LoT-NET

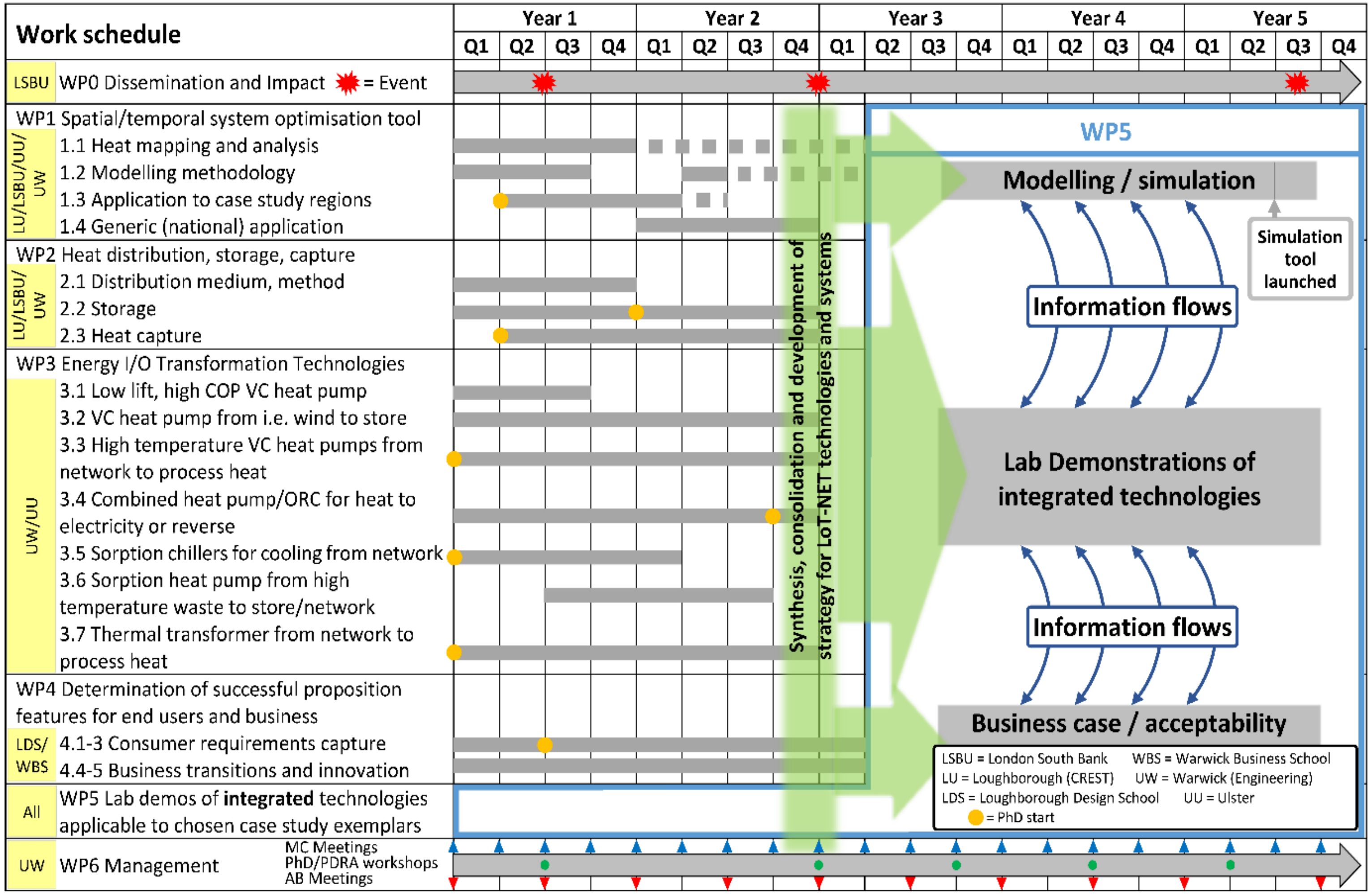
Advisory Board Meeting 24th March 2021
Mid-term Report: Part 2

Low Temperature Heat Recovery and Distribution Network Technologies

Part 2: Agenda – Ambitions for the Case Studies

- Larger scale, real world smart local energy system case studies
- 4th/5th Generation Energy Networks – including “LoT-NETs”
- What questions should the Case Studies answer?
- Case Study: Islington
- Case Study: Loughborough
- Case Study: Warwick
- Discussion & Summary

