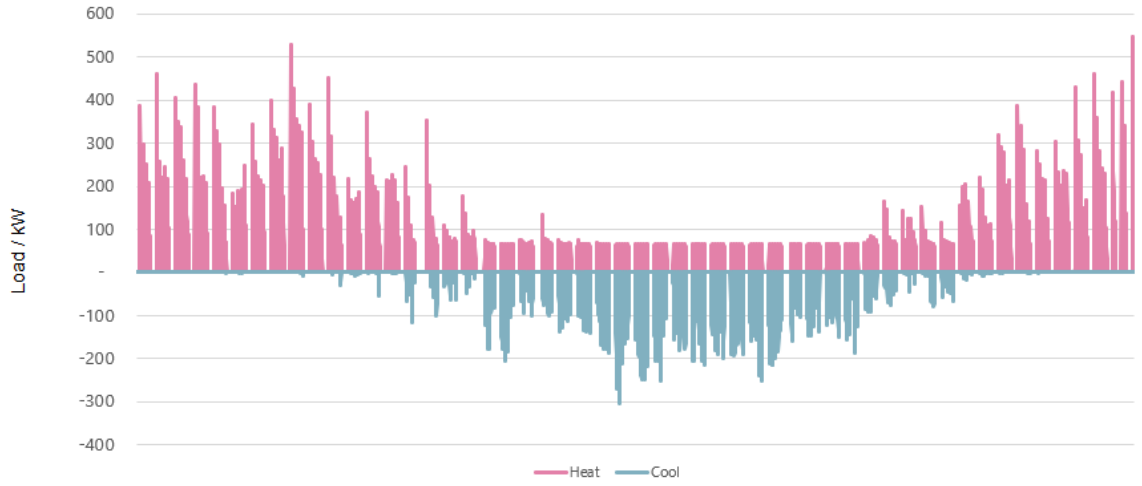
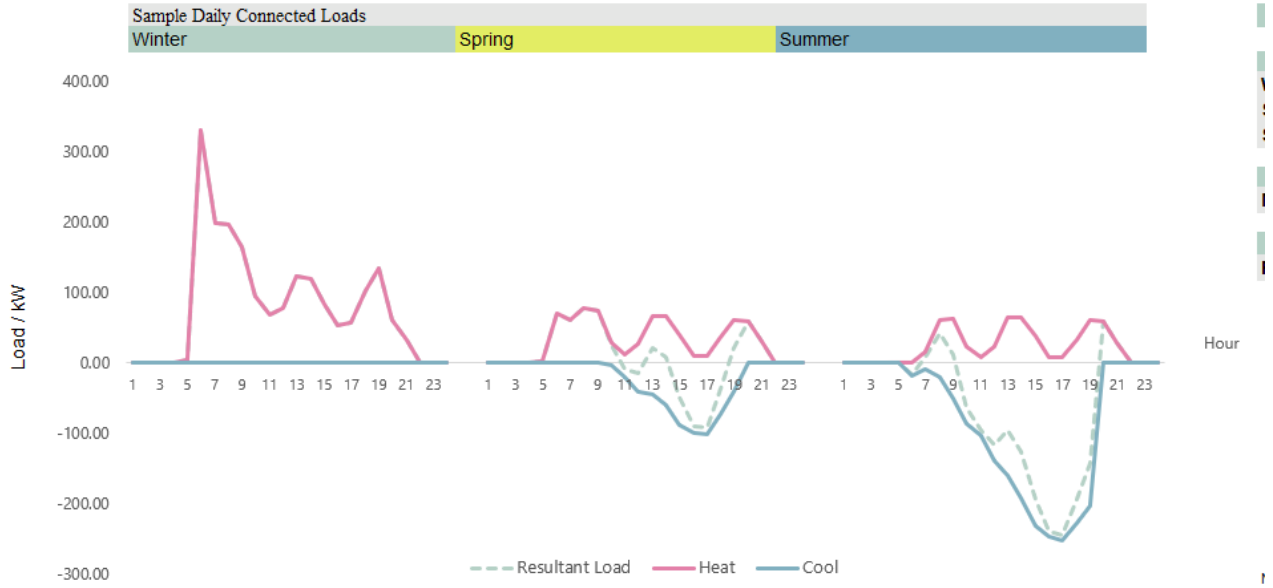
Load Profiles

Residential Space

- 85m^2 residential space
- 5MWh heating
- Cooling omitted due to lack of current cooling infrastructure in domestic dwellings





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5th Generation Energy Sharing Networks

Who can share?

