LoT-NET

Low Temperature Heat Recovery &
Distribution Network Technologies

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REFRIGERATION AIR CONDITIONING HEAT PUMPS

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Heat Network Delivery: The Warwick Case Study

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WARWICK
THE UNIVERSITY OF WARWICK

Ulster University

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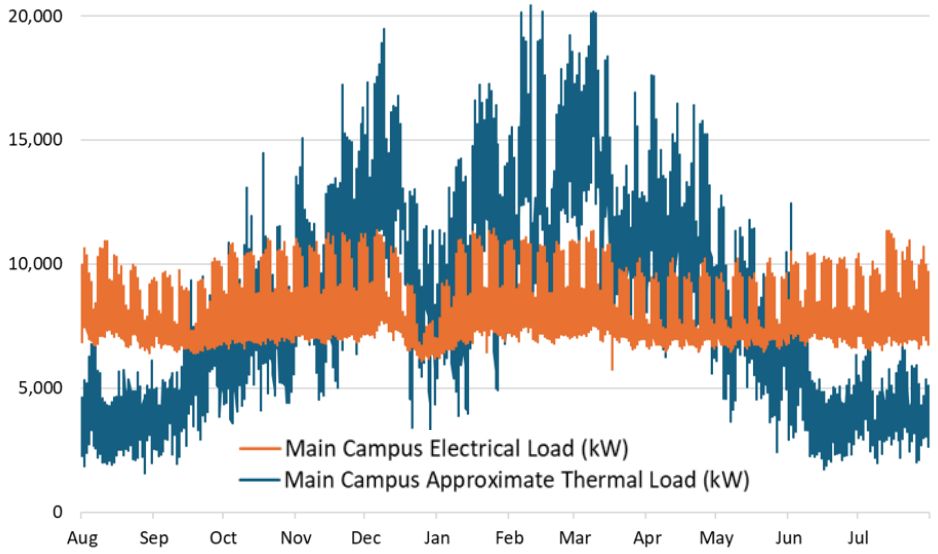
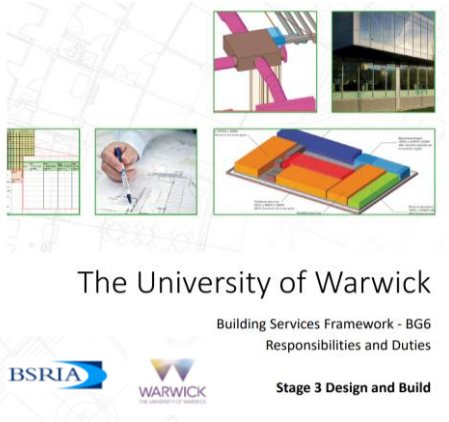
Loughborough University

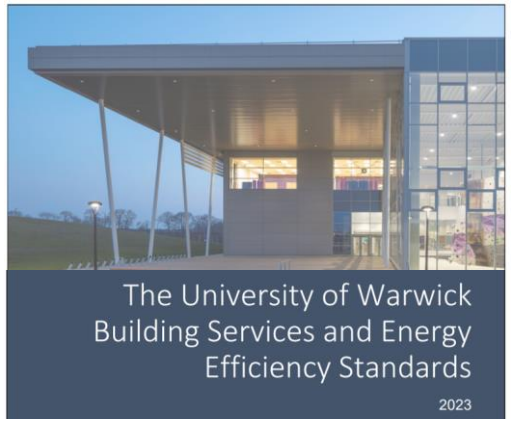
University of Warwick: Reduce, Decarbonise, Smart

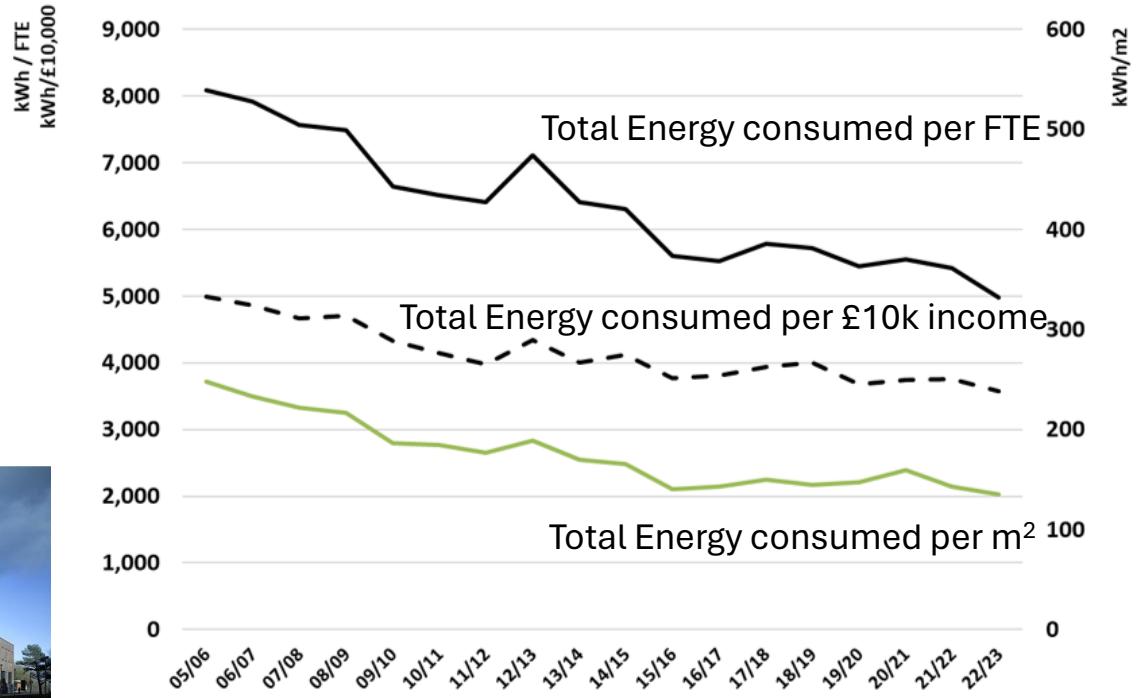
- Warwick's campus – a 'town' of 30,000
  - We operate both the electricity network and a heating/cooling network
  - One of the first Universities to publish a Carbon Management Implementation Plan in 2011
  - Reduced Scope 1&2 emissions by 40-60% per unit space, income & FTE between 2006-2021 but only by 18% overall due to 40% growth
- Declared a Climate Emergency in 2019
  - Net zero for Scope 1&2 by 2030, also Scope 3 by 2050
  - Rethink needed: bold not incremental
- Reduce – 20% further reductions through standards & continuous improvement
- Decarbonise – 40% through sustainable heat centres & local PV
- Smart – aiming for the remaining 40% through being a smart, local energy system