Original Work Packages



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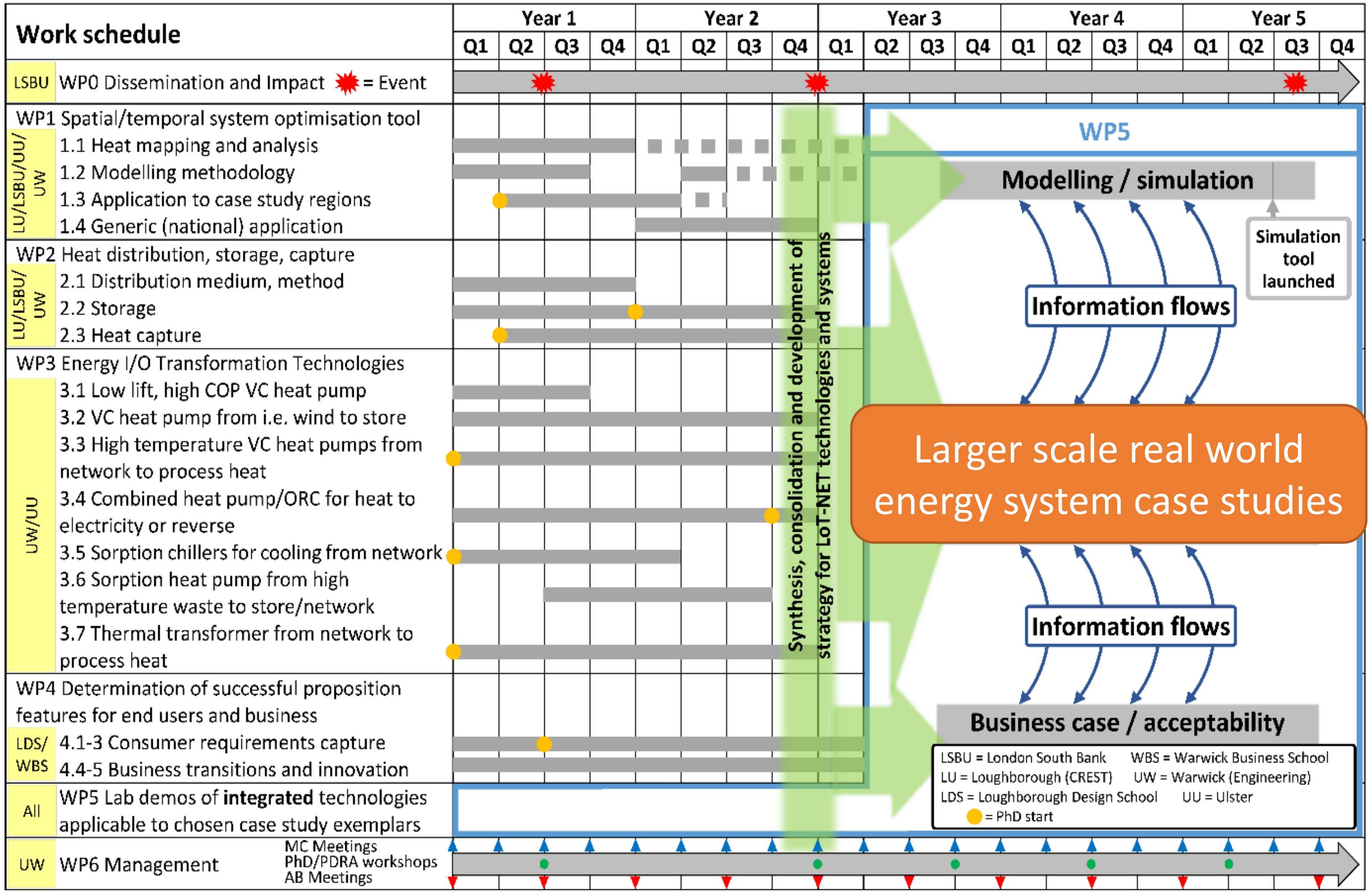
Phase 2: Including larger scale real world energy systems



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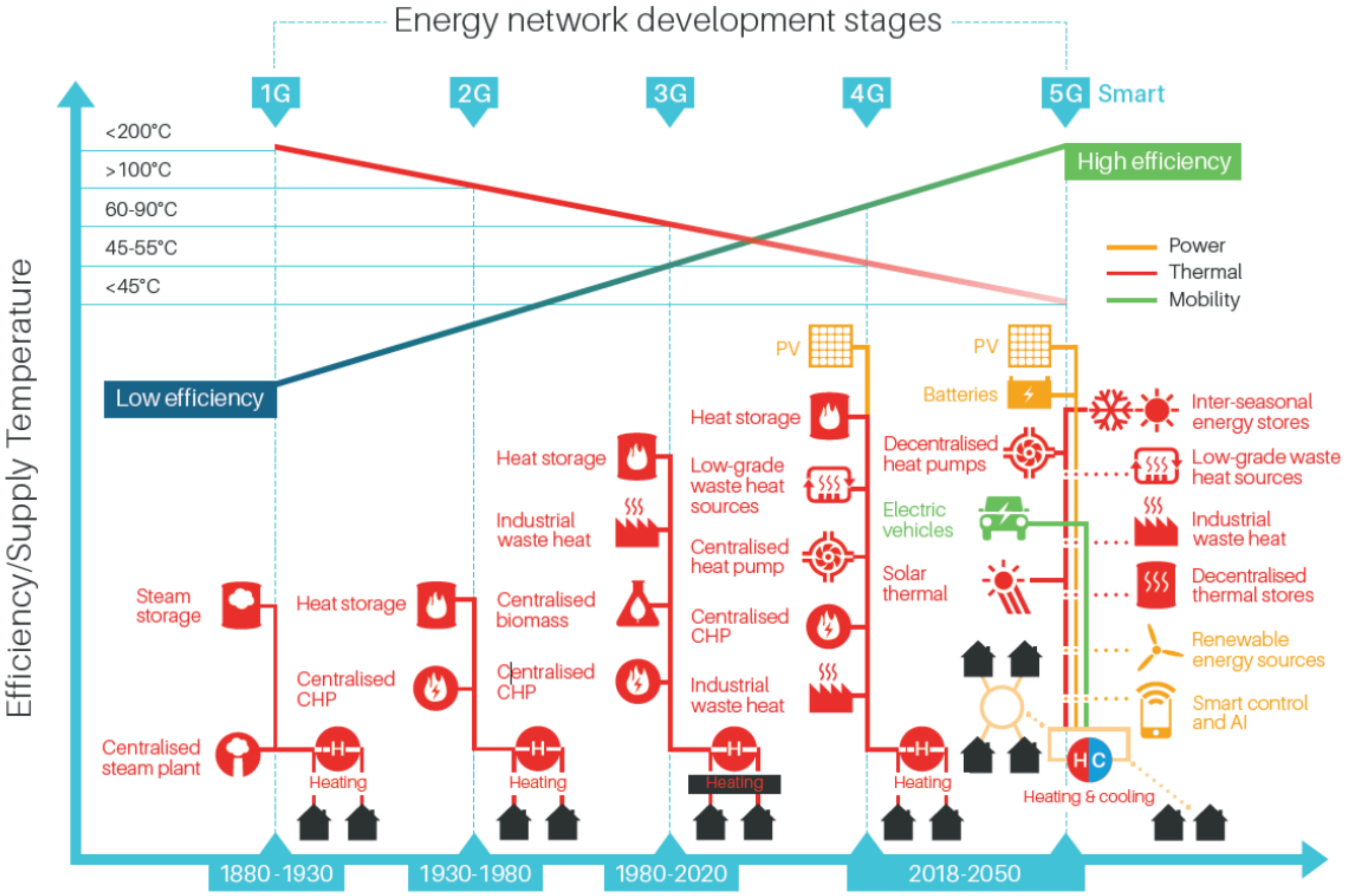
Advancing the conceptualisation of 4th/5th Gen Energy Networks



Revesz A. *et al (2020)* "Developing novel 5th generation district energy networks", Energy 201, 117389

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Case Studies – How can they demonstrate LoT-NET's ongoing work and how do they accelerate LoT-NET's impact?