- For typical type sizes

Table 1. Energy and Power Summary for Unit Buildings

Building Type	Total Energy Load for single units using heat pumps (kWh)				Peak Loads (kW)		
	Total Heat	Total Cooling	Offset Heat	Offset Cooling	Peak Heating	Peak Cooling	Peak Electrical
Residential (85m²)	5'617	143	190	3'744	4	<1	1.33
Office (10'000m²)	337'849	322'390	429'853	225'232	144	461	153.67
Retail (200m²)	944	15'629	20'838	629	8	14	4.67

10'000m² office space ≈ 76 residential dwellings

200m² retail space ≈ 3 residential dwellings

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5th Generation Energy Sharing Networks
Optimisation

- Begin With Cost Optimization

$$\min \sum_{n=1}^{8759} P_{hp,h,n} \times C_{el,n,k} + P_{hp,c,n} \times C_{el,n,k} \quad (1)$$

$$Q_{dem,h} = Q_{hp,h,i} + Q_{TES,h,out} + Q_{hp,off,h,i} \quad (2)$$

- Need to consider influence decarbonisation of heat has on electrical grid
- Use time of use tariffs to minimise effect on grid

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5th Generation Energy Sharing Networks

Is it Worthwhile?

- Time of use tariffs for peak smoothing

Table 3. Time of use tariff costs for domestic and non-domestic users

	Domestic (p/kWh)			Non-Domestic (p/kWh)	
Time Period	Domestic Unrestricted	Low Voltage Network Domestic (Mon-Fri)	Low Voltage Network Domestic (Sat-Sun)	SP Distribution Low Voltage Half-Hourly Metered 2019 (Mon-Fri)	SP Distribution Low Voltage Half-Hourly Metered 2019 (Sat-Sun)
00:00-08:00	2.618	1.227	1.227	1.211	1.211
08:00-16:30	2.618	2.005	1.227	1.761	1.211
16:30-19:30	2.618	9.419	2.005	7.271	1.211
19:30-22:30	2.618	2.005	2.005	1.761	1.211
22:30-00:00	2.618	1.227	1.227	1.211	1.211