Warwick: Setting standards to embed reductions



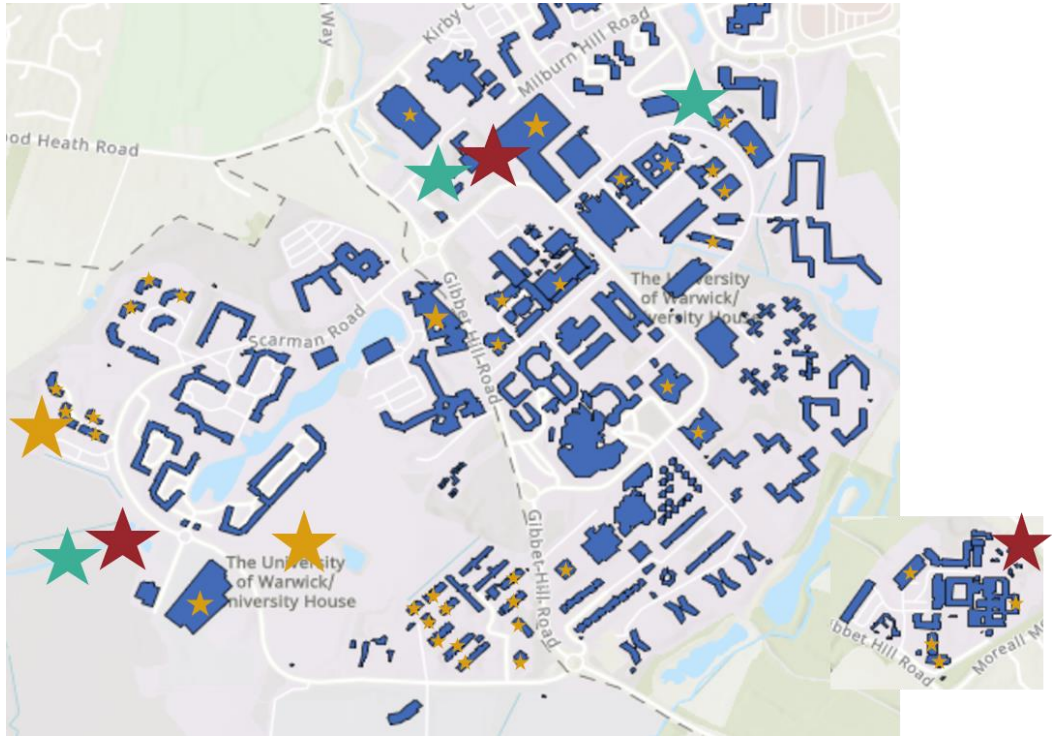




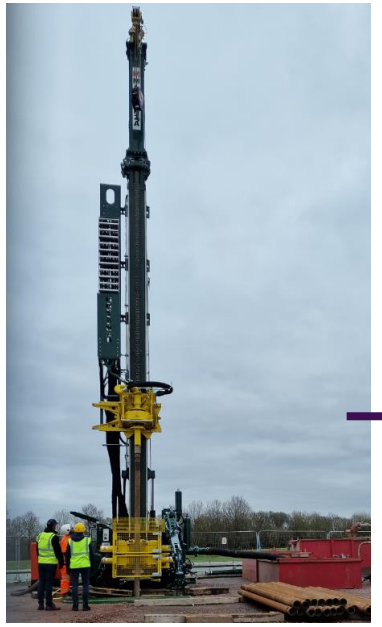
- Reducing the energy use has been matched by committing to purchase renewable electricity.
- Total market-based CO2 emissions reduced by 31% between 05/06 and 22/23.

Warwick: Decarbonising both electricity & heat

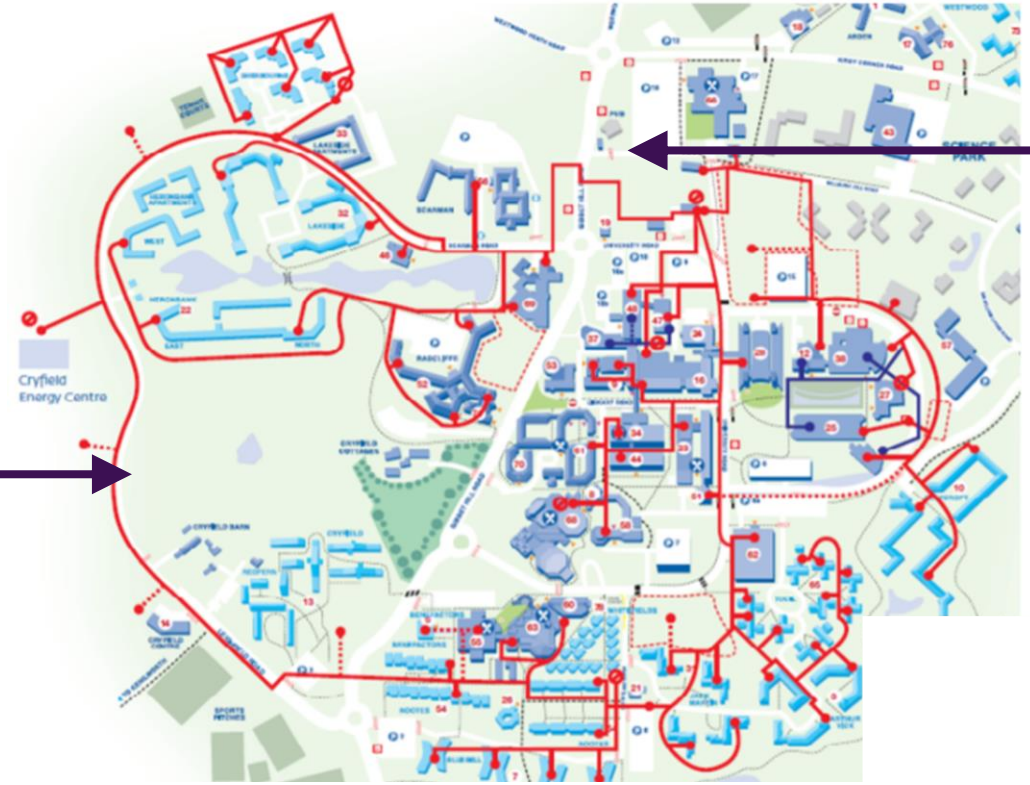
- Shut down the gas burning Combined Heat & Power plants over time….
  - Central energy centre already on standby, saving 2500t CO_2/yr
- Sustainable Heat Centres
  - We've evaluated deep geothermal heat, medium depth ground source heat pumps (~300m), shallow ground source heap pumps (8m) and air source heat pumps as top ups for old buildings.
  - Test drilling for medium depth GSHPs started Dec 23
  - Draft Heat Purchase Agreement by mid 2024
- Solar (PV) – roof-top & ground
  - Pre-2024 roof-top solar: 1MW
  - 0.7MW more roof-top completing early 2024
  - 1.5MW more roof-top out to tender
  - 3+3MW ground arrays in 2024/5 to provide 90% of summer demand and reduce purchased power by 70-80% over the year