- **Islington: GreenSCIES** is a case study investigating an integrated, Smart, Local Energy System (SLES) for a large community in the London Borough of Islington. The system is based around a 5th generation ambient-temperature heat network loop with distributed energy assets such as heat pumps, solar photovoltaic and the flexible integration of electric vehicles.
- **Loughborough town.** The model is currently being used to assess different network options that can deliver a net zero heating solution for the domestic dwellings in the town of Loughborough. It will be refined to assess a range of network typologies include other non-domestic heat demands in the Loughborough area and integrate waste heat sources.
- **The University of Warwick** campus is a multi-vectoral energy system with an electricity network, heating network, cooling network and rising transport demand from EVs. The challenge is to decarbonise energy use to achieve net zero for scope 1&2 emissions by 2030 and add scope 3 by 2050. Work with the Warwick Estates Department has established energy systems at Campus Level (Energy 2020) and for a smarter part of campus (Smart Square).

Case Studies: Questions for discussion – How LoT-NET can inform…..

- What will the CCC's 20% of heating from heat networks actually be?
- How can LoT-NETs help PFER projects be integrated, multi-vectoral systems, not just an assembly of activities?
- How can LoT-NETs make local energy systems smart and flexible?

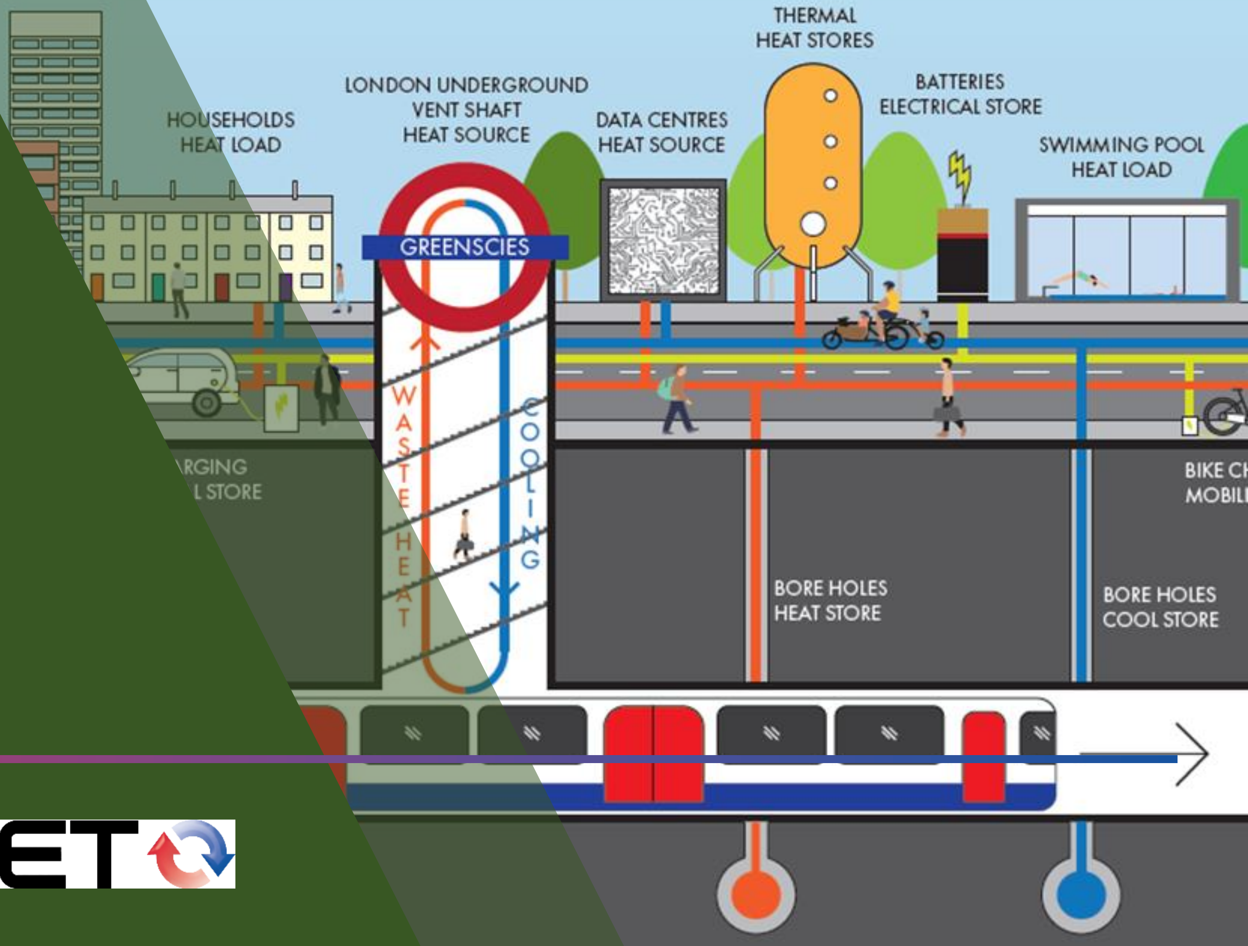
- Other questions LoT-NET's cases can help answer?

