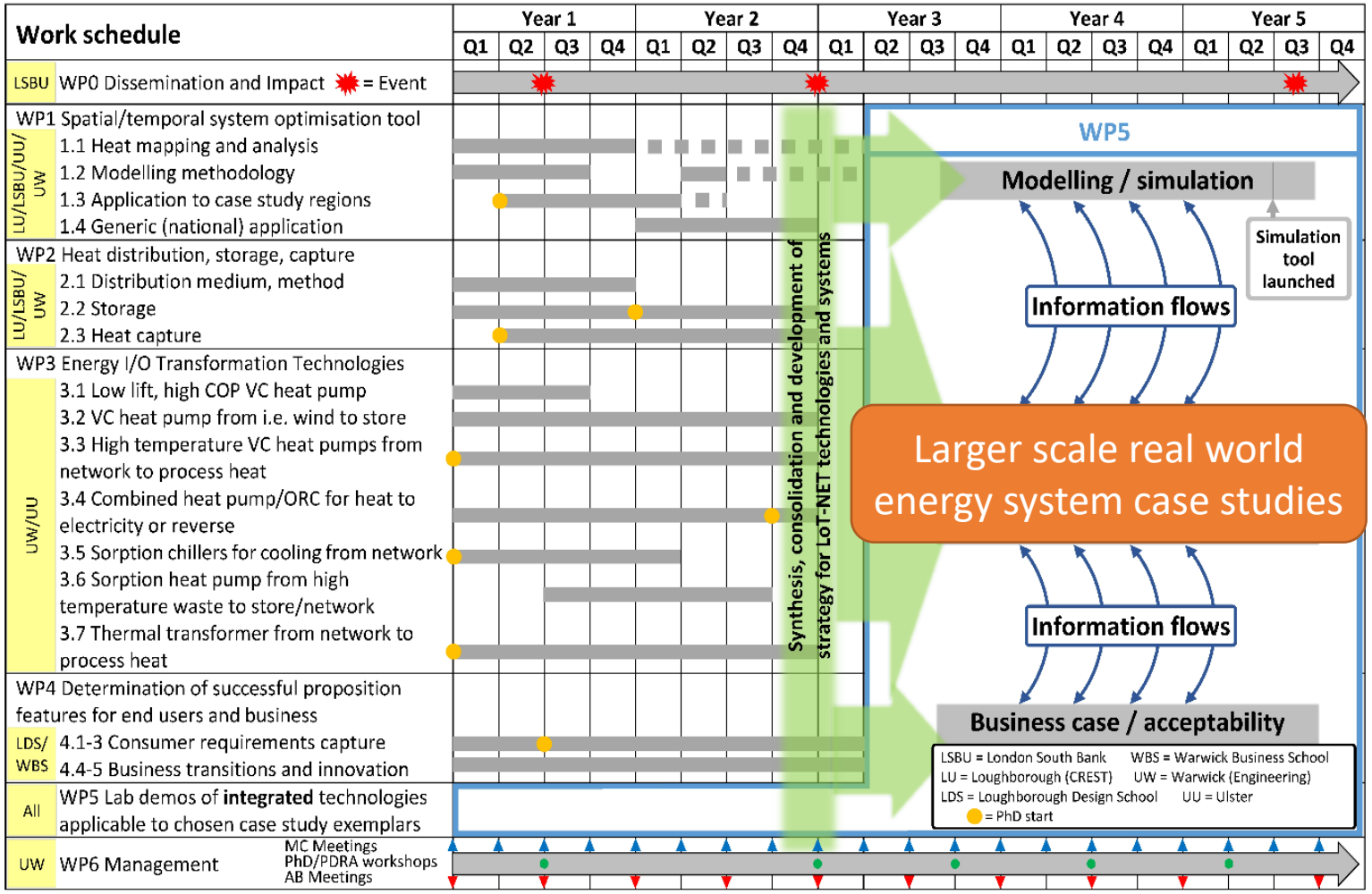
LoT-NET

Advisory Board Meeting 19th October 2023
Cases Overview & Warwick Case Study Update

Low Temperature Heat Recovery and Distribution Network Technologies

Phase 2: Including larger scale real world energy systems

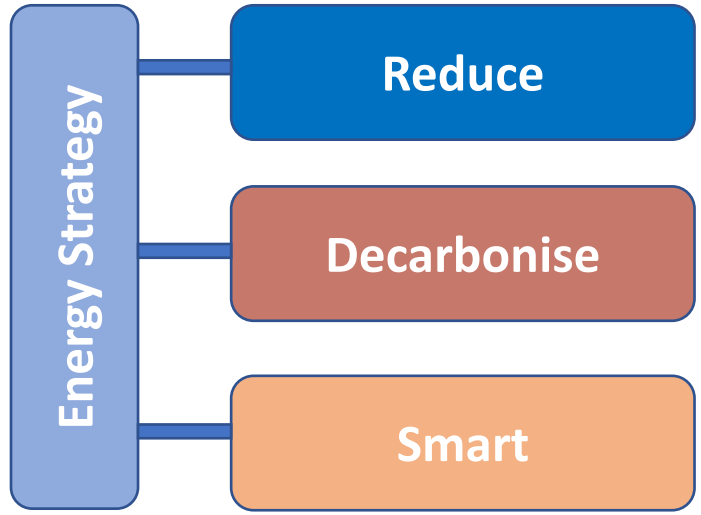


LoT-NET

Case Studies – Demonstrating LoT-NET's work and accelerating LoT-NET's impact

- **The University of Warwick:** decarbonising a campus currently using CHP to achieve net zero for scope 1&2 emissions by 2030 and add scope 3 by 2050. Selecting central and local heat sources, achieving the monitoring & control to be smart and a roadmap for commercial contracting
- **Islington:** Moving on from the **GreenSCIES** case of an urban Smart Local Energy System to comprehensively assess sources for heat capture: transformers, crematoria, water treatment, cold stores, supermarkets, data centres, mine water, etc. Building a portfolio of demonstrators that exemplify what can be achieved.
- **Holywell Park, Loughborough.** A new example of how a modelling approach can assess different options to deliver a net zero heating solution for a semi-industrial complex. Optimising detailed, half-hourly demand with domestic dwellings in the town of Loughborough. Assesses a range of network typologies including shared thermal storage.

