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System Level Thinking

Socio-Techno-Economic Design of Energy Systems driven by Community Needs

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LEADERS IN IDEAS AND SOLUTIONS

Why Systems Level Thinking?

- **Traditional energy system** approaches view energy supply and demand as the respective start and end point of that system.
- This new approach will **optimise energy pathways** beginning by making use of local resource opportunities, and ultimately finish by serving specific community needs.
- Input factors, including for example, embedded and operational energy, cost, technical capacity, affordability and resource availability.
- Optimisation based on Technology Development, Needs Analysis and Measurement, Scenario Mapping and Business Case.

Beneficiaries and end-users

- Local communities
- Governmental agencies
- Technology providers
- Housing associations
- Planners and urban developers
- Energy sector companies – large scale and district
- Local authorities

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Multi-disciplinary Approach

…to systems level design

- Funded by EPSRC Impact Acceleration & GCRF
- Collaboration of Engineers, Social Scientists, Economists
- Researchers from Edinburgh, Orkney, Dubai and Malaysia campuses

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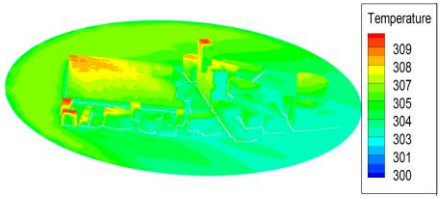
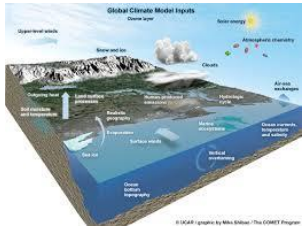
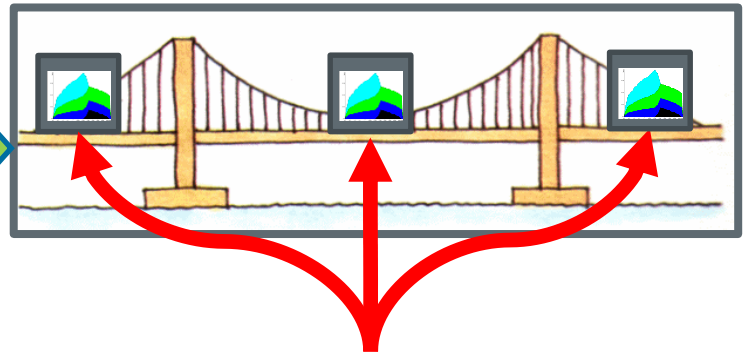
RESOURCE

- Local climate
- Other natural resources







TECHNOLOGIES

Capabilities to meet needs and service requirements

OPTIMISE

- Technological
- Economic/LCC
- Ability to meet social needs
- LCA/Environmental Impact

COMMUNITY SERVICES

- Non-energy defined
- Community needs, service requirements

Sustainable Energy Resource Mapping

- The demand for general cooling in developing countries is expected to be one of the main drivers behind the increase in worldwide energy demand.
- Thermal Comfort, Refrigeration and Cold Chains, Improved Healthcare
- Case Studies:
  - Penang, Malaysia
  - Santiniketan, India
  - Orkney, UK