Islington Case Study

GreenSCIES

The Urban Case

Graeme Maidment and Akos Revesz
London South Bank University



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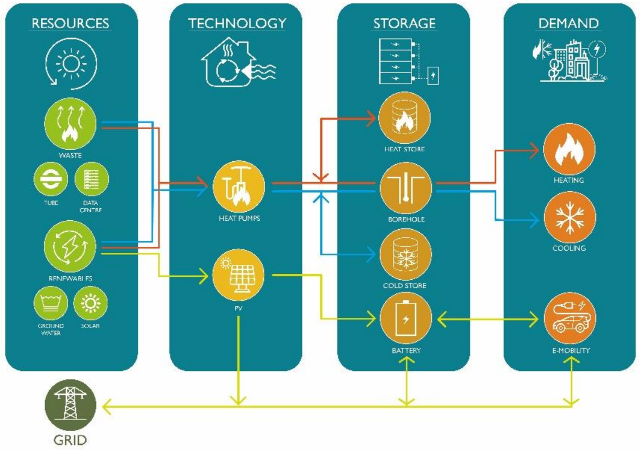
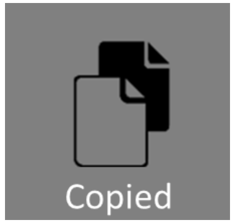
How will GreenSCIES work?

Smart local energy system

- Detailed design for an integrated energy network in the LBI connecting 33,000 residents and circa 70 businesses.
- Low carbon heating and cooling network.
- Waste heat recovery from data centres and the London Underground.
- Local, renewable power generation.
- Electric vehicle (EV) and vehicle-to-grid charging.
- Battery storage and flexibility services using artificial intelligence.
- Decentralised energy centres/hubs integrating and optimising low carbon energy technologies across heat, power and transport.





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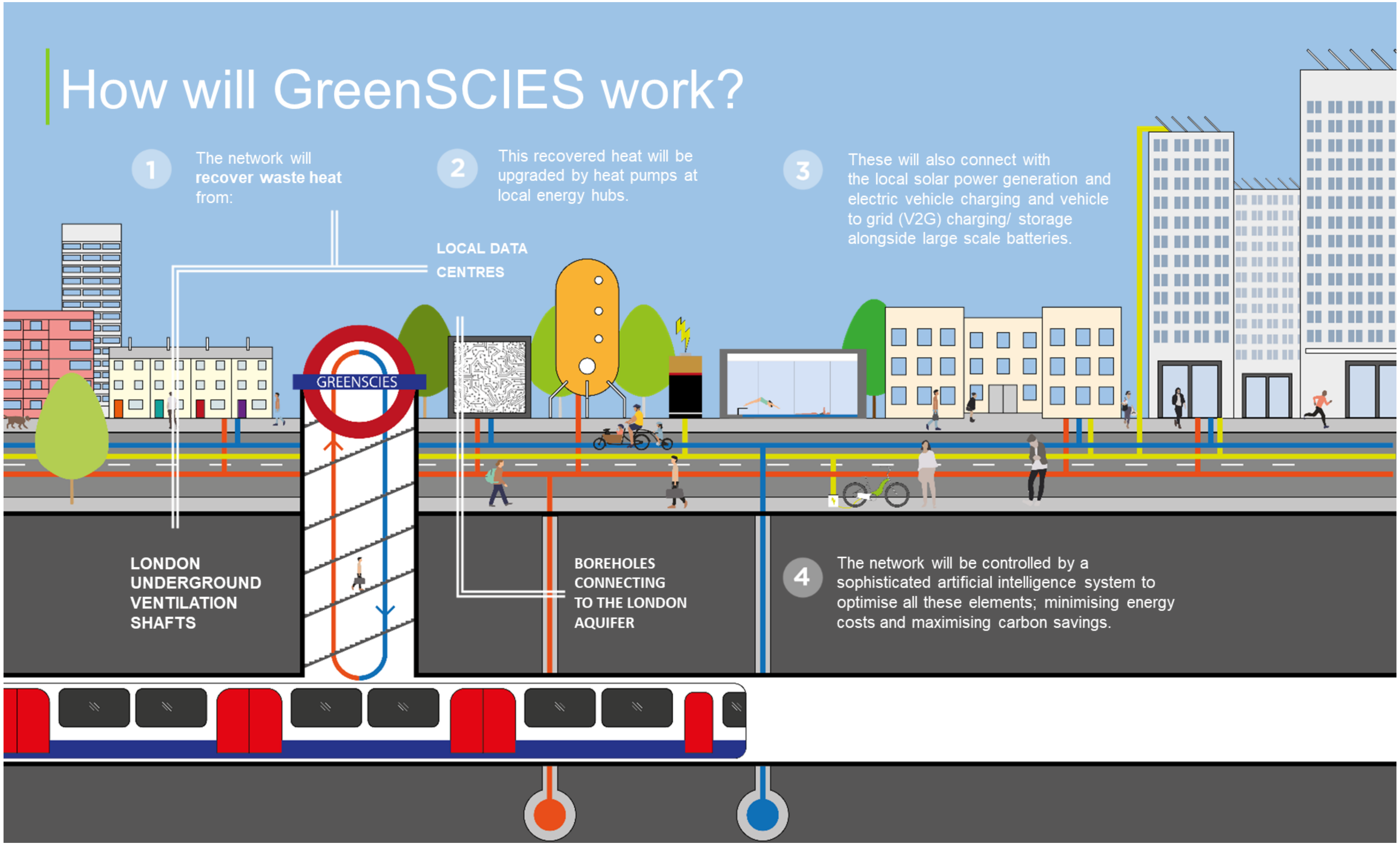