Case Study Warwick – The Integrated Campus Case



- University of Warwick Campus
  - Community of 34,000; ~£10pa spend now rising to ~£30-40M
  - Net Zero for Scope 1&2 by 2030
  - Net Zero for Scope 3 by 2050
- Energy & Infrastructure Strategy
- Projects
  - Reduce: using Warwick Standards for better buildings and better operations
  - Decarbonise: campus level solutions that decarbonise the supply of heat & electricity
  - Smart: Smart Square as a smart, integrated system using a LoT-NET
  - Management of a Smart Local Energy System – becoming a “local DSO” offering flexibility
- Encompasses **Work Package 4.5** – Low temperature heat networks in Smart Local Energy Systems

Case Study Warwick – Dissemination & Recognition

- Communication & Dissemination since AB8
  - Awarded “Best Paper” at the Association of University Engineers Annual Conference, Sept 2024
    - “Warwick's Response to Net Zero Carbon - A global and institutional perspective”, presented by Gerard Hunter, Professor David Elmes and David Hammond.
  - MBA Case Study on Smart Local Energy Systems: April 2023 (UBC Vancouver), May 2023 (Warwick), PUC Chile June 2023 (Warwick), July 2023 (UBC Vancouver), Wits South Africa Sept 2023 (Warwick)
  - Visit to Warwick of Shanghai Jiao Tong University’s Low Carbon College, June 2023
  - University of Warwick Press Event: Sustainability Summit, Sept 2023 (The Shard)
  - The “smart-ready” Faculty of Arts building is in the RIBA’s Stirling Prize 2023 shortlist
    - https://www.architecture.com/awards-and-competitions-landing-page/awards/riba-stirling-prize
  - University of Warwick ranked 9th in the world for SDG12: responsible consumption and production
    - Impact Rankings 2023 | Times Higher Education (THE)
- Response submitted to the Department for Energy Security & Net Zero’s consultation on **Proposed amendments to the Boiler Upgrade Scheme Regulations**
  - Submitted October 2023 using evidence from the study on Heat Pump Readiness carried out by Ned Lamb, presented at AB7
  - Paper now ready for submission

Technical Documents

Case Studies

NEDeRS

AUE Guides

AUE Academy (Learning & Development)

Tom Bradley Award

The AUE presents the Tom Bradley award to the member who presents the best paper at the annual conference. The Tom Bradley prize is a large "Egg Timer" with a duration of 30 minutes, which is presented at the conference dinner and is held by the recipient until the following conference.

Gerard Hunter, Head of Building Services and Infrastructure from University of Warwick won the Tom Bradley Award for his paper on "Warwick's Response to Net Zero Carbon - A global and institutional perspective", *presented with Professor David Elmes and David Hammond*. This was presented at the Gala Dinner held at University of Warwick on 7th September 2023.

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Department for Energy Security & Net Zero

Proposed amendments to the Boiler Upgrade Scheme Regulations

Consultation run by The Department for Energy Security and Net Zero: 31/8/23-12/10/23
https://www.gov.uk/government/consultations/proposed-amendments-to-the-boiler-upgrade-scheme-regulations

Response prepared by:

- Ned Lamb, Research Associate, Warwick Business School, University of Warwick
- Professor David Elmes, Warwick Business School, University of Warwick.

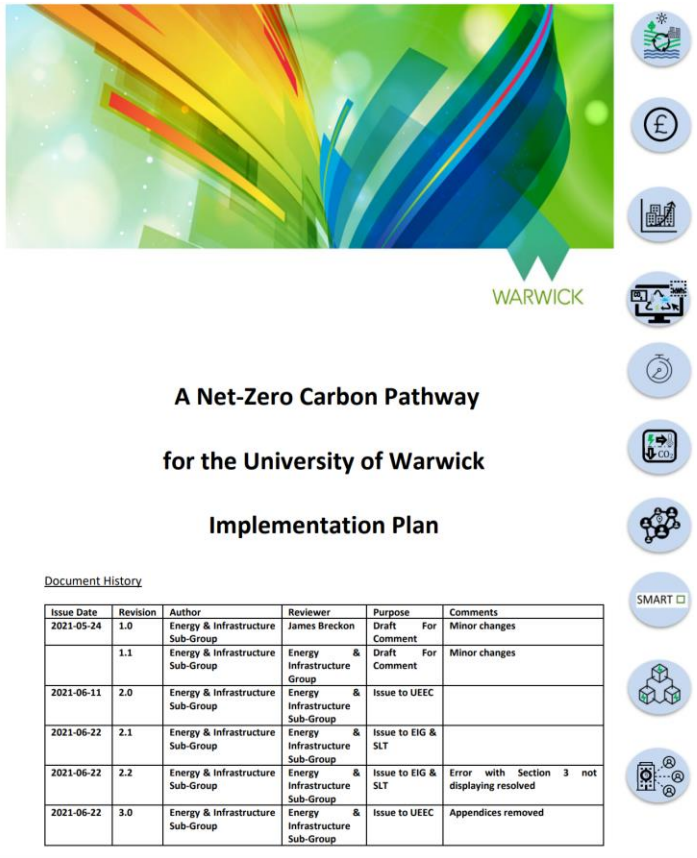
Researchers in the Low Temperature Heat Recovery and Distribution Network Technologies (LoT-NET) programme

Case Study Warwick

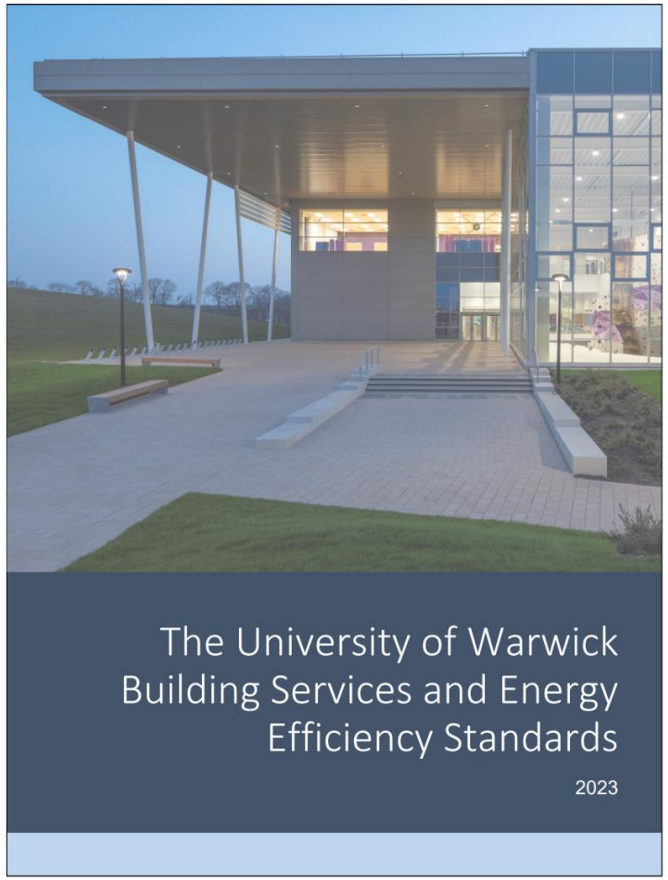
- AB9 Update: Progress at different “levels”
  - Energy Action Group
    - *Fortnightly; led by the University’s Finance Director to accelerate progress (and realise savings)*
  - Reduce: applying Warwick Standards
    - New build & retrofit complete, *now expanding into Net Zero O&M standards & procedures*
  - Decarbonise: campus level solutions that decarbonise heat & power supplies
    - *Progress at Campus Level: Progress on the overall campus-level solution (DE)*
  - Smart: Smart Square as a smart, integrated system using a LoT-NET
    - *Progress at the Smart Square Level: Verifying heat use modelling of buildings in Smart Square (RC)*
    - *Progress at the Level within buildings: Monitoring and control within a building (DE)*
  - Management of Energy Networks – becoming a local DSO offering flexibility
    - Need results of the above first!