Warwick: Large Ground-source Heat Pumps to provide Sustainable Heat Centres



Cryfield Rig



Kirby Corner Rig

Warwick: A Smarter Local Energy System

SMART □

- “Smart Square” making energy use more flexible
- Better, smarter buildings…
  - Monitoring & control standards
  - Making base loads flexible
- … as part of a smarter local energy system
  - Fewer peaks, less CAPEX
  - Lower temperature heat network
  - Flexibility to the network

710 acres (2.88 km^2)

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Residential Non-residential Car Park

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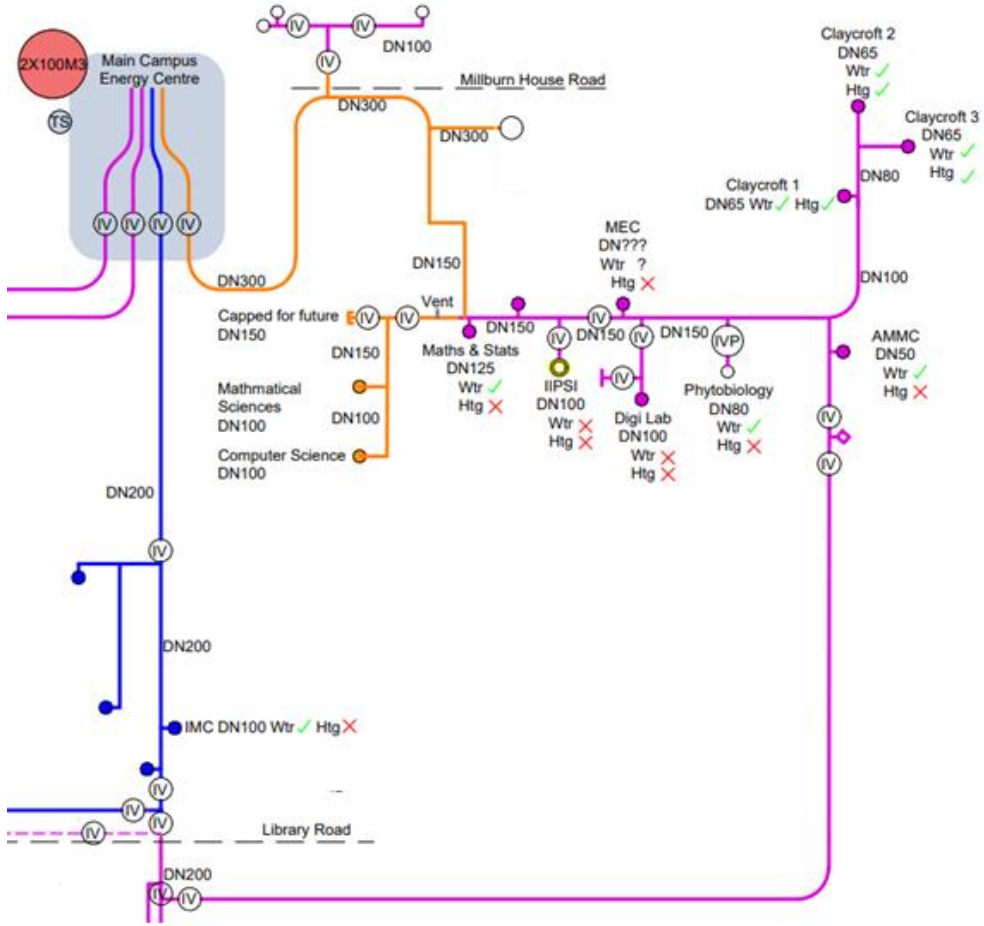
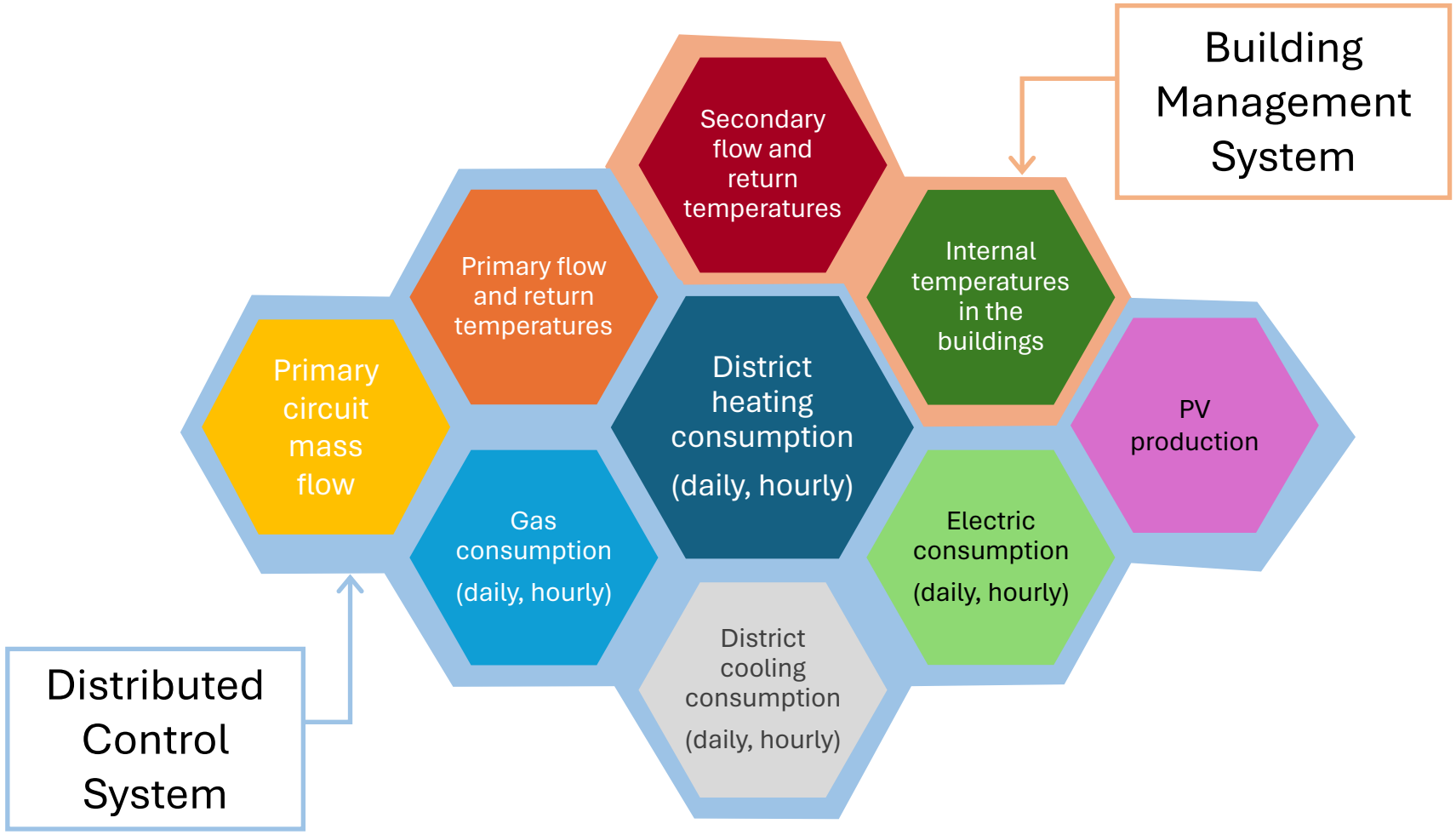
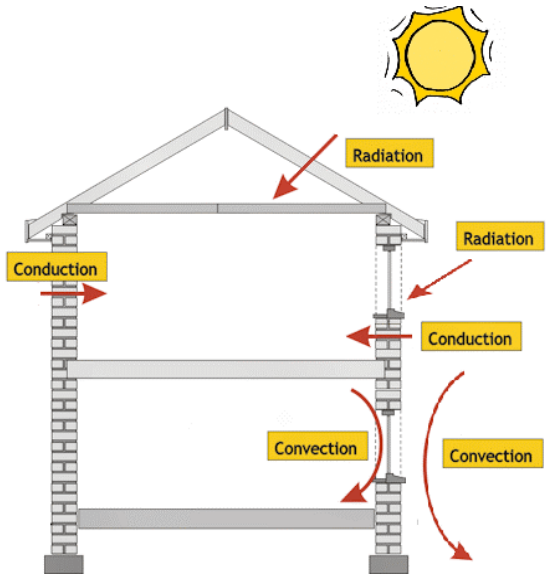