5th Generation Energy Sharing Networks
Load Duration Curves

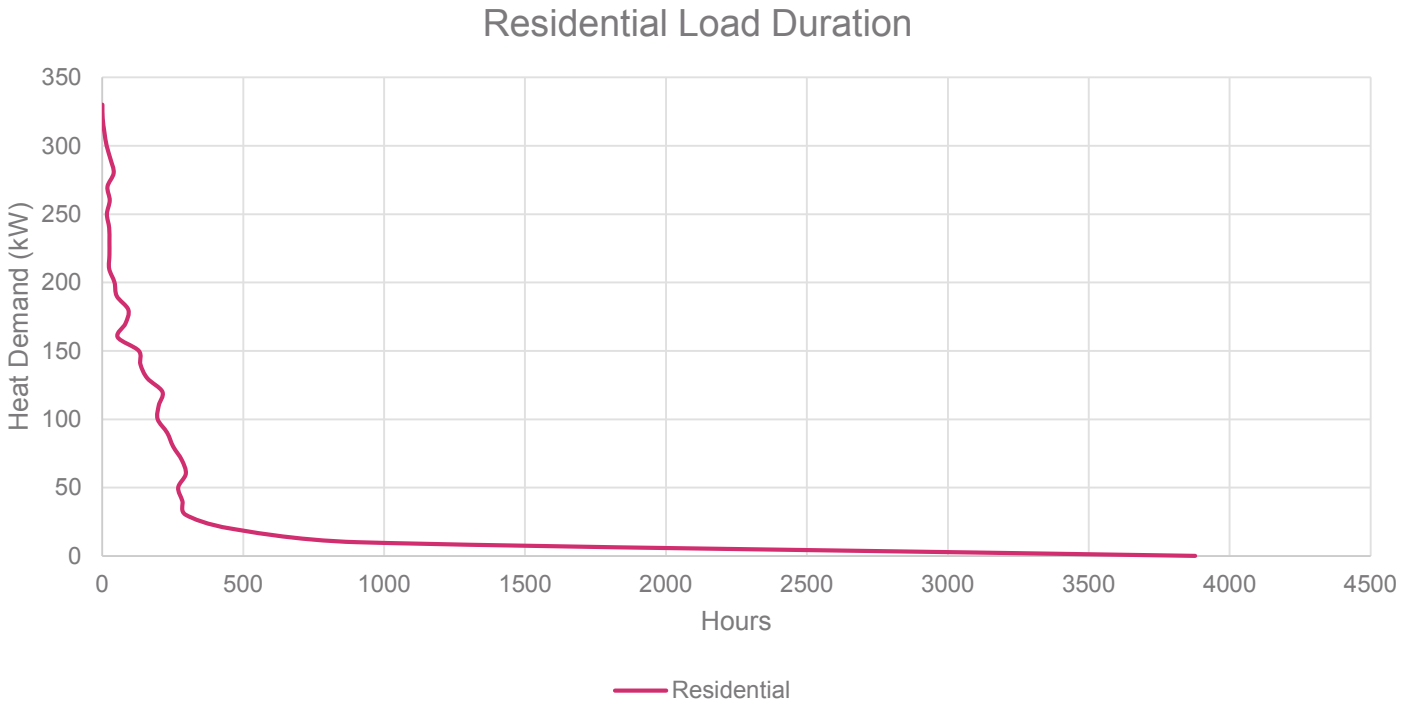

Figure 5. Residential Load Duration Curve for 76 dwellings

5th Generation Energy Sharing Networks
Load Duration Curves

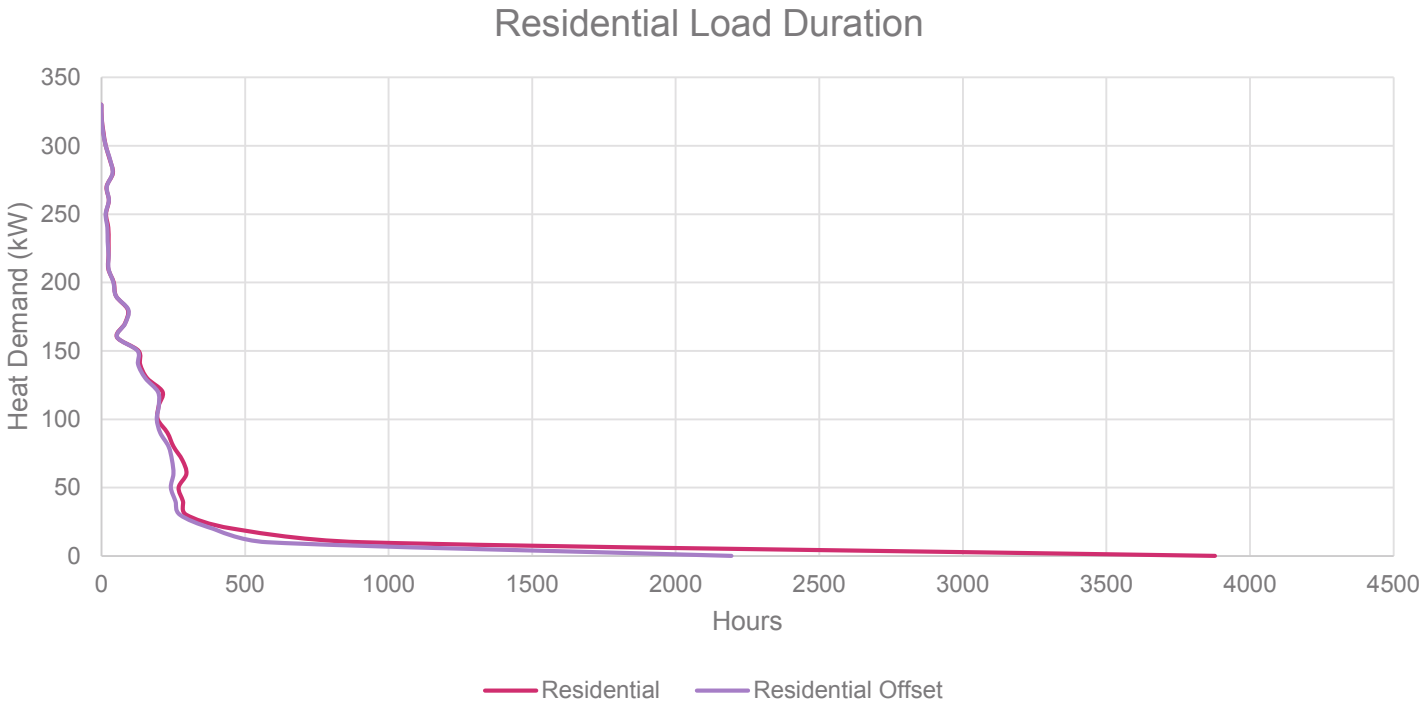