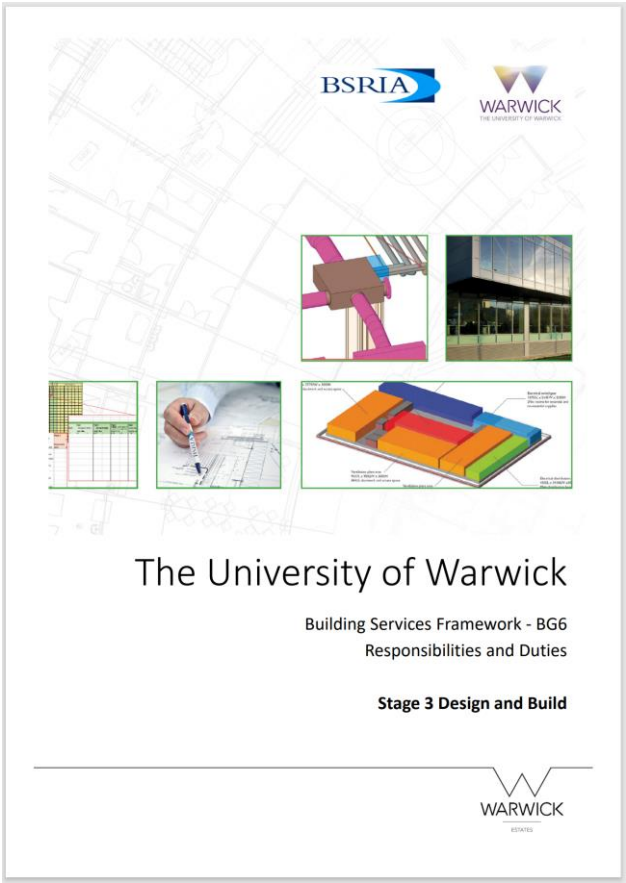
Case Study Warwick – Progress at Campus level

- Telling the Standards & Procedures story….



Issue Date	Revision	Author	Reviewer	Purpose	Comments
2021-05-24	1.0	Energy & Infrastructure Sub-Group	James Breckon	Draft For Comment	Minor changes
	1.1	Energy & Infrastructure Sub-Group	Energy & Infrastructure Group	Draft For Comment	Minor changes
2021-06-11	2.0	Energy & Infrastructure Sub-Group	Energy & Infrastructure Sub-Group	Issue to UEEC	
2021-06-22	2.1	Energy & Infrastructure Sub-Group	Energy & Infrastructure Sub-Group	Issue to EIG & SLT	
2021-06-22	2.2	Energy & Infrastructure Sub-Group	Energy & Infrastructure Sub-Group	Issue to EIG & SLT	Error with Section 3 not displaying resolved
2021-06-22	3.0	Energy & Infrastructure Sub-Group	Energy & Infrastructure Sub-Group	Issue to UEEC	Appendices removed





Case Study Warwick – Progress at Campus level

- Telling the Heat story….
- Lessons learned from the somewhat complex and at some times competing analysis of decarbonizing heat supplies
- The cascade of choices for *campus level* heat sources
  - Deep: Geothermal heat sources (3000m)
    - “Desktop” evaluation but significant up front drilling tests needed – on hold
  - Medium: 4 sites for large scale heat pumps c.10MW capacity, 300m open boreholes
    - Progressing STEM GC and Social Sciences GC
    - Tender process for test drilling completed
    - Test drilling in November 2023
    - Heat Purchase Agreement drafted by Q1 2024
  - Shallow: Arrays of 20x8x8m ground source heat pumps
    - Ruled out after consultant evaluation due to space required (2 acres per building!)
- Plus local, building specific air source heat pumps
  - Especially to top up older buildings if on a lower temperature heat network

Case Study Warwick – Progress at Campus level

- Telling the Smart story….
- Initial work on “being smart” has often ended up as work on “being less dumb”
  - For example, BEMS Reboot completed: Recommissioning of >500 heating, cooling and ventilation control systems across 117 buildings,
    - Phase 1: Carbon Saving of 1,000t pa, Energy cost savings of £600k pa for £165k cost. Completed in 2022/23.
    - Phase 2 tbc: Carbon Saving of 900t pa, Energy cost savings of £300k pa for £300k cost. Planned for 2023/24.
    - Developing “BEMS Net Zero Carbon Standards” and redefining boundary with contractors
- This then enables the Smart work being carried out by LoT-NET researchers…..

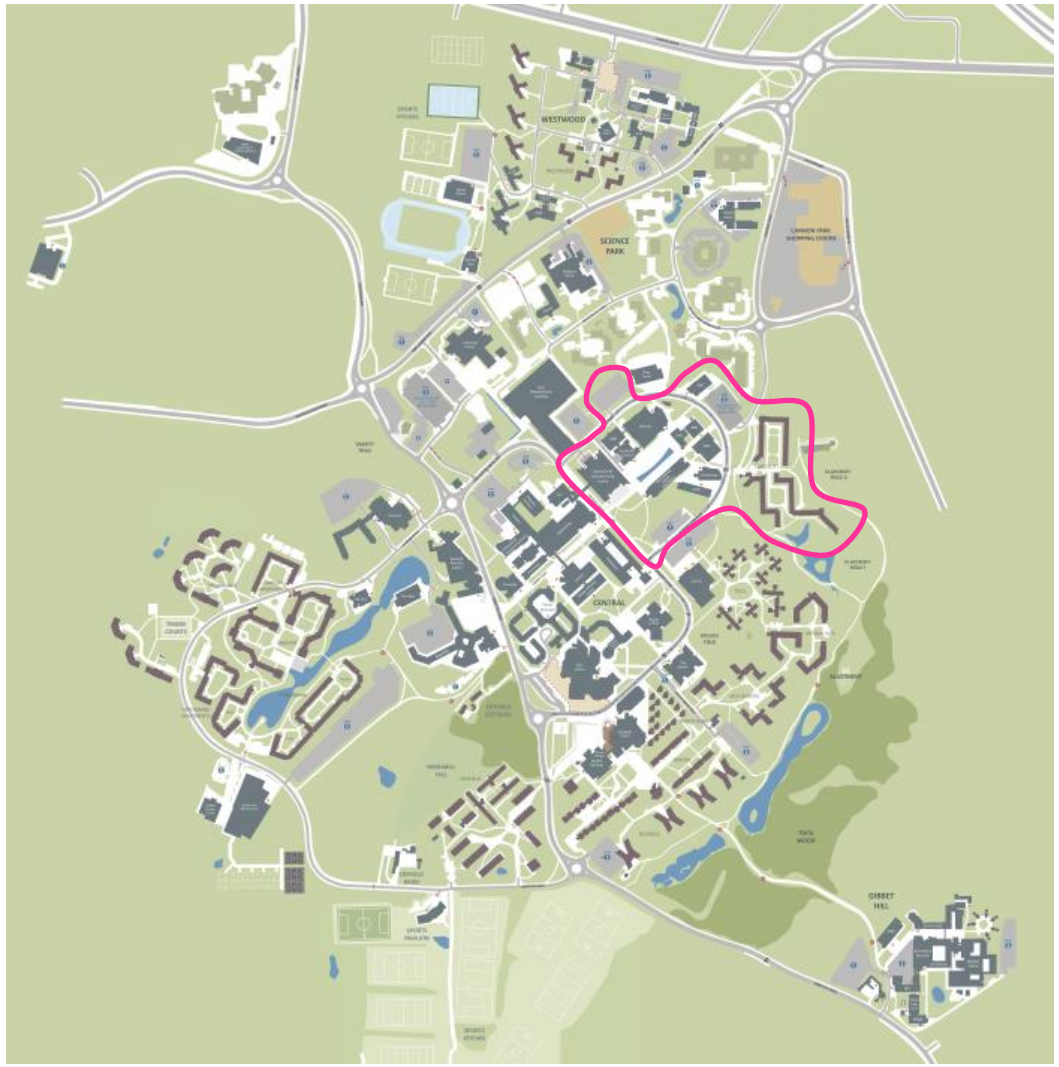
Case Study Warwick – Progress at Campus level