Smart Square: the need for comprehensive data



- Accurate and reliable internal temperatures are needed
- Also accurate and reliable secondary circuit temperature is needed
- BMS data was difficult to access as contractors managed it
- Rebooting needed for some building control systems
- Ultimately the need for DCS and BMS integration

Smart Square: adding thermal mass to building analysis



Thermal transmittance

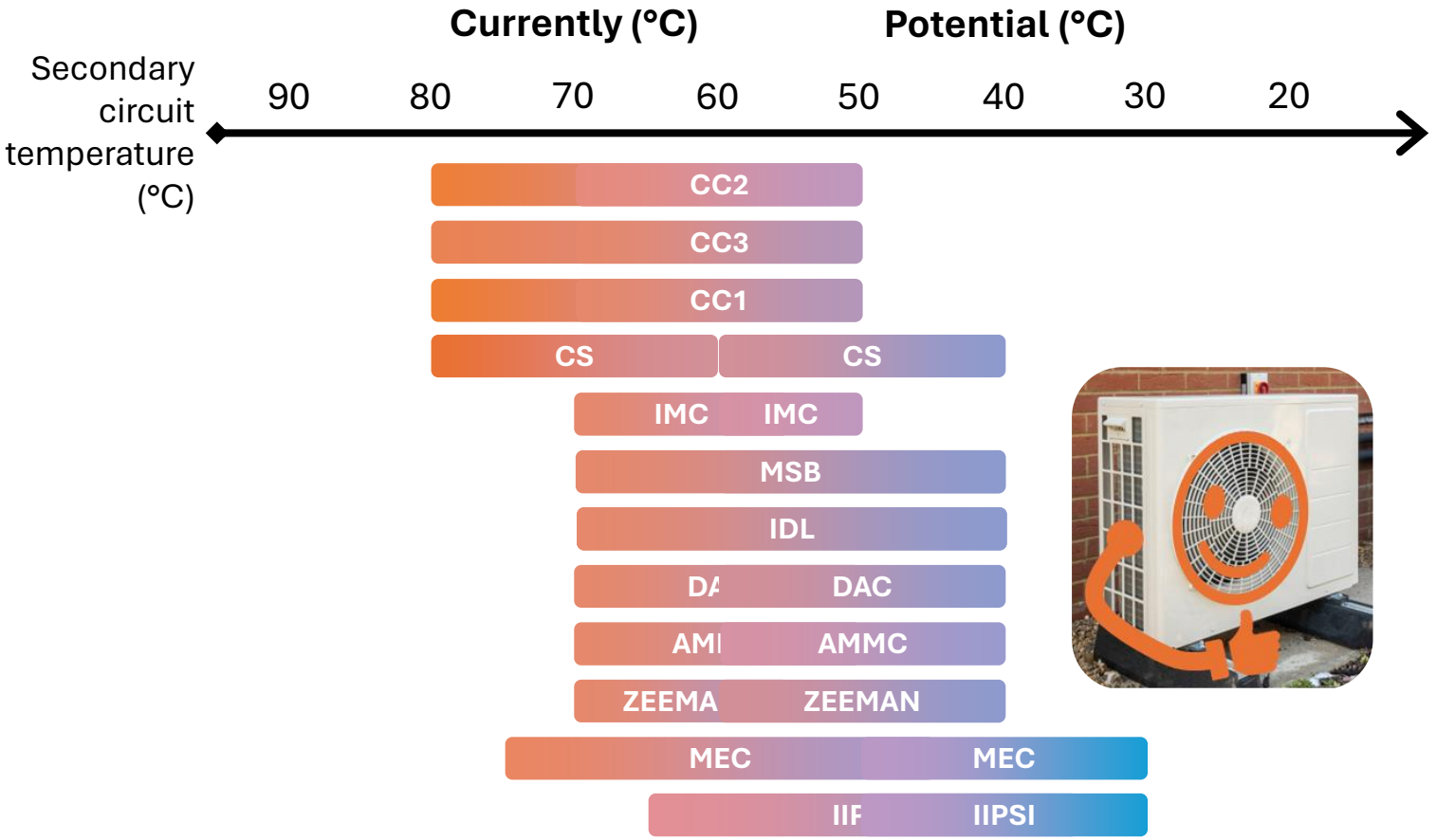
Thermal mass

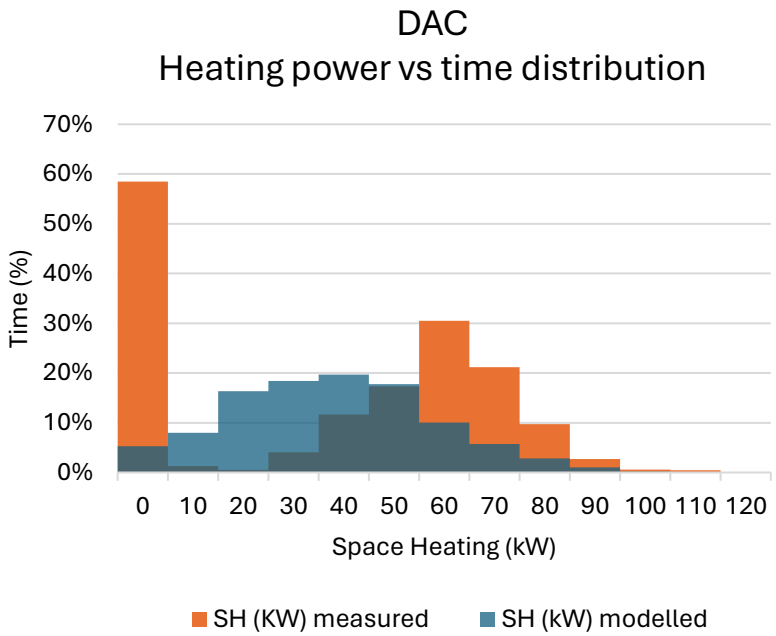
Solar gain

But...

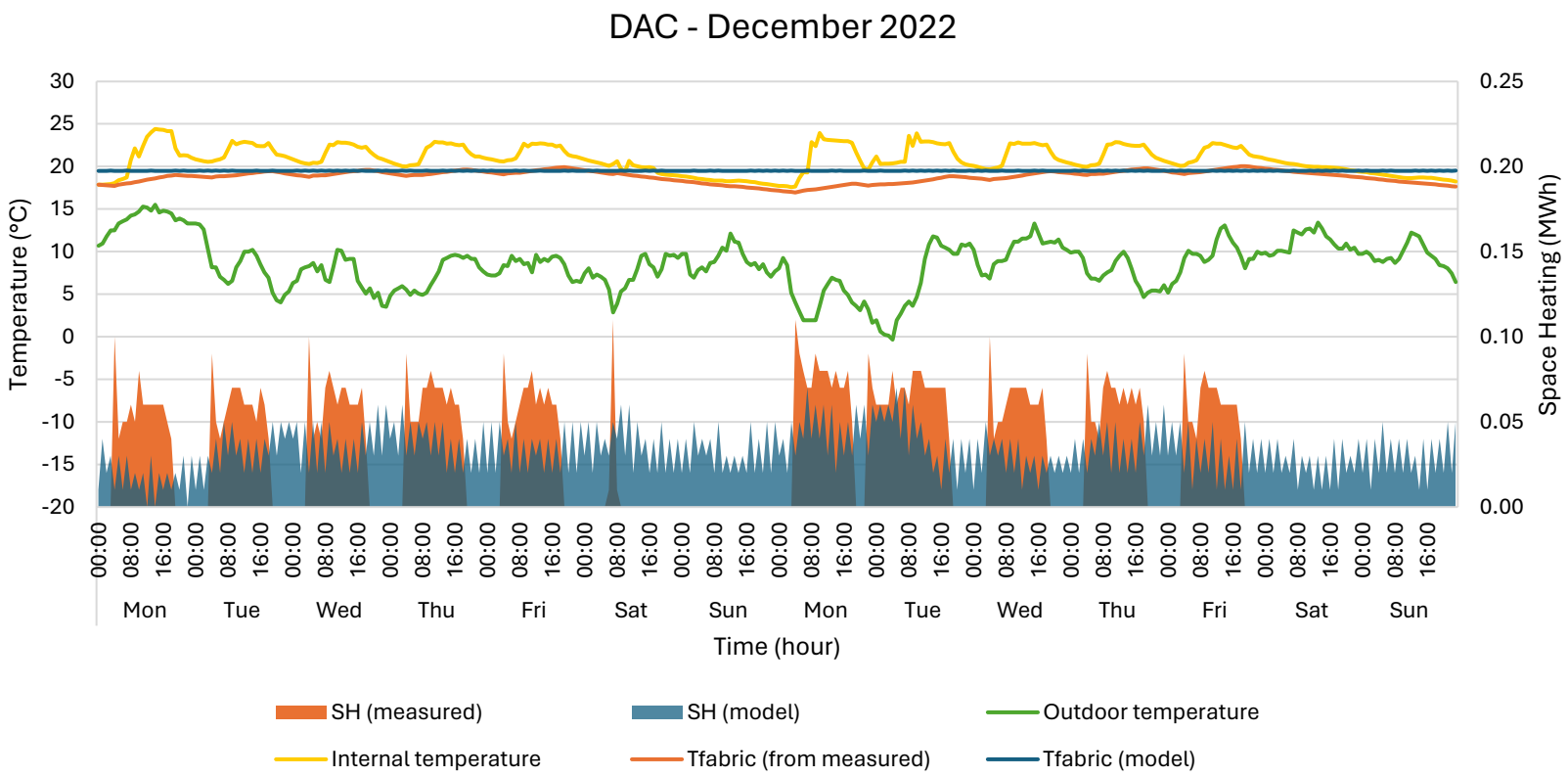
"Human factor"