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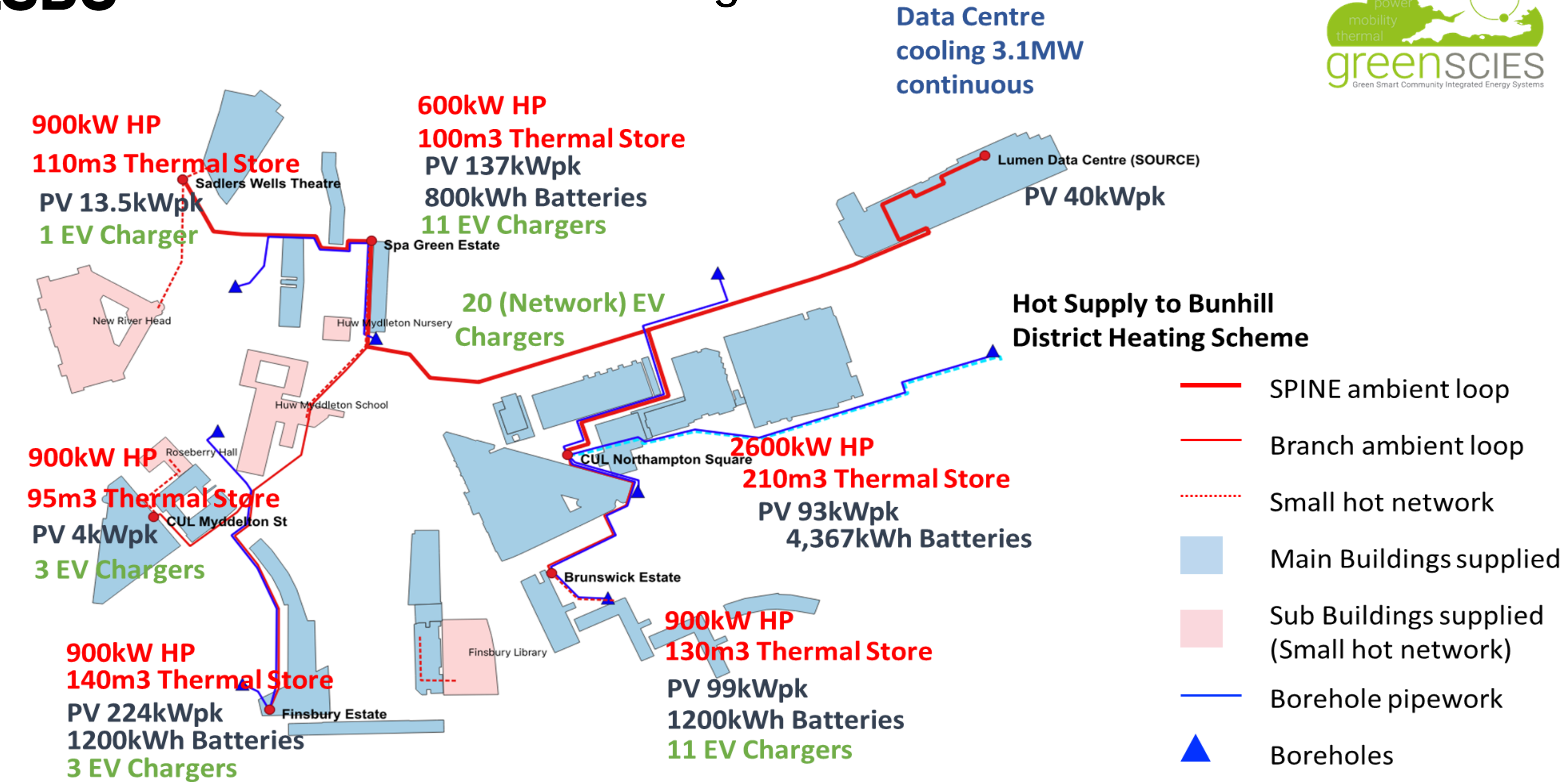
The network in Islington



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The research being undertaken in LoT-NET supports GreenSCIES by:

- Providing wider access to low temperature heat networks
- Testing and Evaluating novel technological solutions incl. heat distributing, pumping and storage.
- Exploring demand side challenges associated with waste heat recovery and use.
- Mapping UK wide opportunities where schemes can be rolled out.

On the other hand GreenSCIES provides LoT-NET:

- A practical case study that is being designed to a construction ready stage in central London
- Understanding of the benefits and economics of specific solutions
- Insights into real life implementation challenges
- Demand side considerations through community engagement
- Opportunities for PhD students to work with organisations like LBI, TfL and LUMEN data centre
- Real life data to model operational performance of LoT-NET solutions

Case Study: Loughborough – The Town Case

- Loughborough- market town in the east midlands.
  - 23,478 dwellings, mix of different building types.
  - Approximately 67,000 population in 2018.
- 1186 towns in England and Wales with populations between 5,000 and 225,000.
  - 91 population > 75,000,
  - 347 population > 20,000 and <75,000,
  - 748 population > 5,000 and < 20,000
  - Total population represented about 32.6 million people.
- Loughborough can be treated either as a single unit or broken down in to sub units providing scope for modelling and optimising district heat networks at different scales.

Case Study: Loughborough – Further model development

- The Loughborough case initially acts as the case to develop and expand our model development
  - Modelling will be refined to provide greater temporal and spatial resolution
  - This allows different operational strategies to be assessed
- Areas to expand:
  - Building thermal mass and influence on heat demand profiles.
  - Network operating temperatures. Constant or variable. (High in Summer –for seasonal store charging, Lower in Winter – for seasonal store discharging while still meeting heat demands.)
  - Assessment of waste heat availability and potential for harvesting and upgrading.
  - Incorporate models for new heat generation technologies and approaches, size, distribution, efficiency, etc
  - Storage: number, size, temperature, duration, type, location on the network
  - Network of networks, efficiency, cost, robustness implications
- Expansion of model boundary to include domestic electrical loads and their impact on renewable generation requirements (electrification of transport)

Case Study: Loughborough – Developing the modelling capabilities to….

- A range of system options to provide net zero heating.
- System cost optimisation to provide indicative cost per dwelling assuming different levels of user uptake.
- Influence of network topology and operational strategy on cost and performance.
- Cost sensitivity analysis, (flexing costs of each network component) to determine robustness of any proposed solutions.
- Sensitivity to building thermal performance and the impact of different levels of building retrofit.
- Longer term simulations to confirm solution robustness. (40-60 years of weather data may be required to capture changes in weather other than those due to global warming).
- Assessment of likely future loads (including cooling) and system performance using UKCIP weather data.