- Telling the Commercial story….
- What to do ourselves vs what to do with a commercial partner
  - Can share further details from Q1 2024 onwards!

Case Study: Warwick – Progress at the Smart Square level

SMART

- Represents 10% of campus energy:
  - Operate a lower temperature heat network
  - Integrate management across power, heating, cooling and transport
  - Smart building demonstrators
  - Opportunities for flexibility
  - Build upon the significant level of monitoring and control in place
- Achieving a smart and flexible local energy system
  - Cost and carbon reduction
  - To be rolled out across Warwick, and beyond



Case Study: Warwick – Smart Square

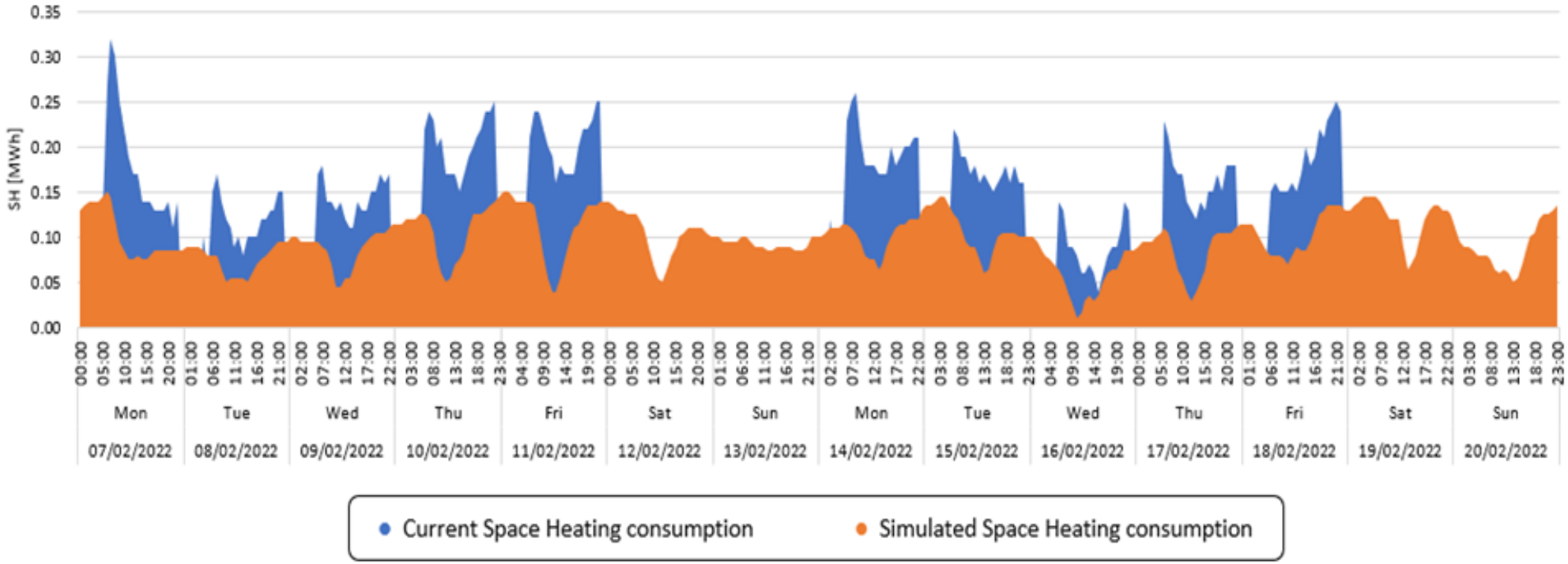
Two complementary streams of work

- Progress at the Smart Square Level: Verifying heat use modelling of buildings in Smart Square (RC, Eng)
  - Modelling and now the verification of how the heating of buildings across smart square can use building properties to smooth and reduce heat demand when supplied by a low temperature heat network (Eng)
  - Modelling completed and presented at AB8
  - Securing the data for empirical verification discussed here
  - Data now being received fortnightly for the 23/24 heating season
- Progress at the Level within buildings: Monitoring and control within a building (NS, WBS)
  - Ensuring the monitoring and control of both heat and power necessary for the successful ongoing management of Smart Square (and other) buildings
  - Retrofit of existing buildings
    - Detailed study of the WBS building presented at AB8
    - For example: increased the known use of electricity from 33% to 58% but 80% is baseload
    - Discovered that our Gas and District Heat Meters were both under-reading and are being replaced
    - Preparation for 6 building discussed here: WBS, Computer Sciences, Zeeman, Claycroft, Social Sciences & FAB
  - Optimising new buildings and helping define Net Zero standards for building monitoring & control
    - “Soft landing” evaluation of recent new builds (FAB, IBRB, etc)