Smart Square: reducing temperature in the district heating network





Smart Square: using building thermal mass to reduce peaks



Measured maximum Space Heating power: 0.11 MW

Low temperature network maximum Space Heating power: 0.07 MW

↓36%

Measured total Space Heating energy: 10.18 MWh

Low temperature network total Space Heating energy: 11.03 MWh

↑8%

When heat is electrified with Heat Pumps:

Current Space Heating profile COP: 1.72	**Lower temperature network Space Heating profile COP:** 3.15

Current temperature network Electrical energy consumption: 6.08 MWh

Lower temperature network Electrical energy consumption: 3.82 MWh

↓37%

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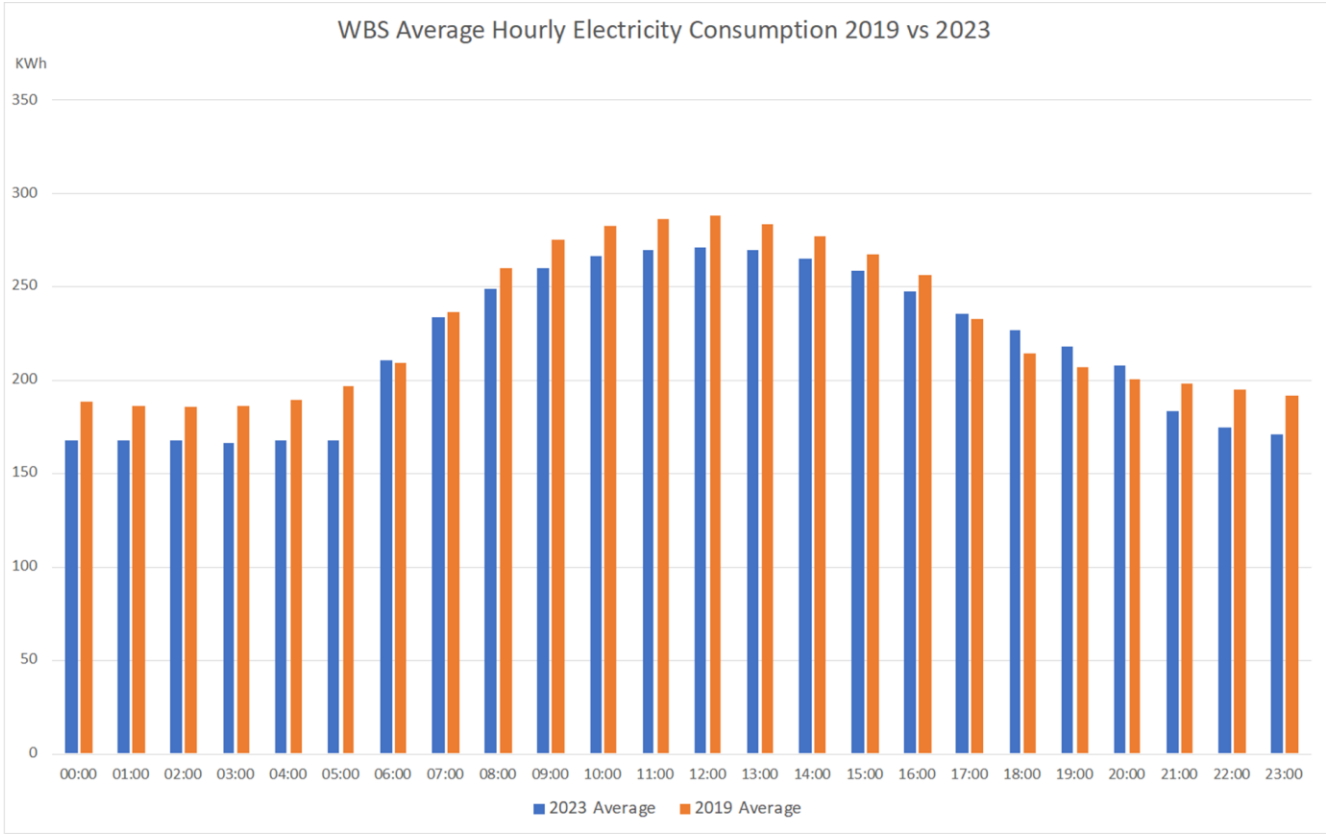
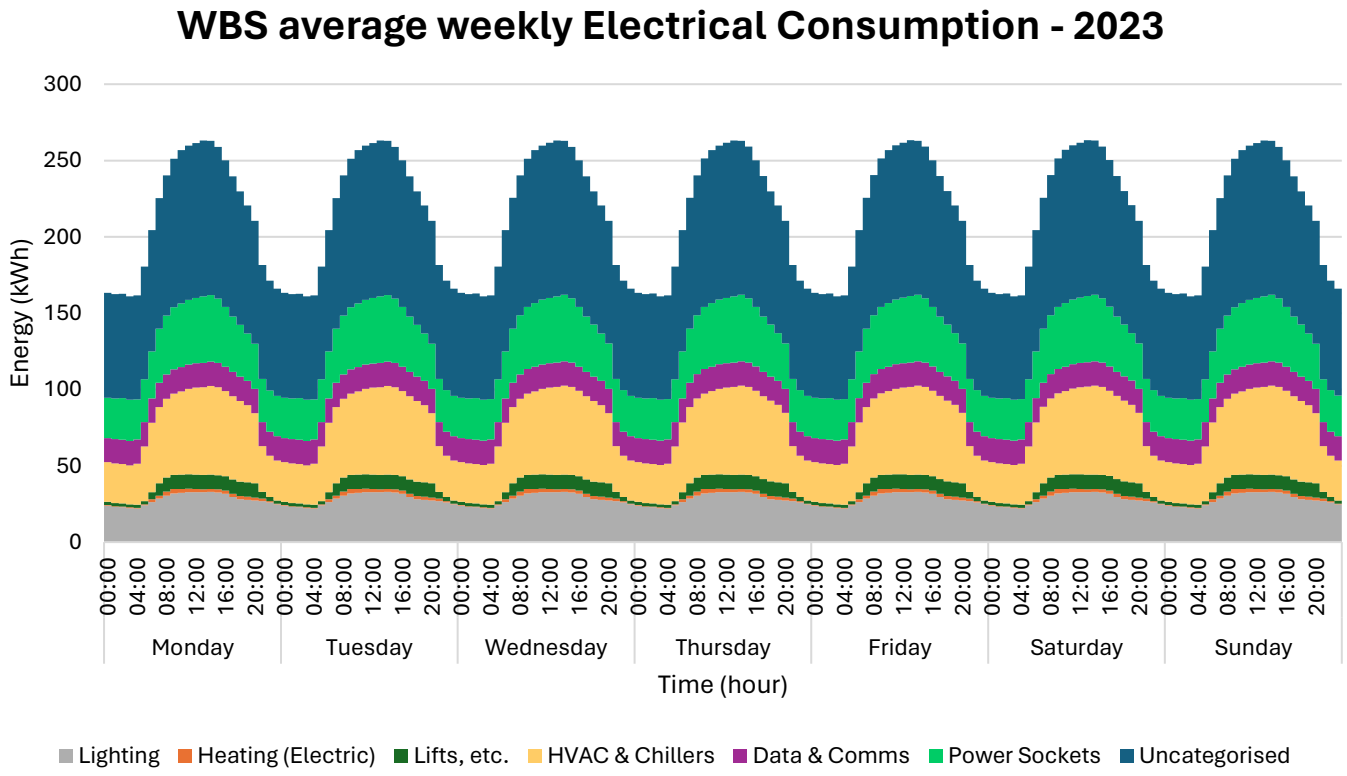
Warwick Business School: Changing Electrical Demand 2019 - 2023