Figure 6. Residential Load Duration Curve for 76 dwellings

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Next Steps

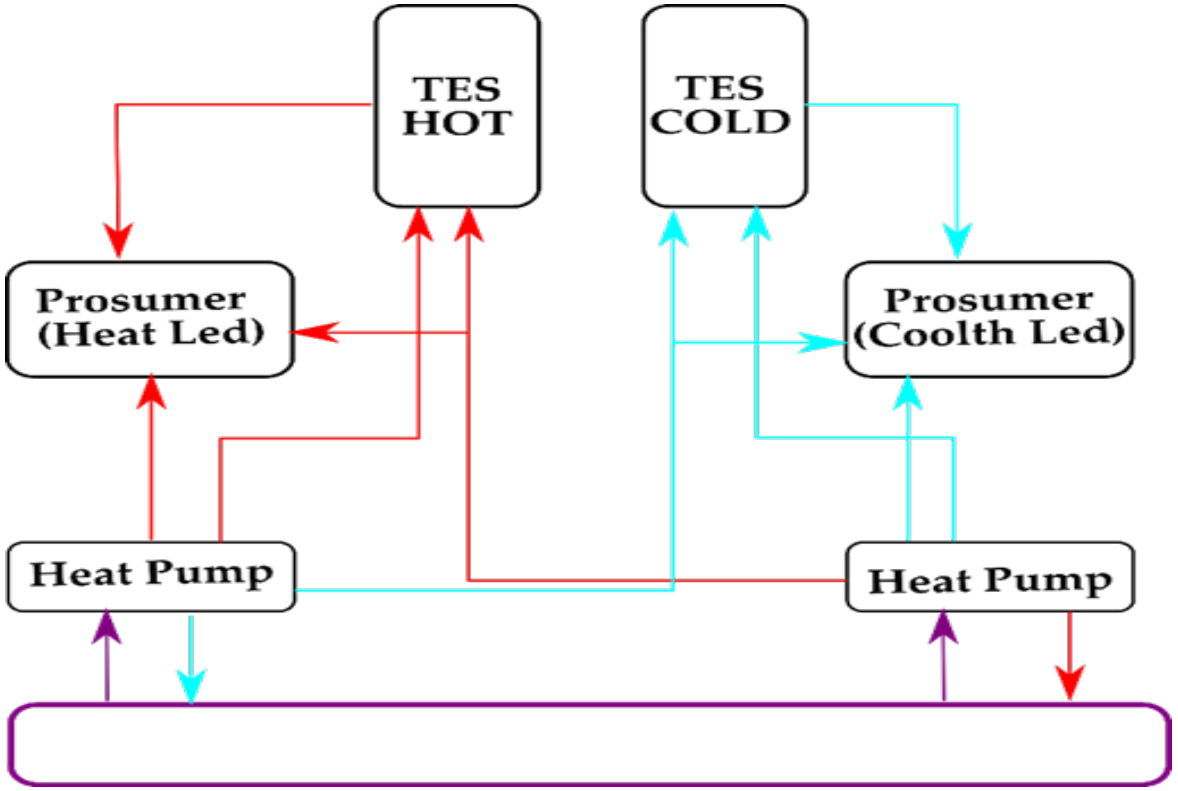

Figure 7. Block diagram of 5G heat network showing hot streams (red) cold streams (blue) and the ambient loop (purple).