Case Study: Warwick – Smart Square

SMART

A reminder of the modelling work from AB8



Current max SH [MW]
0.350
Simulated max SH [MW]
0.155

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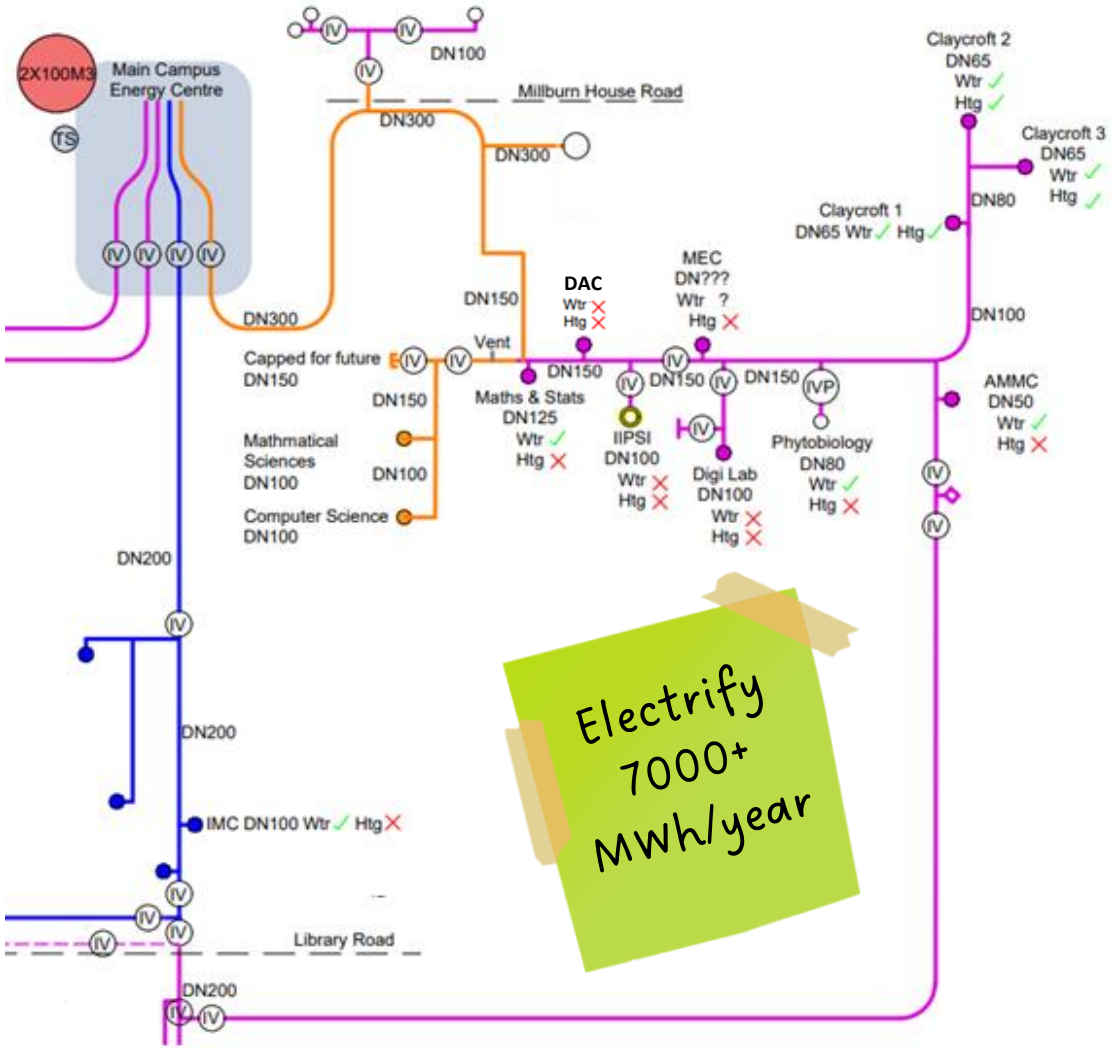
Progress at the Smart Square Level: Verifying heat use modelling of buildings in Smart Square

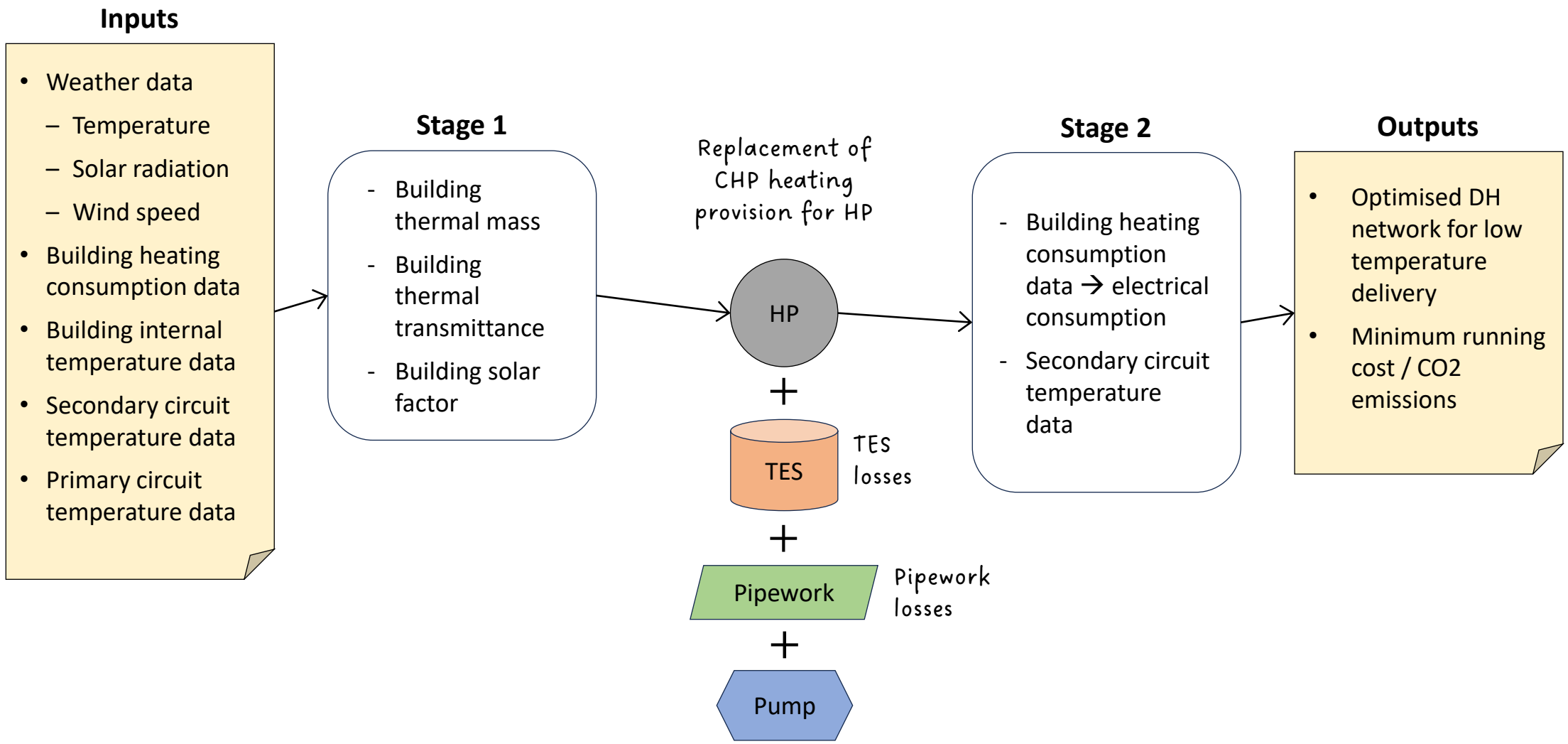
Low Temperature Heat Recovery and Distribution Network Technologies