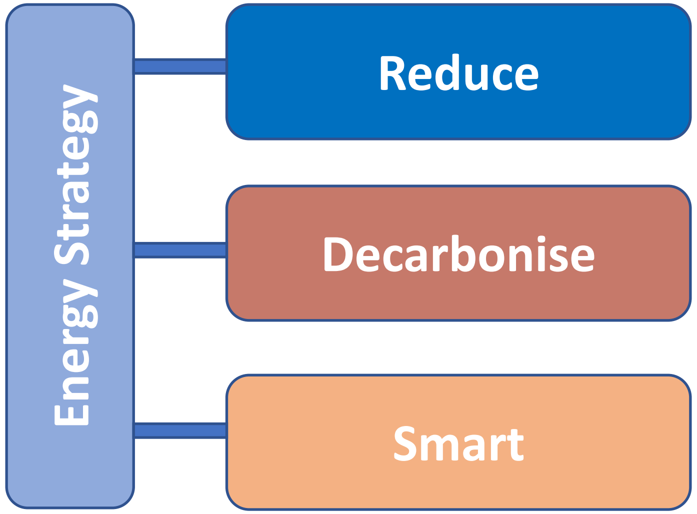
- Do heat loads need to be met completely 100% of the time? What impacts on cost does flexibility in this area deliver?

Case Study: Loughborough – Building from the 3 initial case studies

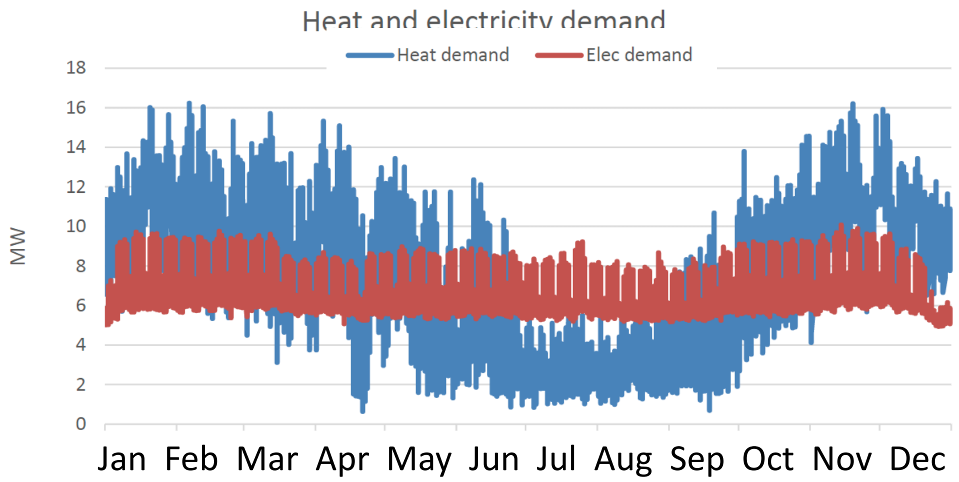
- From analysis and comparison of the 3 case studies a set of key system component options, network topologies and operational requirements will be derived that allow net zero heat delivery to be achieved at minimal cost.
- A set of minimal constraints with weightings will be established
  - For example: linear heat density, existing infrastructure, available sites for storage, waste heat sources, available local renewable energy sources, other loads to be met, etc.
- This will allow areas to be assessed and allotted to four different categories:
  - Ideal candidate area, (score >95%)
  - Good candidate area, (score >80%)
  - Possible candidate area, (score > 60%) and
  - Limited potential.
- Following an initial sift of areas the model will be applied to areas for which data is available in each of the categories to refine and assess the robustness of the constraints and weightings.

Case Study Warwick – The Integrated Campus Case

- University of Warwick Campus
  - ~£10pa spend, community of 34,000
  - Net Zero for Scope 1&2 by 2030
  - Net Zero for Scope 3 by 2050
- Energy & Infrastructure Strategy
- Projects
  - Energy 2020 – campus level system that decarbonises supply
  - Smart Square – smart, integrated system using a LoT-NET
  - The Warwick Standard – better buildings, new and retrofit
  - Management of Energy Networks – becoming a local DSO
- Enabling workstreams
  - Quick wins & optimisation, Low Carbon Technology Scanning, Electrical Network Improvements, Sustainable Drainage Strategy, Financing



Case Study: Warwick – Energy 2020

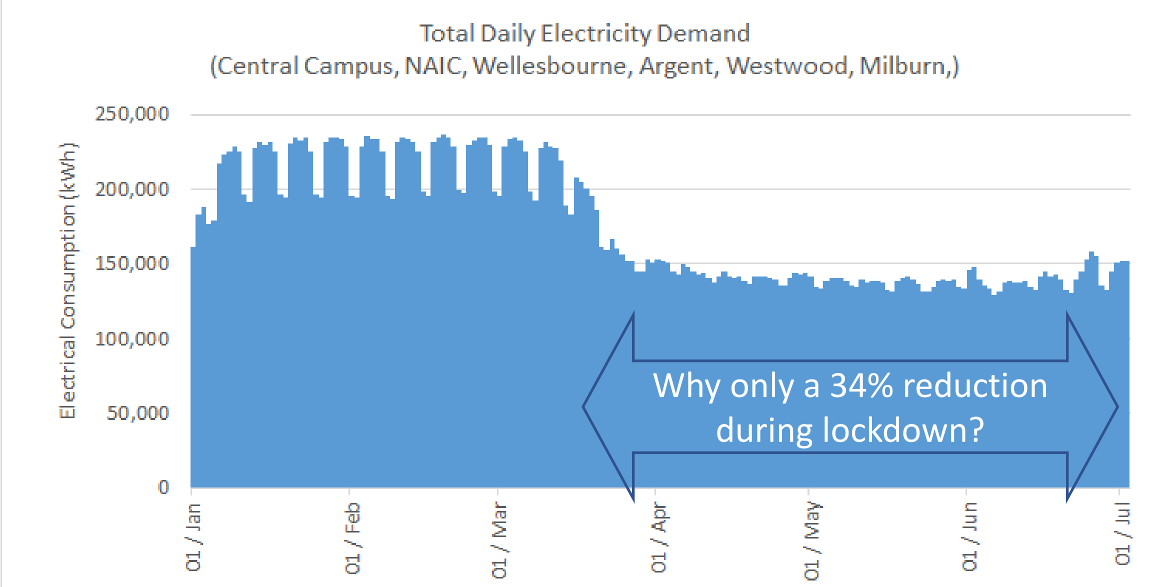


- Energy 2020 increases onsite PV generation (6MW) with battery storage (1MW), campus level ground source Heat Pump (1.4MW) and electrical network improvements.
- This allows central CHP use to be halved over time and a shift in the heat network from central supply to more distributed heat sources and storage.

