



# For the Change Makers

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*18<sup>th</sup> September 2019*

London South Bank  
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Loughborough  
University



# LoT-NET

UK Research  
and Innovation

## LoT-NET: WP4

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# WP4: Determine key end use and business requirements for timely adoption

- **WP4.1: Understanding household priorities** [LDS Year 2]
  - Determine what a low-temperature network needs to deliver to users, including service requirements such as comfort, hygiene, affordability and barriers / enablers
- **WP4.2: From user requirements into technology design** [LDS Year 2-3]
  - Identify user requirements to inform technology development and design
- **WP4.3: Consumer engagement with low carbon heating and cooling** [LDS Year 2-3]
  - Determine information provision to assist consumers in their engagement with low-temperature heating and cooling systems and how this might impact on demand shifting
- **WP4.4: Energy transitions and competing for investment** [wbs Year 1, 4]
  - Low temperature networks as competing investments in the energy transition
- **WP4.5: Low temp heat networks as an innovation system** [wbs Year 2-4]
  - Assessing market penetration for low temperature networks as an innovation system requiring the cooperation and participation of a network of organisations along with policy and regulatory frameworks, standards and skills development.

# WP4: AB2 Update

- **WP4.1: Understanding household priorities** [LDS Year 2]
- **WP4.2: From user requirements into technology design** [LDS Year 2-3]
- **WP4.3: Consumer engagement with low carbon heating and cooling** [LDS Year 2-3]
  - Unfortunately, the PDRA due to join at the start of Y2 has recently resigned and so recruitment has started to seek a replacement
- **WP4.4: Energy transitions and competing for investment** [WBS Year 1, 4]
- **WP4.5: Low temp heat networks as an innovation system** [WBS Year 2-4]
  - A choice between researching and demonstrating – seized the opportunity of the latter!
    - Have kicked off PDRA recruitment but wanted to see what their focus might be
  - What is the role of a low temperature heating & cooling network in a net zero context?
    - University of Warwick Campus Masterplan for 2020-2030
  - Enabling low temperature heating and cooling to be part of a multi-vectoral, smart local energy system
    - Transactive Energy approach: study of existing business models

# Last time: Energy transitions and competing for investment

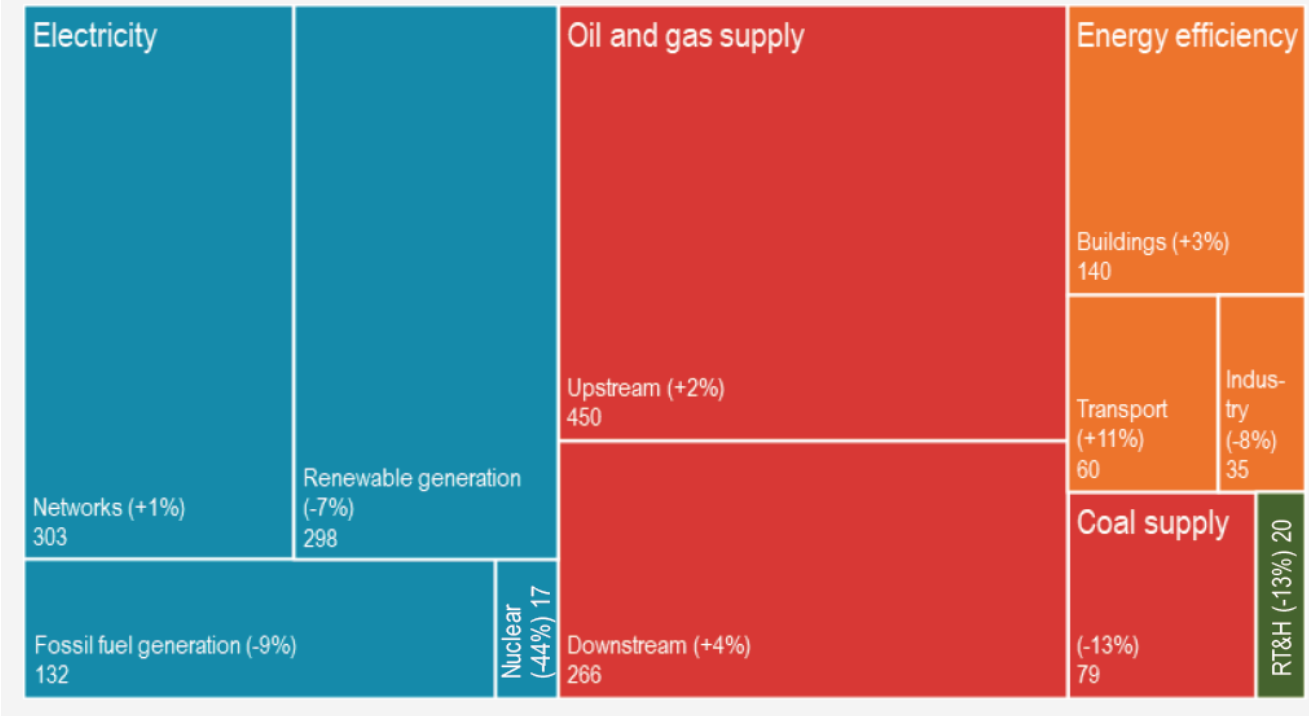
Low temperature networks **are in competition** for investment against other choices for energy **supply, storage and consumption**, as part of **wider shifts in focus**