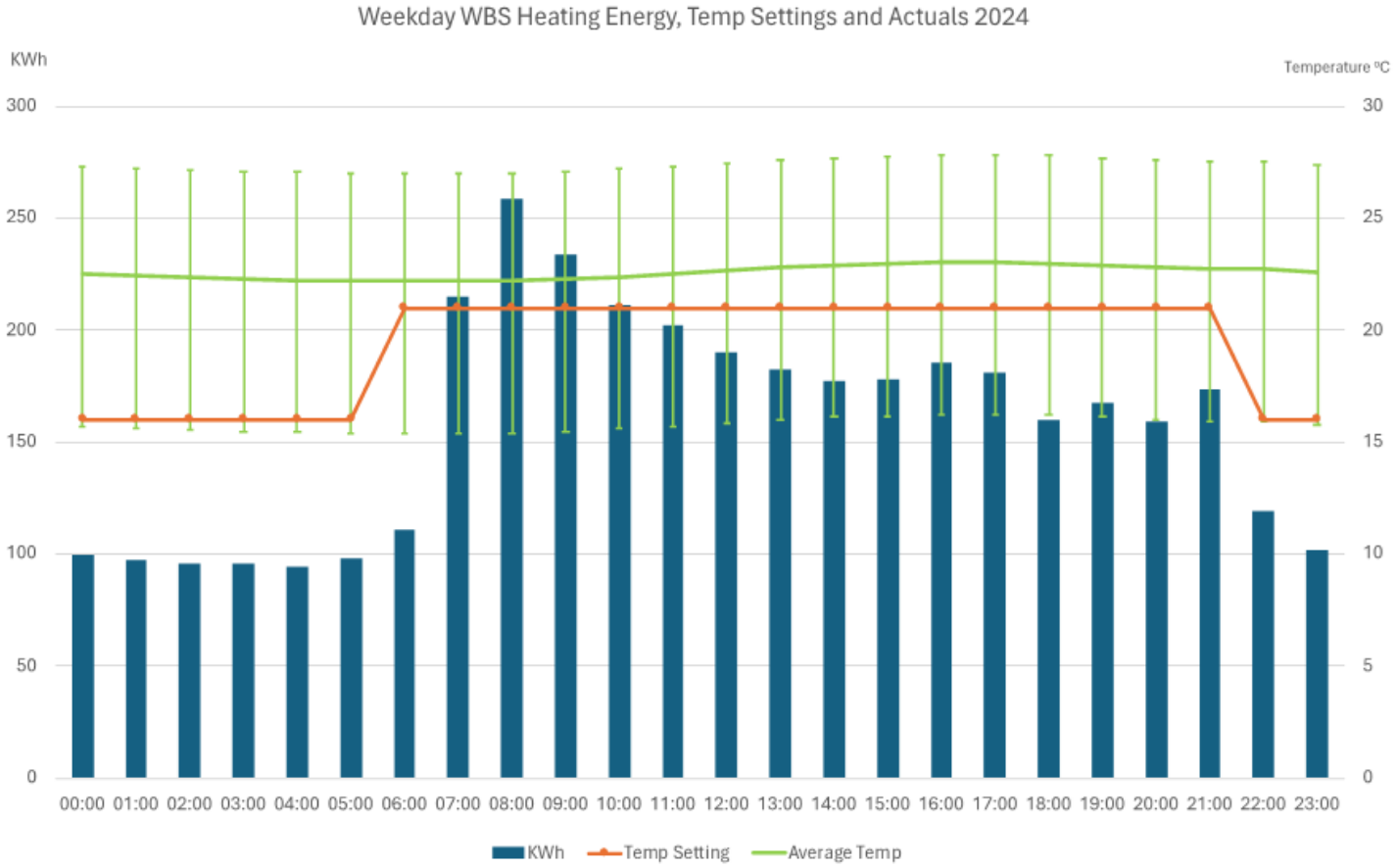
- Baseload makes up the vast majority of our consumption – it was around 80% in 2019
- By the end of 2023 we had reduced baseload by approximately 15% - it still makes up over 70% of demand because we had also slightly reduced peak demand
- Around the shoulder hours (6-8am & 5-8pm) demand increased compared to 2019 - this was due to the HVAC system and enhanced post-COVID ventilation