Smart Square: district heating network

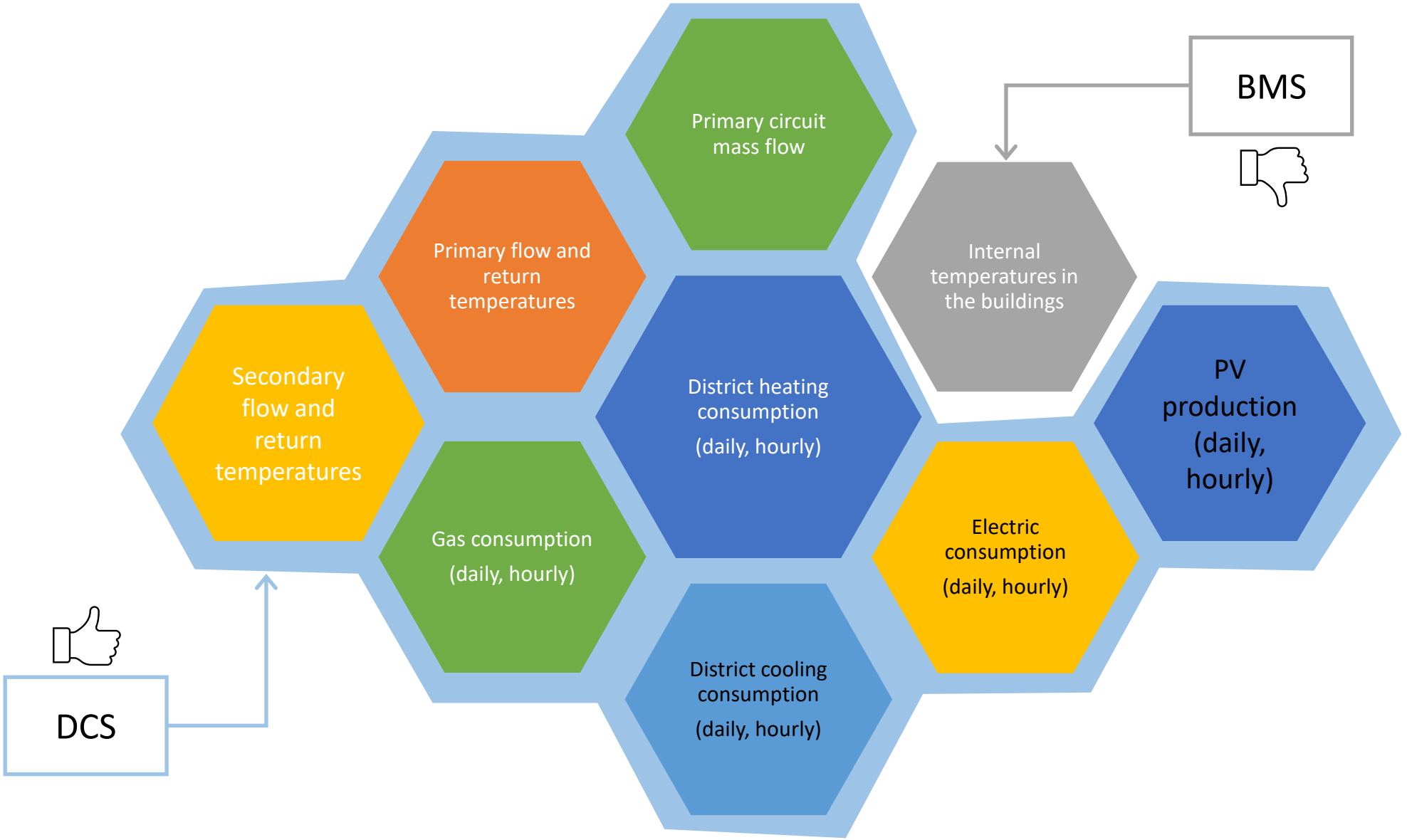


Residential Non-residential Car Park

Simulation / Optimisation



Buildings analysis: “Available data”



Lack of BMS data ☹

Update October 2023: better BMS data after raising the issue with senior management

SmSq latest update

- BMS data of more buildings of SmSq to be shared with us every 2 weeks
- Monthly meetings with Estates to discuss LoT-NET collaboration: data sharing, running experiments, etc

- Researcher has left the project but…
- A new PhD student has started (17th Oct 2023) with the following project scope:
  - Analysis of the University of Warwick's district energy network
  - Analysis of building fabric and operation
  - Design modified district heating systems that can operate using renewable energy sources (and heat pumps) and evaluate their efficiency
  - Develop building control systems that can optimise the system as a whole
  - Assess the value of storage
  - Identify additional measures that should be implemented on the heat network in order to improve efficiency or cost effectiveness

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Progress at the Level within buildings: Monitoring and control within a building

Low Temperature Heat Recovery and Distribution Network Technologies

Case Study: Warwick – Smart Square

SMART

Monitoring and control within a building

- The smarter management of heat & power on a lower temperature network that we have modelled needs better monitoring and control
  - Retrofit of existing buildings
  - Optimising new buildings and helping define Net Zero standards for building monitoring & control
    - “Soft landing” evaluation of recent new builds (FAB, IBRB, etc)
- Impact & contribution to practice
  - Smoothing to reduce heat peaks at campus level avoids £1-2M per MW in capital expenditure on decarbonised energy supply capacity