Incremental .....	Exponential
Supply focus .....	<b>Consumption &amp; storage focus</b>
Large, centralised .....	<b>Distributed</b>
Technologies .....	<b>Systems</b>
Power .....	<b>Heating &amp; Cooling</b>
Unhealthy .....	Healthy
Rules .....	Principles
Not very smart .....	Much smarter
Markets .....	Governments

**LoT-NET**

# 2017 Capital investment in the supply and use of energy

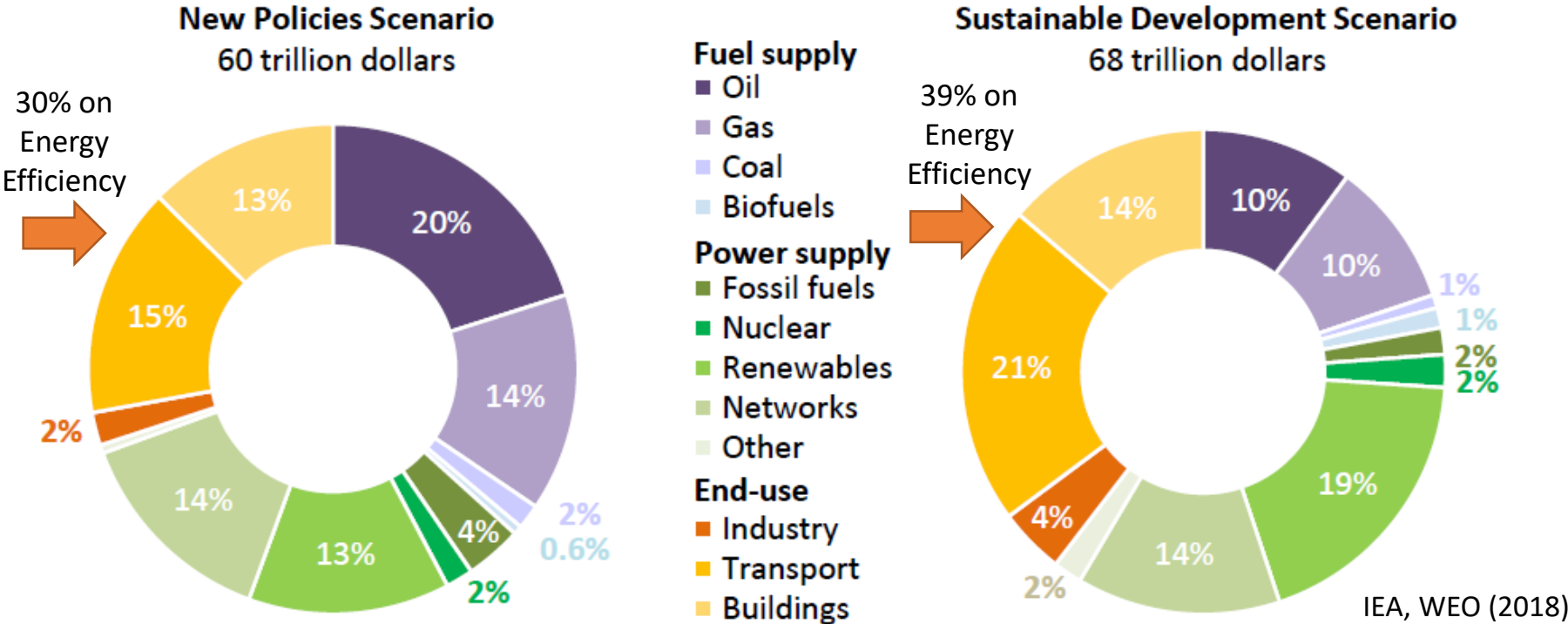
Global Capital Investment in the Supply & Use of Energy (\$1.8Tn in 2017)



IEA, WEI (2018)

# Looking ahead over 20 years, end use efficiency investment needs to rise to 30% or to nearly 40% for a 1.5°C goal

Cumulative investment needs by sector in the IEA's New Policies and Sustainable Development scenarios, 2018-2040