Smart Square: Improving controls to reduce “unknown” demand and make baseload more flexible

Consumption Type	2022	2024
Lighting	9%	14%
Heating (Electric)	4%	1%
Lifts, etc.	2%	3%
HVAC & Chillers	18%	26%
Data & Comms	5%	7%
Power Sockets	0%	14%
Uncategorised	62%	35%
Total Electricity	41.7 MWh	39.0 MWh

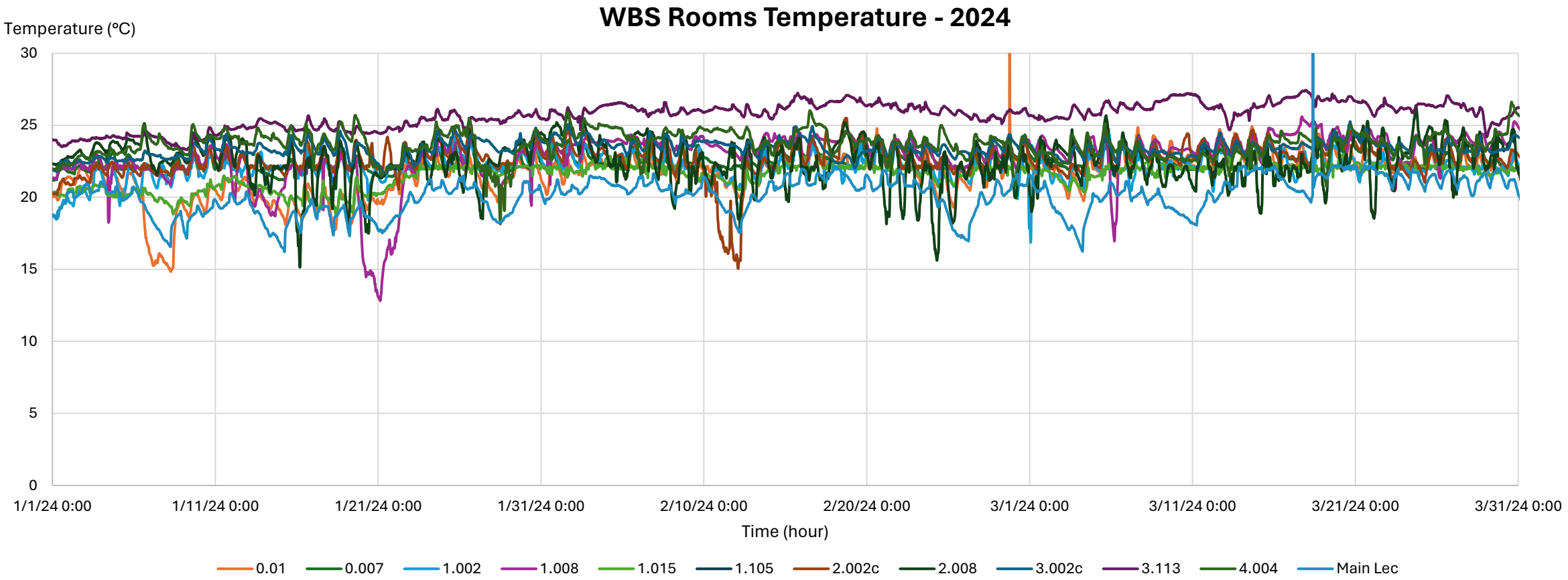


Smart Square: Proposing standards for net zero monitoring, control, and operations



- Heat Profile for WBS matches other buildings with a morning peak, trailing off
- System is set to deliver min. of 16°C at night and 21°C in the day
- Our sensors show an avg. temp of 22-23°C over the whole day
- Our sensors show max. temp ranges between 16 and 27 °C for 90% of time
- Older buildings need standards for retrofit monitoring and control

Smart Square: For older buildings, standards for retrofit monitoring and control



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Smart Buildings projects summary

Inputs

Weather

- National Grid composite weather variable (CWV)
- Solar irradiance

Energy

- Building heat, gas and electricity consumption

People

- Building occupancy

Building

- Control settings (set points and schedules)
- Heating system performance data
- New heat sensors spread to reflect range of key variables (façade, floor, room type)

Outputs

- Optimise DH network for low temperature delivery - minimum running cost / CO_2 emissions
- Simulation programme for any network / building
- Recommendations re thermostatic sensors:
  - optimum placement in a building
  - minimum number required
- Lessons learned concerning:
  - variability within building types and uses
  - impact of changing building standards on need for monitoring and control systems

In Summary: Reduce, Decarbonise, Smart

- Reduce
  - Reduced Scope 1&2 emissions by 40-60% per unit space, income & FTE between 2006-2021 BUT only by 18% overall due to 40% growth
  - The need to set bold standards not rely on incremental improvements
  - Now at 31% overall reduction with a further ~10% from rolling out construction & operational standards
- Decarbonise
  - Evaluated multiple alternatives for decarbonising heat and stop burning gas
  - Proceeding with large, ground source heat pumps accessing the aquifer
  - Decarbonising heat to reduce a further 30-40% of Scope 1&2 emissions
  - +200% roof top PV underway and potentially +600% ground based PV to lower electricity costs
- Smart
  - Across the buildings in Smart Square: Fewer peaks, less CAPEX, lower temperature heat network, flexibility for the surrounding electricity network.
  - Within the buildings in Smart Square: Monitoring & control standards and making base loads flexible
  - Rolling “Smart” across campus to reduce Scope 1&2 emissions 30-40%

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Questions?

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Close

Professor Bob Critoph

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