Case Study: Warwick – Smart Square

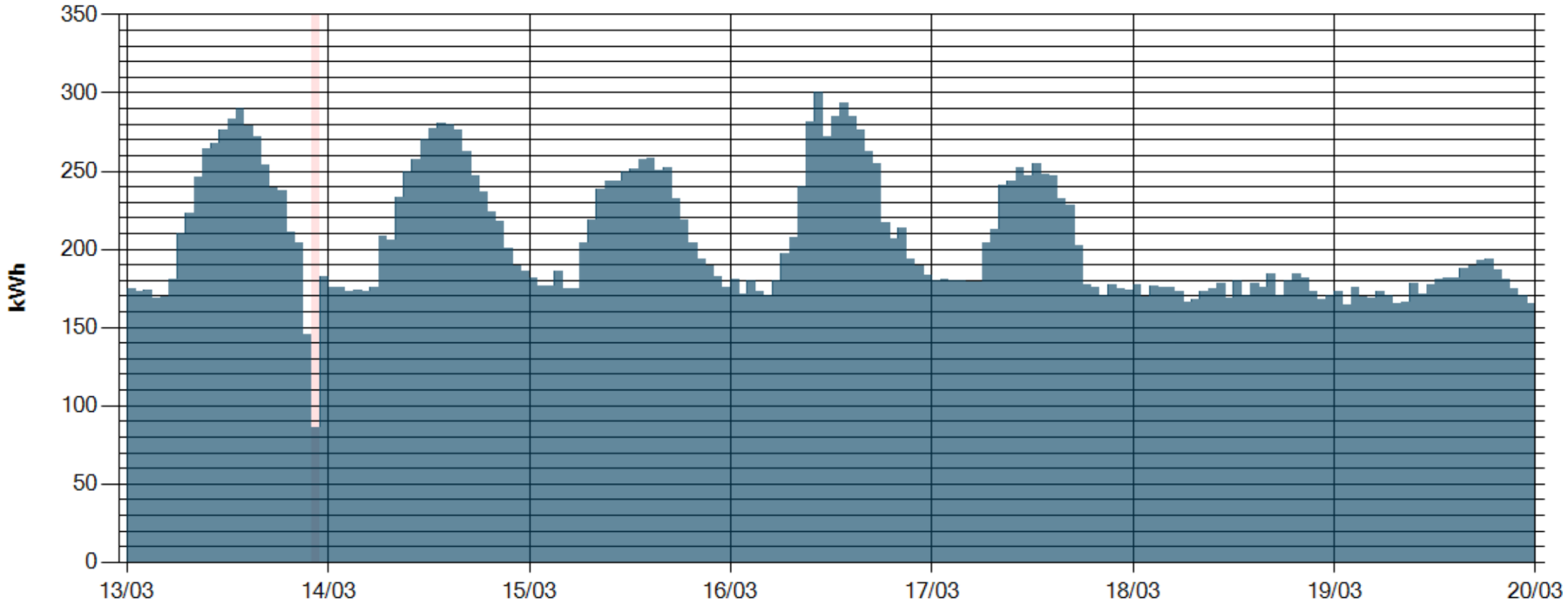
SMART

Monitoring and control within a building: Retrofit of existing buildings

- Activities since AB8
  - Increased the known use of electricity in WBS from 33% to 58% reported at AB8, however 80% is baseload
  - Over the summer of 2023, the Estates Team commenced a meter-locating, registering and labelling exercise
  - When complete, known use should reach over 85% – in line with the latest building regulations
  - Discovered that WBS Gas and District Heat Meters were both under-reading and are being replaced
  - Heat monitoring upgrades for 6 buildings for the 23/24 heating season: WBS, Computer Sciences, Zeeman, Claycroft, Social Sciences & FAB

Case Study: Warwick – Smart Square

From AB8: Baseload still makes up over 80% of demand in WBS - little flexibility.



Total Electrical Load for all phases of the WBS Building for 13th-19th March 2023.

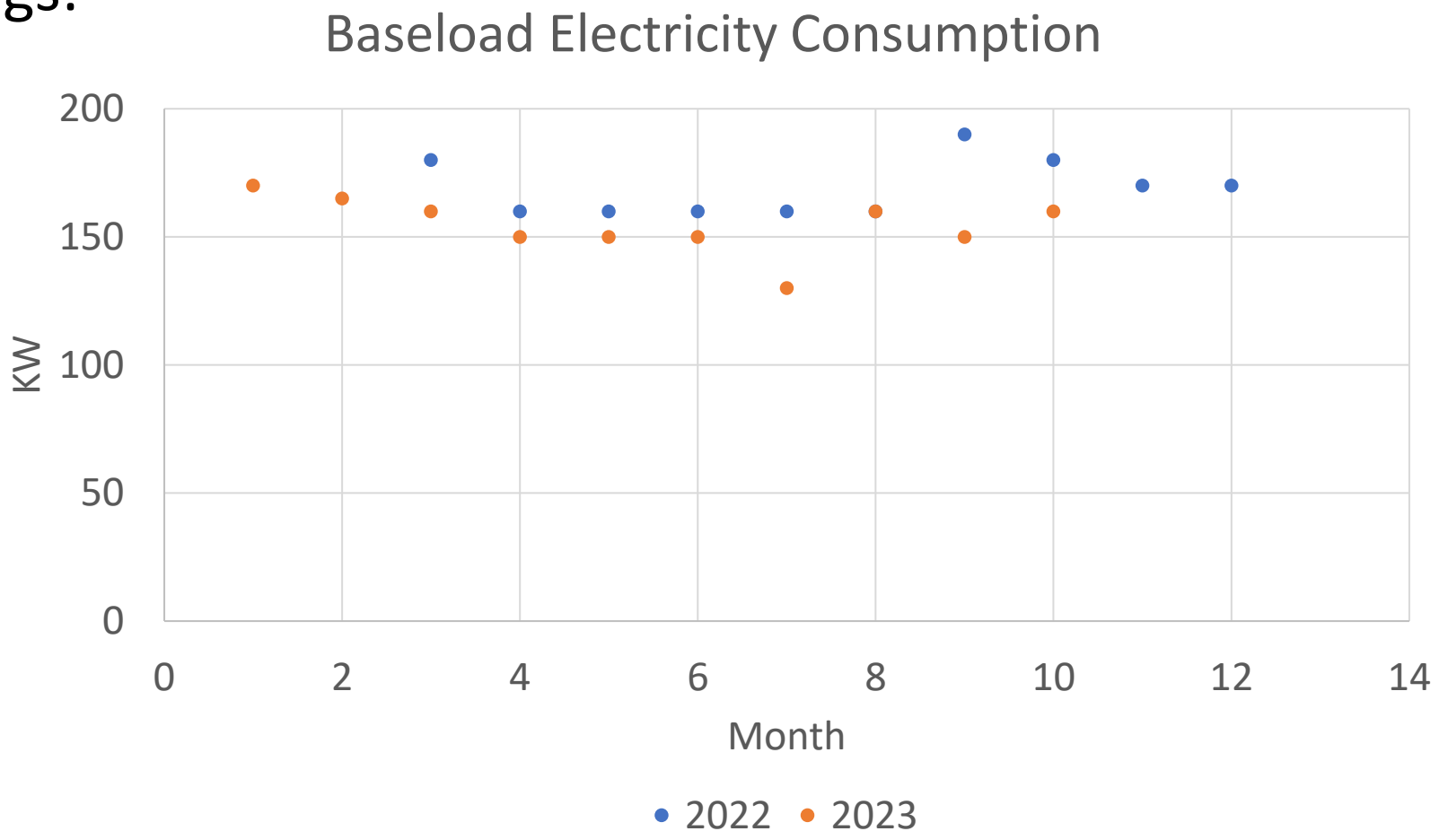
Total: 34,536.850 kWh
Average: 4,933.836 kWh / Day

Case Study: Warwick – Smart Square

SMART

Retrofit of existing buildings: Electrical baseload

- Night time base load electrical use in WBS has been lowered throughout 2023.
- This is despite an increase in baseload of approx. 10KW due to temporarily increased computing load as part of IT system migration.