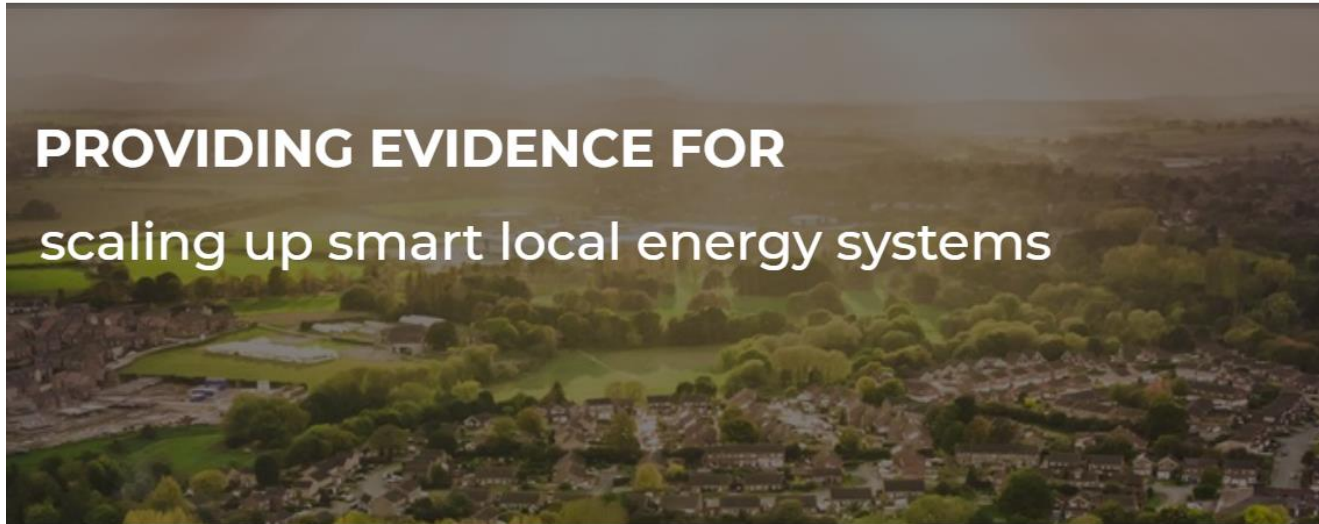


IEA, WEO (2018)

# Since our last meeting....



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## Smart Local Energy Systems

Energy systems around the world are going through a phase of rapid change. However, the concept of energy transition isn't new - society has seen many changes associated with energy over time. In the UK, the Industrial Revolution saw a shift from an energy system primarily reliant on traditional biomass and other renewable sources (e.g. wind, water, muscle power) to an industrial system reliant on steam power fuelled by coal. Before the 1950s most energy systems relied on local rather than the global energy networks that are available today.

## The EnergyREV Consortium has been formed to help drive forward research and innovation in Smart Local Energy Systems.

It supports the wider Industrial Strategy Challenge Fund's programme on Prospering from the Energy Revolution through its activities in 6 key Themes:



### Infrastructure

Adapting advances in AI, data analytics and controls to enhance smart local energy systems.



### Business

Understanding current local energy business sector to accelerate innovation.



### Institutions

Assessing policy, regulation and markets for local energy sector change.



### Users

Reveal how user preferences and practices evolve over time in relation to local energy systems.



### Developing a whole systems understanding

Capture and synthesise knowledge from all aspects of the value chain, utilising learnings.



### Supporting Scale-up

Understanding potential constraints that can prevent scale up of local energy systems and solutions to overcome them.



# EnergyREV will be advising and researching PFER's three major demonstrators, ten detailed designs.....

## Smart local energy systems demonstrators and designs

Government will invest in fast-tracking up to 3 practical local energy systems demonstrators and around 10 whole system design studies. The practical demonstrators will build supply chain capabilities, deliver positive changes for energy consumers, and inform future projects. The design studies will create a pipeline of investable projects for the future.



## Innovation Accelerator Fund

The Innovation Accelerator Fund will develop and commercialise smart local energy system products and services, and engage with the best international research and innovation opportunities.

WP4 will be contributing to this and will report back on work relevant to LoT-NET. But it requires a shift in focus for WP4.3&4.4 to avoid duplication:

- Pulling forward the Demonstrator focus of Lot-Net Y3-5 to use the case study of Warwick's campus and other university campuses as a sector able to demonstrate what Lot-NET/SLES can achieve.
- Fill a gap in how heating and cooling are integrated into multivectoral local energy systems.



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## Net Zero – The UK's contribution to stopping global warming



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6.78MB

Published:

2 May 2019

This report responds to a request from the Governments of the UK, Wales and Scotland, asking the Committee to reassess the UK's long-term emissions targets. Our new emissions scenarios draw on ten new research projects, three expert advisory groups, and reviews of the work of the IPCC and others.

The conclusions are supported by detailed analysis published in the [Net Zero Technical Report](#) that has been carried out for each sector of the economy, plus consideration of F-gas emissions and greenhouse gas removals.



Climate Changed

# U.K. Adopts Law for Net Zero Fossil Fuel Pollution by 2050

Jessica Shankleman

June 24, 2019, 7:58 PM GMT+1

The lower chamber of Britain's Parliament approved a move to toughen targets on fossil fuel pollution, setting a goal of reaching a level of net zero by 2050.