Case Study: Warwick – Lessons from Lockdown: testing our flexibility

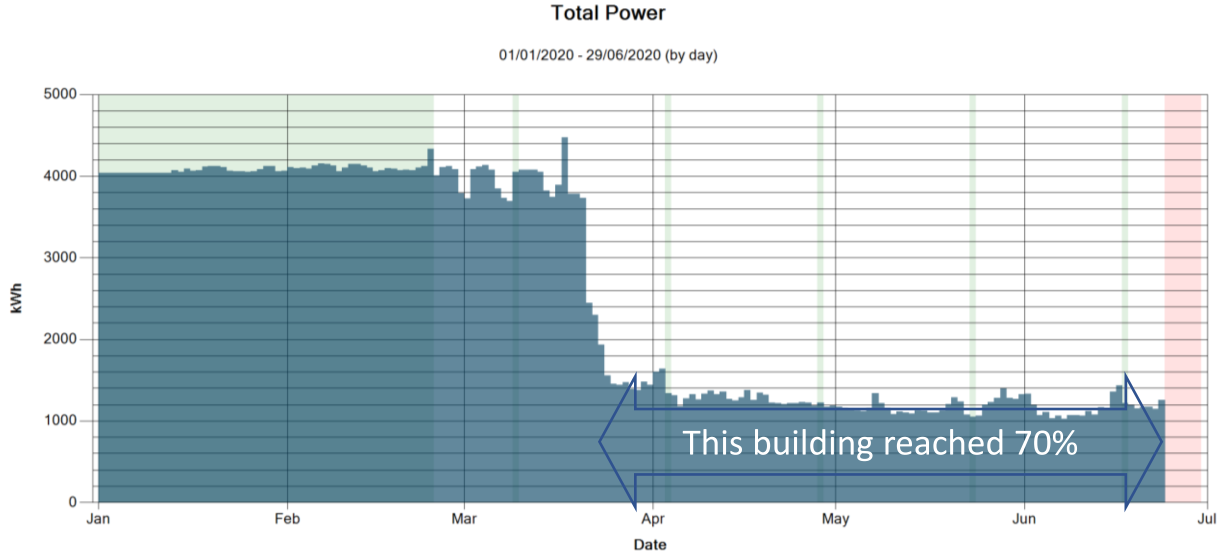
Campus Power Reduction since Lockdown was 34%

- Average daily power use down 34% after lockdown
- Average power use down 30% vs 2019
- Baseload power use down 23% after lockdown



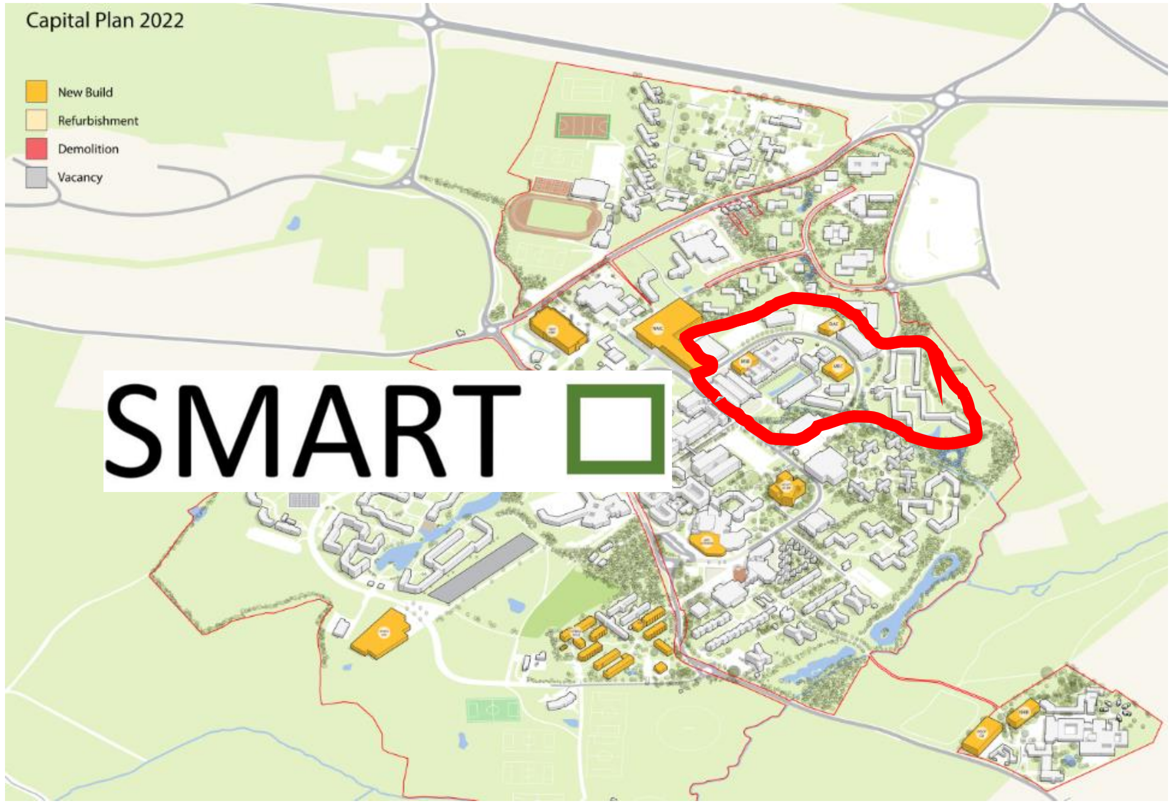
Sports Hub Power Reduction since Lockdown >70%

- Building well understood after "energy focused soft landing"
- Detailed monitoring reports in place before lockdown
- Fast action after lockdown



Case Study: Warwick – Smart Square

- Smart Square upgrades 10% of campus to include a lower temperature heat network, integrated management across power, heating, cooling and transport, smart building demonstrators and a transactive energy platform.
- This part of campus has significant levels of monitoring and control in place that provides actual building and network performance.