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5th Generation Energy Sharing Networks

Next Steps

- Identify and Include additional heating/cooling loads (e.g. supermarket refrigeration)
- Develop dynamic model in TRNSYS tool

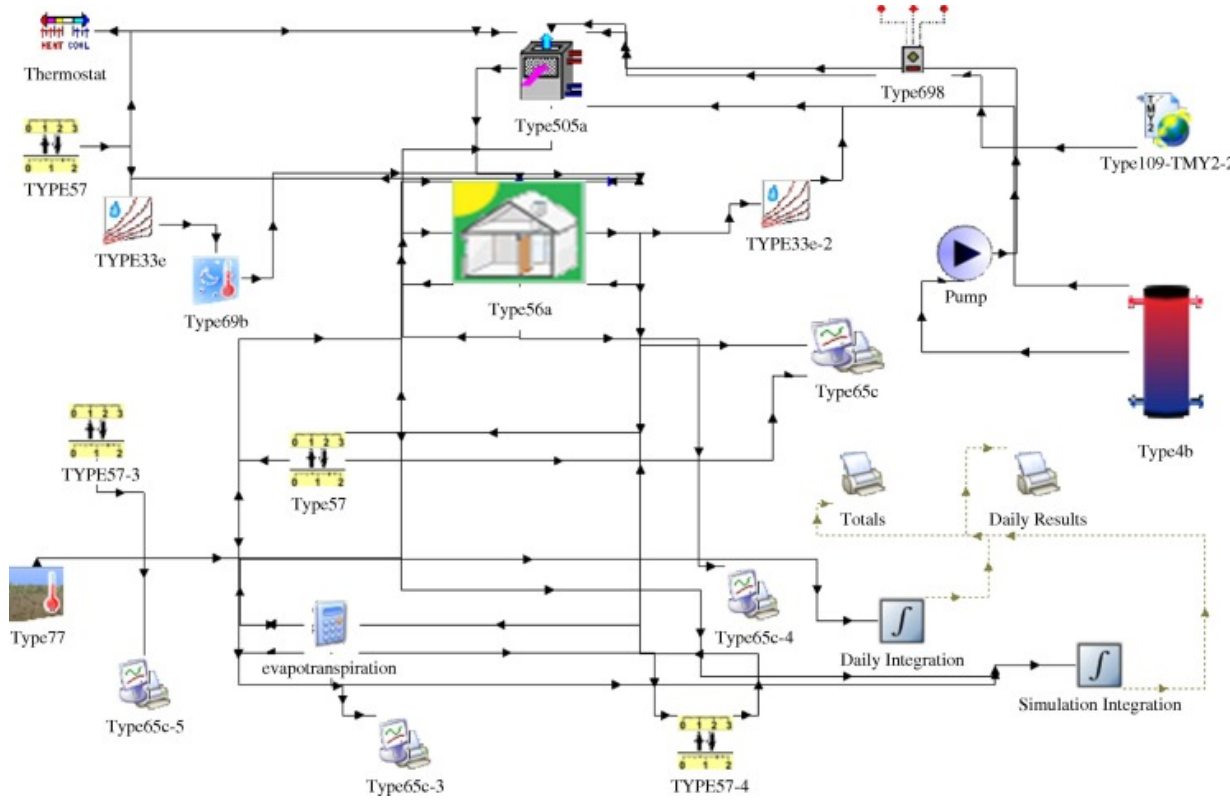

Figure 8. Example TRNSYS model

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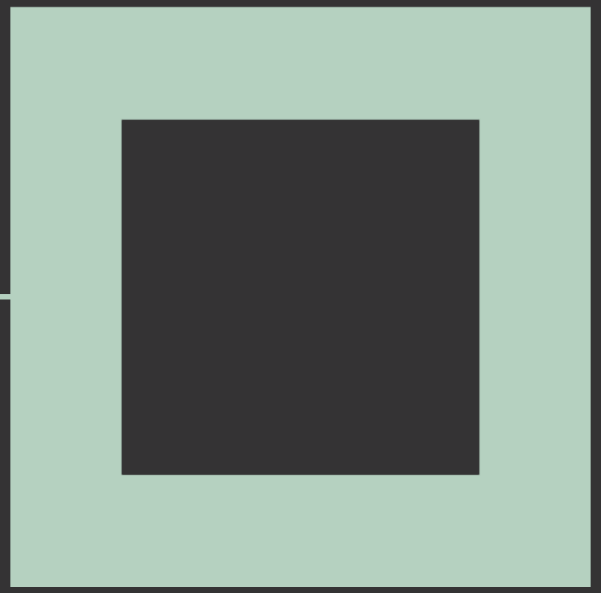

Thank you.
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