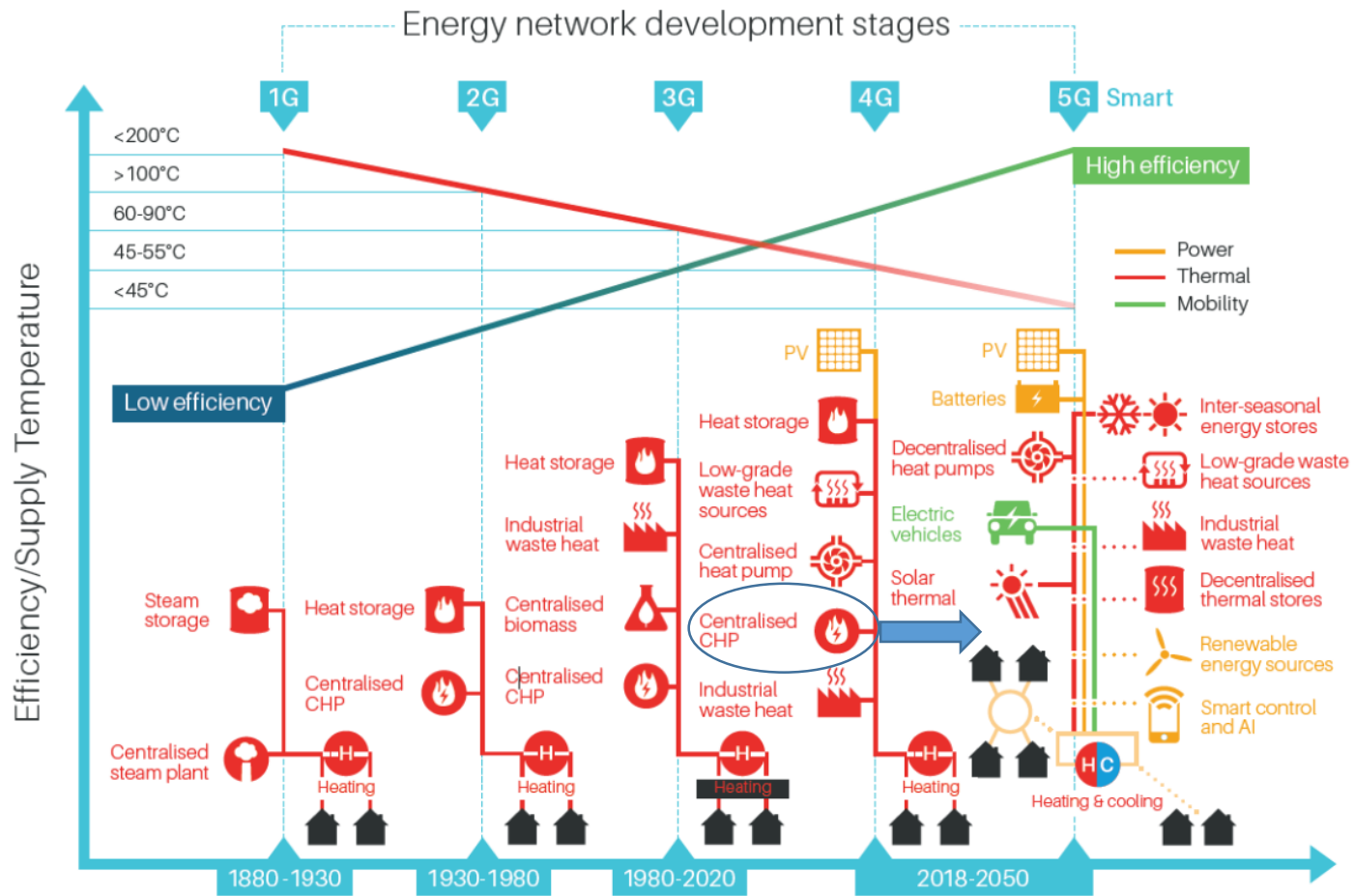


Figure 1 Energy network development stages and 5G smart energy network concept (Revesz et.al. 2019)

# Heating and Cooling in a Net Zero, Smart Local Energy System

From a case study of the University of Warwick's campus to an informed view of demonstrator systems across the sector

# The University of Warwick's campus is a nationally recognised local energy system

- A 24/7/365 town of 30,000 people
- 290 hectares with over 150 buildings providing 560,000m<sup>2</sup> of space
- Mix of residential, offices and light industry
- 19km heating/cooling network and we own the 11kV network
- Self-generates at least 60% of heat and power needs with 8.6MWe electricity generation capacity from 6 gas CHP's
- -46% Carbon emissions per £1,000 income since 2005/6
- 54% increase in floorspace since 2005/6: overall emissions down 8%
- Nominated for the Association of Decentralised Energy's Public Sector Project of the Decade in 2017
- A BEIS 2019 Heat Network Case Study

## Our Future Campus

### Creating a vision for our future campus

In discussion with University staff, students and neighbours in 2018/19, we told us you want a greater sense of place here, with a feeling of more social environmental sustainability. You told us you want better regional connect campus, and improved cycle/pedestrian facilities.

We've taken your feedback on board to create a masterplan for the develo

This vision for our campus is a critical enabler to our [University strategy](#) – experience of our students, staff and visitors whilst looking beyond our ph connectivity to support our region's growth.

### Vision

Our campus masterplan is a blueprint for the future development of the University campus. A blueprint that imagines how the environment, buildings and infrastructure we create will ensure Warwick can become one of the world's exceptional university campuses. A blueprint that imagines how the campus connects our neighbouring communities with our students and staff for their mutual benefit.

These are the key aims underpinning our vision:

- To form a vibrant learning, working, and living community.
- To shape a distinctive campus experience that has a 'cosmopolitan in the countryside' feel.
- To transform regional transport connectivity to campus.
- To create an accessible, inclusive, and people-focused environment.
- To deliver a SMART carbon neutral campus.