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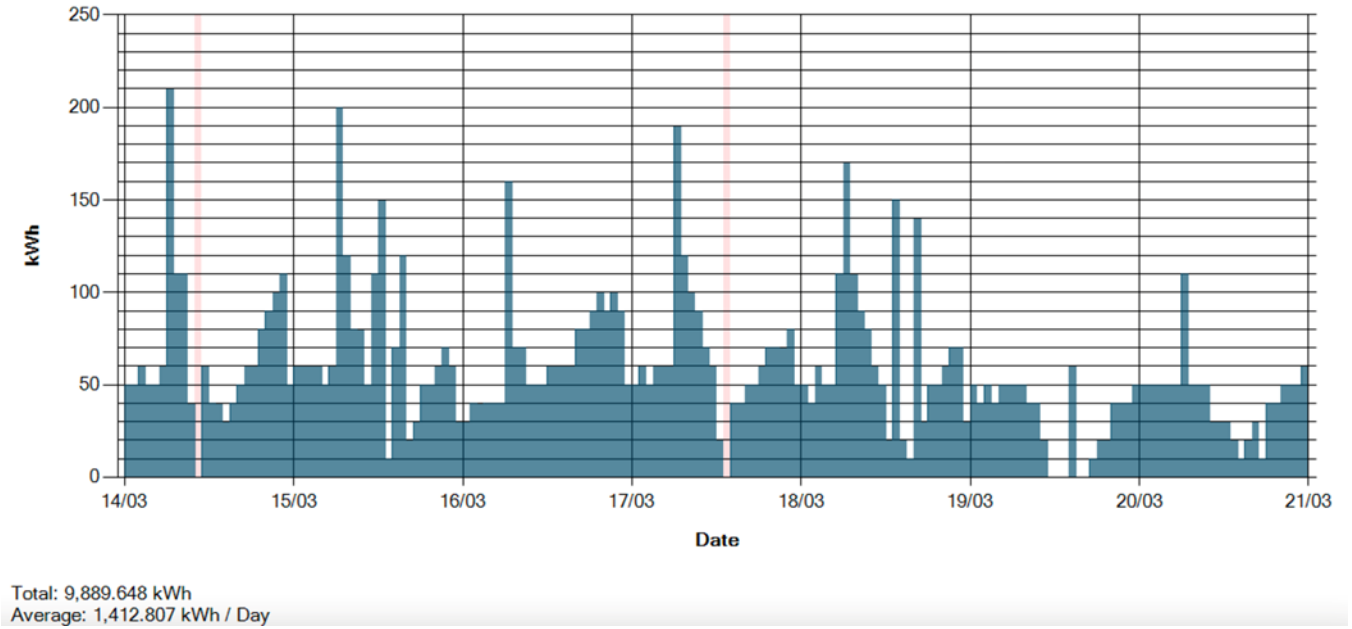
Case Study: Warwick – Smart Square

Retrofit of existing buildings:
Heating

The challenge: WBS heat use from the District Heating Network for 13th-19th March 2023

- 80% baseload
- Large peaks, x4 baseload
- “Too hot”



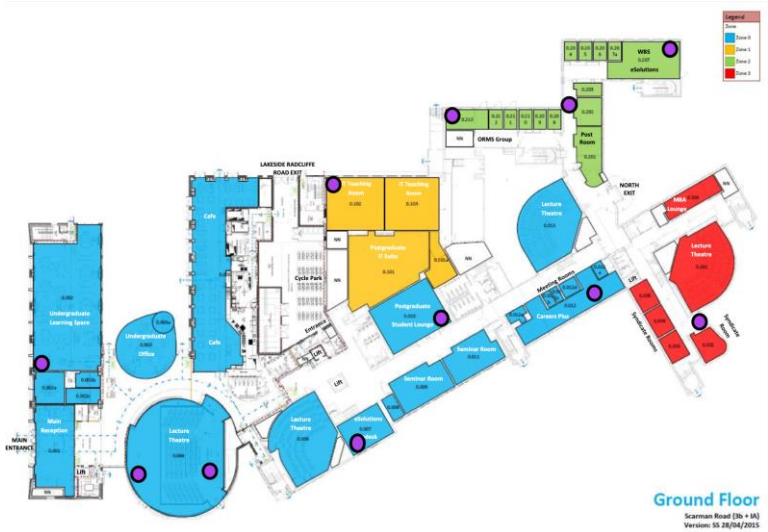
Case Study: Warwick – Smart Square

SMART

Retrofit of existing buildings: Upgraded controls to understand and optimise heat consumption

Heat sensors are hard-wired into the LAN ports as an IT security measure. The codes on the port allow ITS to remotely monitor them through the server rooms.

The heat sensors are placed around the buildings across all floors allowing us far greater understanding of heat within the building.



The sensors are slightly smaller than a match box and deliver a temperature reading every 10 minutes.

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Case Study: Warwick – Smart Square

SMART

Retrofit of existing buildings: Rolling out the upgraded controls across 6 buildings for the 23/24 heating season

- WBS: Built 1999-2014, 3-4 Storeys, Variety of Heating & Cooling Solutions.
- Computer Sciences: Built in 2000, 4 storeys containing offices and computer labs and single heating and cooling solutions.
- Zeeman: Built 2004-2008, 3-4 storeys of mainly office space with single heating and cooling solutions.
- Claycroft: 3 storey Student Residences built in the late 90s, change of flow temperatures to be trialled following sensor installation.
- Social Sciences: Built in 1977, 2-3 storeys of office space with a single heating solution.
- FAB: The University's most recently completed building. We will be using the data from the building's in-built sensors to compare to our retrofit solution.

Case Study: Warwick – Next Steps

The experimental programmes:

- Progress at the Smart Square Level: Verifying heat use modelling of buildings in Smart Square (RC, Eng)
- Progress at the Level within buildings: Monitoring and control within a building (DE, WBS)

The stories:

- The standards and procedures story
- The (large scale and small scale) heat story
- The (dumb to) smart story
- The commercial story

Back-up

Objective: reducing secondary circuit temperature

$T_{in} \approx 21°C$

80/60°C
70/50°C
60/40°C
50/30°C

$$\dot{Q}_{SH} = \dot{Q}_{SH,rated} \cdot \left(\frac{MWT - T_{in}}{MWT_{rated} - T_{in}} \right)^{1.3}$$

Historic max $\dot{Q}_{SH}$

$MWT_{rated} \approx AVRG(\bar{T}_{Sec\ flow}, \bar{T}_{Sec\ rtrn})$