Thermal Demand Mapping

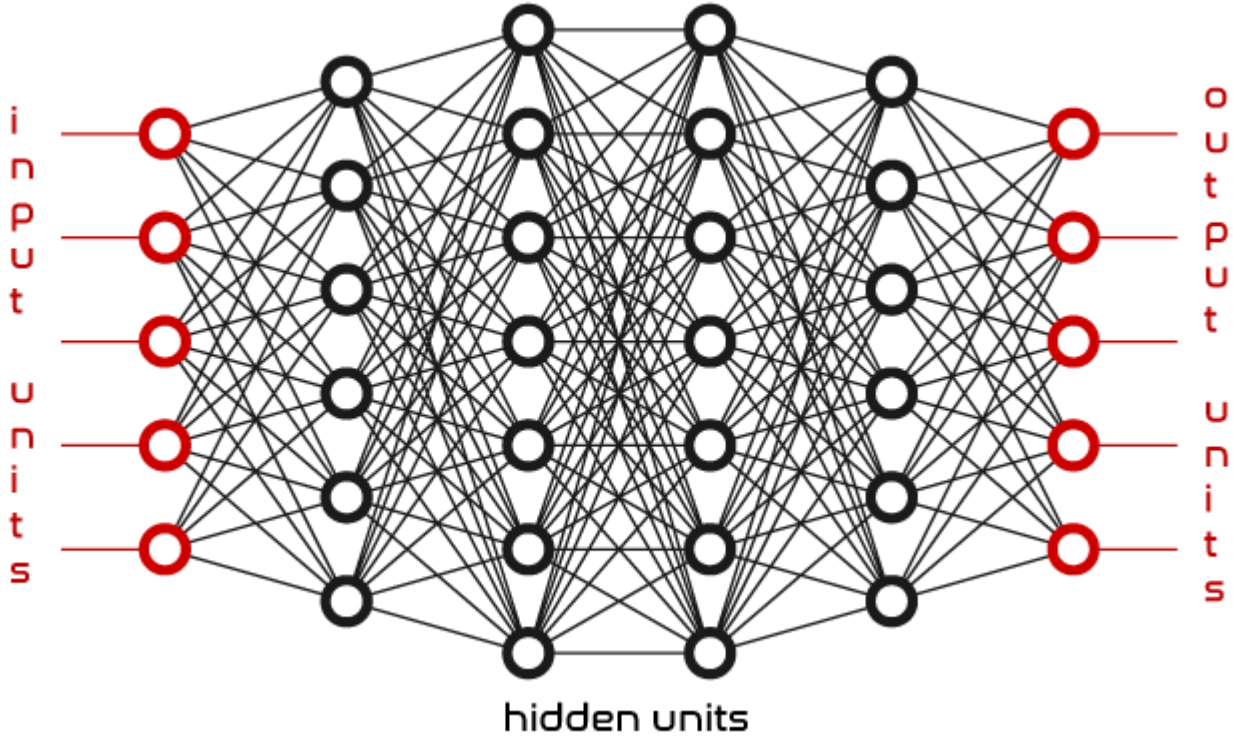
- Systematic Review to establish a comprehensive and structured understanding of:
  - heating and cooling behaviours and practices across home, work, transport and social/entertainment spaces
  - how notions of comfort are negotiated between stakeholders in different spaces
  - how non-heating based methods influence perceptions of temperate and comfort.
- Connect the elements in the abstraction hierarchy in order to define how low level processes support higher level thermal purposes and vice versa

Bridging Demand & Resource

- Within an “energy system”, the common components can be categorised as Supply, Infrastructure/Distribution (including storage) and Demand.
- A series of idealised benchmark **characteristics will be suggested** that would allow for that specific resource to meet the identified thermal energy requirement in the built environment.
- Technology choices will then be applied to this framework to find the **combination of technologies** that could come closest to these idealised parameters.
- A **technology-agnostic** approach to define the final design.

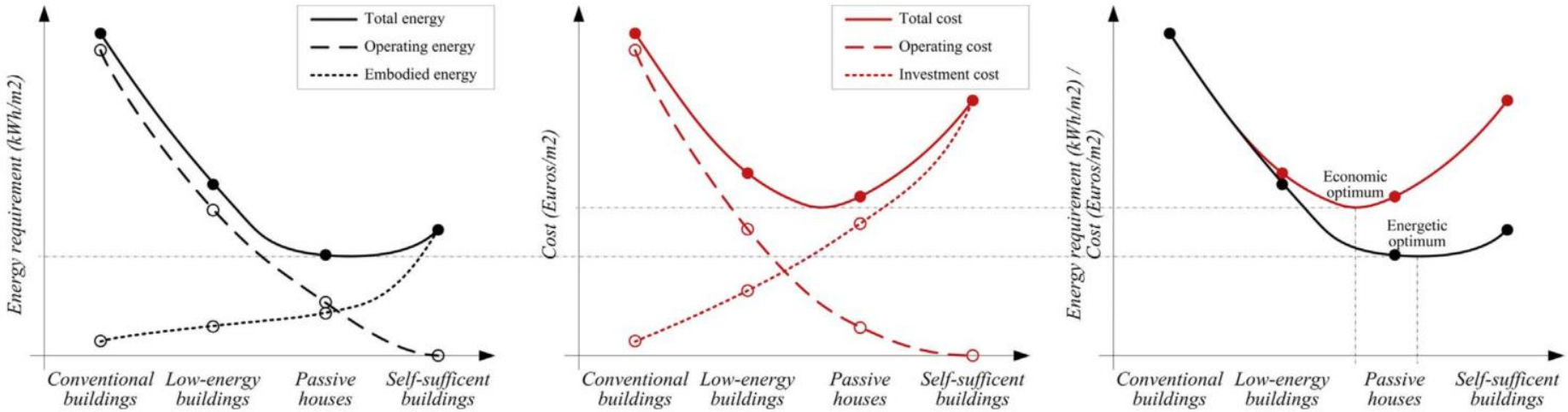
Modelling Approach

Artificial Neural Network



System Optimisation

Trade-off between embodied and operating energy, investment and operating costs



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Questions?