### Themes for development

The next phase of work is to develop our plans under four overarching campus development themes. Click on an image for more information



[Transport and Mobility](#)



[Design and Landscape](#)



[Energy and Sustainability](#)

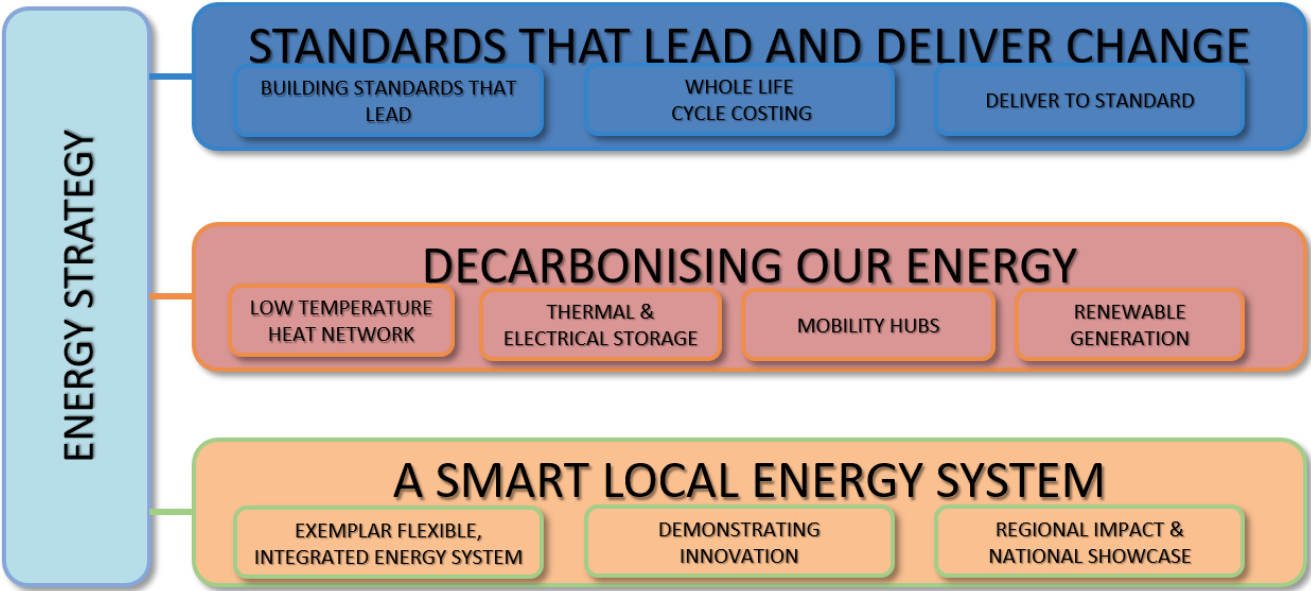


[SMART Campus](#)

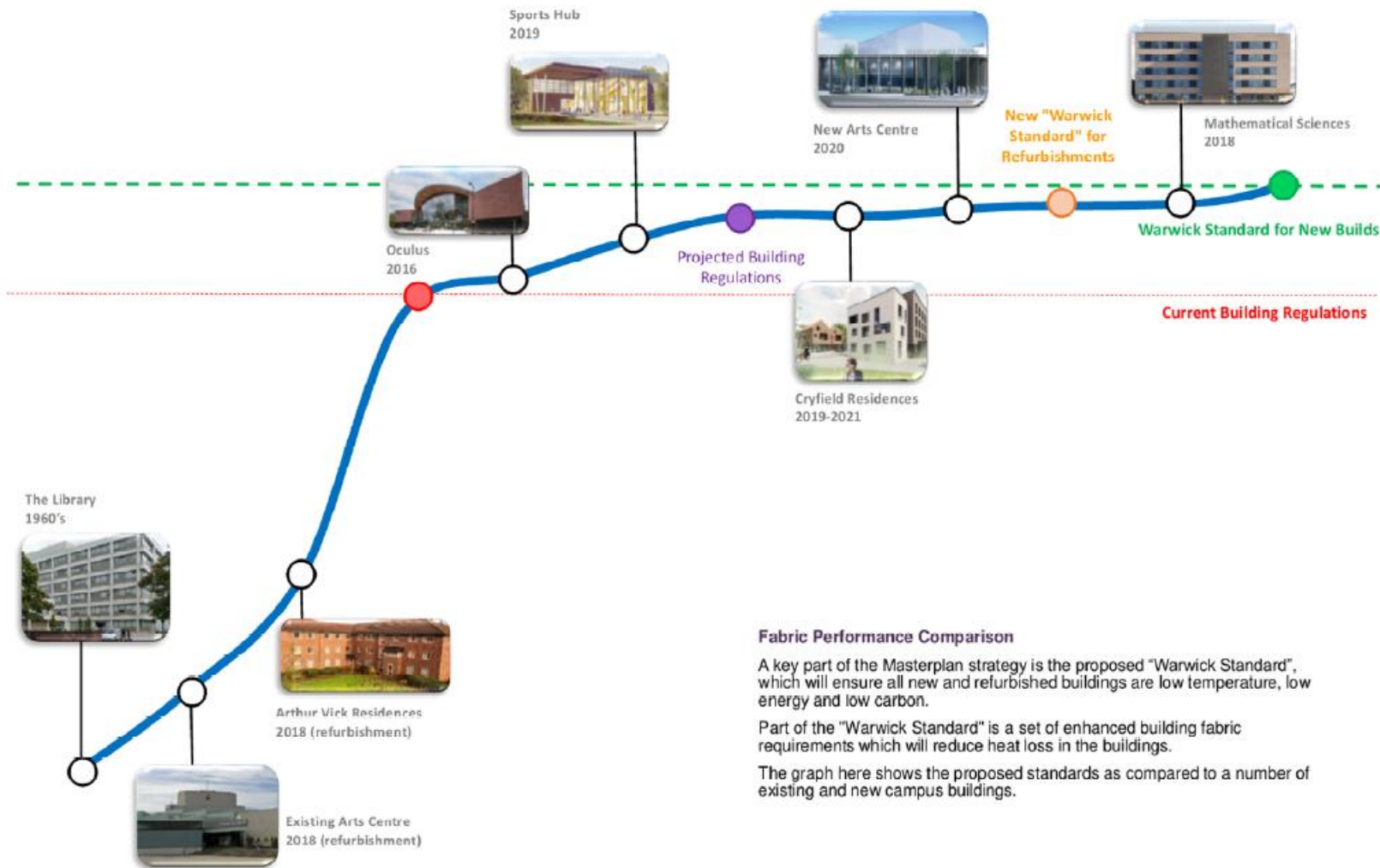
# Our Goal for the Warwick Campus: To deliver a smart, carbon neutral campus