Case Study: Warwick – Next Steps for Smart Square

Estates focus

- Data: Operational Quick Wins
- Top 10s: despatch/shift/store?
- Smart Buildings? - Gap Analysis
- Integrated Network Analysis
- Building Fabric Upgrades
- Plant Upgrades

Research Focus

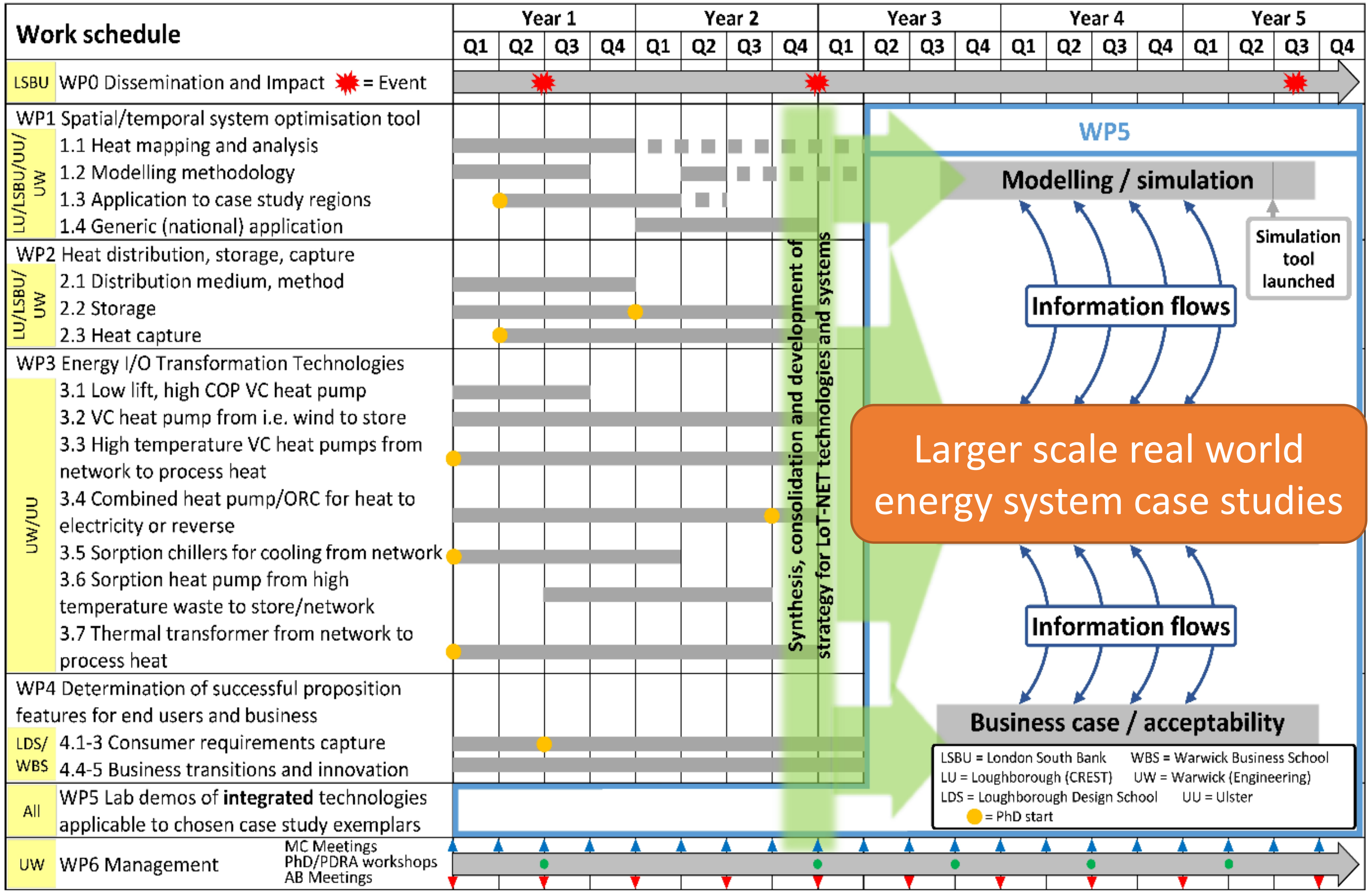
- Data: Overview but also Granularity
- Metering & Control Adjustments
- “Flexibility Index”
- Developing the Smart□ LoT-NET
- Top 10s: Agent characterisation
- Transactive platform across Smart□

Case Studies: Summary & Discussion

- Three cases:
  - Urban SLES (4,000-33,000): Integration around a LoT-NET, PFER DD
  - Campus SLES (34,000 community): Integration around a LoT-NET, PFER DD-linked
  - Town (70,000): Modelling capability to deliver net zero heat at minimal cost

- Questions to help answer
  - What will the CCC's 20% of heating from heat networks actually be?
  - How can LoT-NETs help PFER projects be integrated, multi-vectoral systems?
  - How can LoT-NETs make local energy systems smart and flexible?

Phase 2: Including larger scale real world energy systems



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LoT-NET: Phase 1 Review and Phase 2 Transition

- Phase 1 Review
  - The Y1-2 focus on capture, storage and conversion technologies and individual work packages has progressed broadly as expected in Y1-2.
  - In addition, we have developed the modelling environment that will enable the various technologies to be assessed for use and integration into energy systems.
  - We also have the intention to expand the modelling capability to include electrical energy demand.
  - Overall strategy and phasing as proposed but added research on larger scale real world energy systems in place of the ‘lab demonstrations of integrated technologies’ initially proposed for Y3-5
- Phase 2 Transition
  - Three case studies introduced for AB discussion and guidance