Use less, lower the emissions and lead on how local energy systems help our campus, help our region and demonstrate clean growth in the UK

WARWICK ENERGY TRANSITION PLAN  
(Local Solution to Global and National Drivers)







#### Fabric Performance Comparison

A key part of the Masterplan strategy is the proposed "Warwick Standard", which will ensure all new and refurbished buildings are low temperature, low energy and low carbon.

Part of the "Warwick Standard" is a set of enhanced building fabric requirements which will reduce heat loss in the buildings.

The graph here shows the proposed standards as compared to a number of existing and new campus buildings.

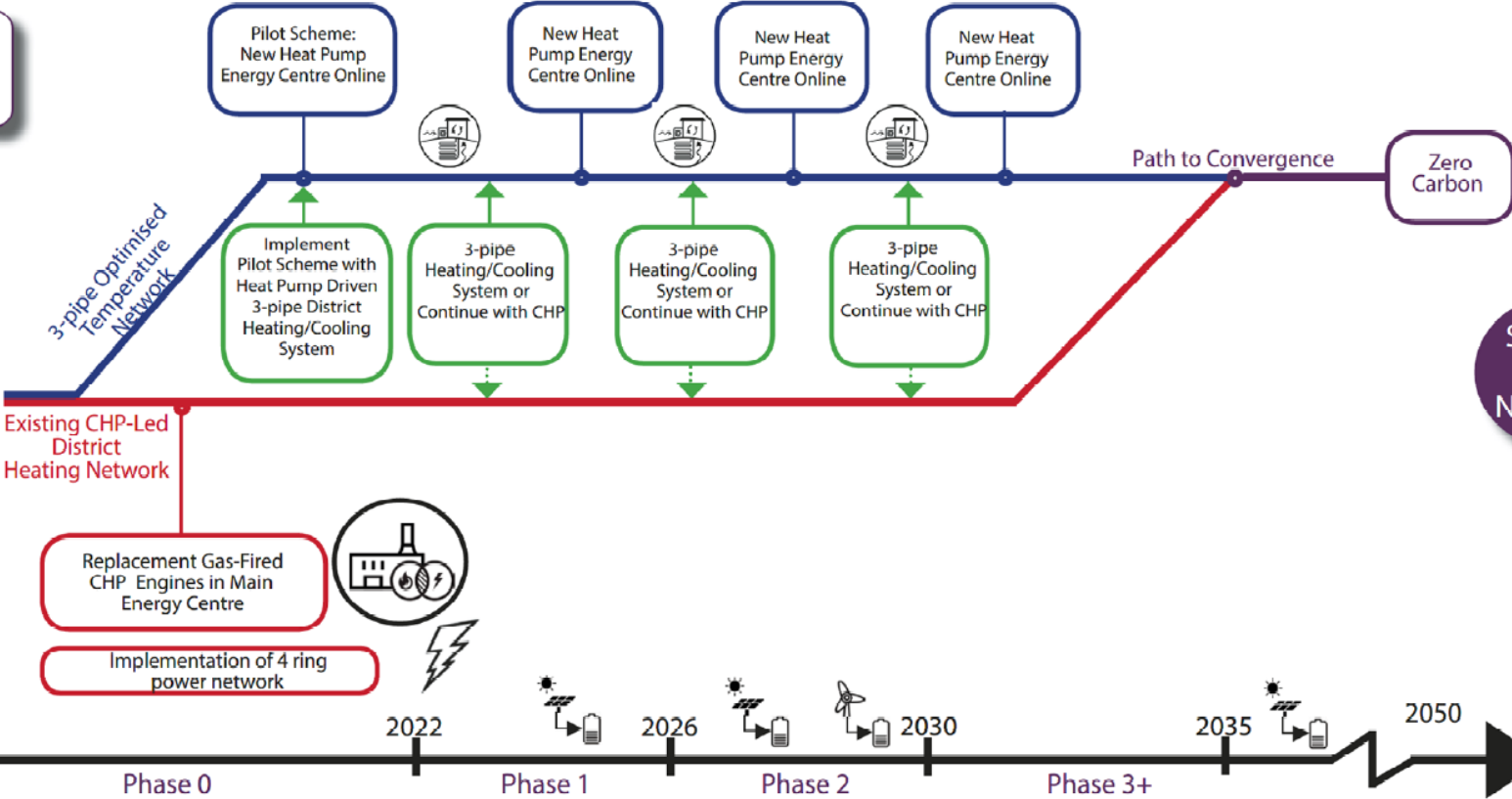
# Warwick Standard



Low Energy Buildings - Thermally Efficient Envelope

Optimised Temperature - High Efficiency Building Services

SMART Buildings with Intelligent Controls



# *Integrating* heating and cooling into a multi-vector, smart local energy system

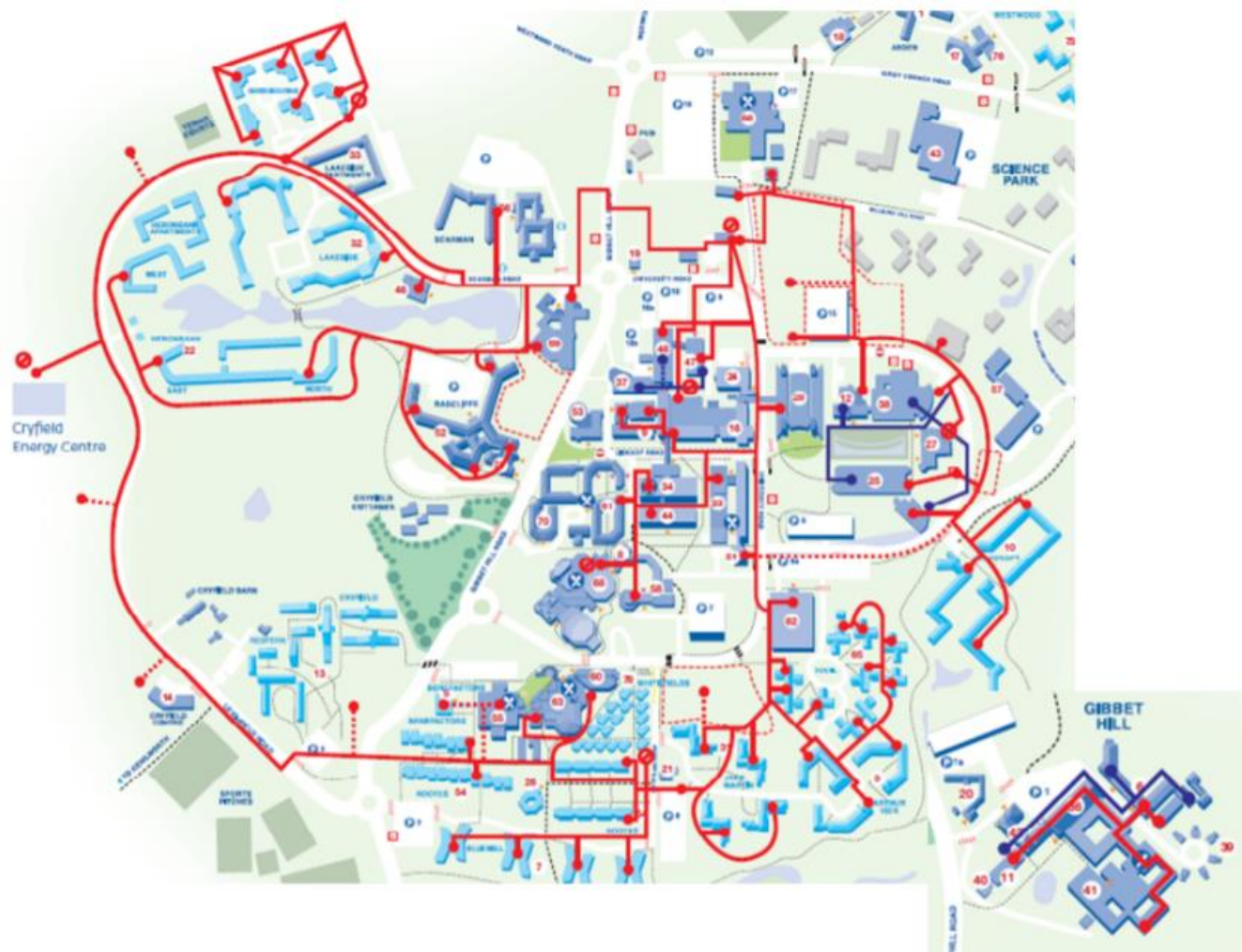
Creating and using a transactive energy platform with AI agents representing a broad range of elements that generate, store and use energy, and that use machine learning to propose and carry out transactions not typical in conventional, siloed control systems.

# Research Question

- If low temperature heating and cooling is to be part of smart local energy systems, how will they interact in a multiple energy vector system?
  - The traditional approach of using conventional, vector-focused control and management systems.... then thinking how to link them up and cope with
  - Demonstrate the novel approach of using AI agents on a transactive platform where machine learning guides rapid, secure, inexpensive physical, financial and emissions transactions between vectors.
- This makes a focus on the innovations being made in Peer-to-Peer (P2P) trading, Virtual Power Plants (Aggregators) and Transactive Energy
  - Initial development of a TE platform for the Warwick Campus SLES
  - “Platform Business Model Design in the Transactive Energy Sector” (Taggart, 2019)
  - Joined the IEA’s Demand Side Management Technology Collaboration Program’s [Global Observatory on Peer-to-Peer, Community Self-Consumption and Transactive Energy models](#)

# Developing a transactive energy platform for the Warwick campus

- Open Innovation approach involving....
  - WBS (David Elmes, Mark Skilton)
  - Warwick Estates Dept (Joel Cardinal, Gerard Hunter, Mark Jarvis)
  - Warwick Institute for the Science of Cities (Maths Dept: Chris Conlan, PhD student)
  - Fetch.AI (Yujian Ye, Jonathan Ward, Maria Minaricova)
    - AI spin-out from Deep Mind that was then acquired by Google
    - “Fetch.AI is at the forefront of accelerating research and deployment of emerging technologies, including blockchain and AI. Its solutions are designed for people, organizations, and IoT. The project has created an Open Economic Framework (OEF) that serves as a decentralized search and a value exchange platform for various autonomous economic agents. This is supported by a smart ledger that can support more than 30,000 transactions per second, and which is ready to meet the demands of the next generation of connected devices.”
    - <https://fetch.ai/#/vision>
    - Focus on Autonomous Agents, an Open Economic Framework and a Smart Ledger





# TE Dataset - V1

- Main Energy Centre

- 3 CHP Engines
- 2 Boilers
- Thermal Store

- MAS Building

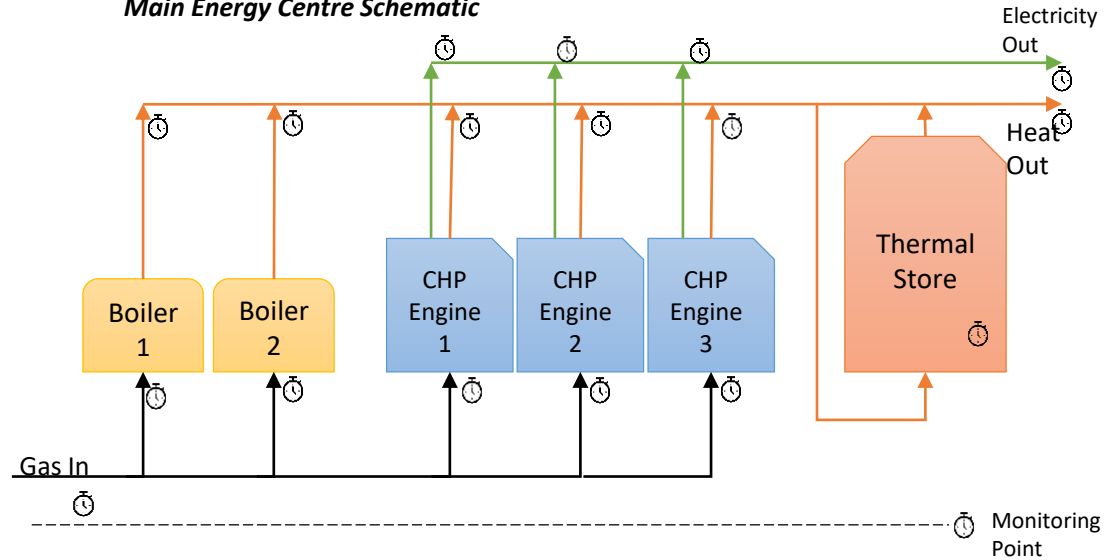
- District heat and power in
- Solar heat and power in

- EV Charging

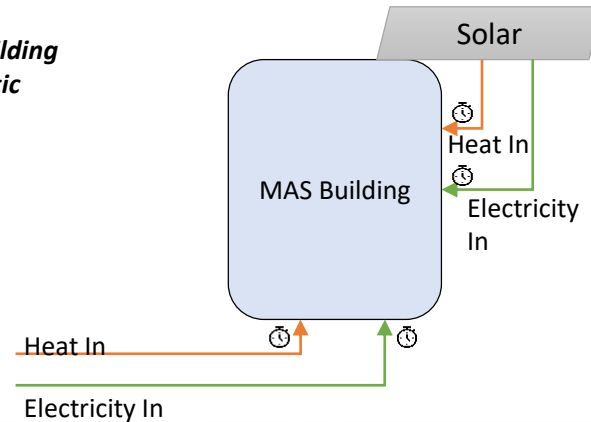
- District power in

- And what to add for V2?

*Main Energy Centre Schematic*



*MAS Building Schematic*





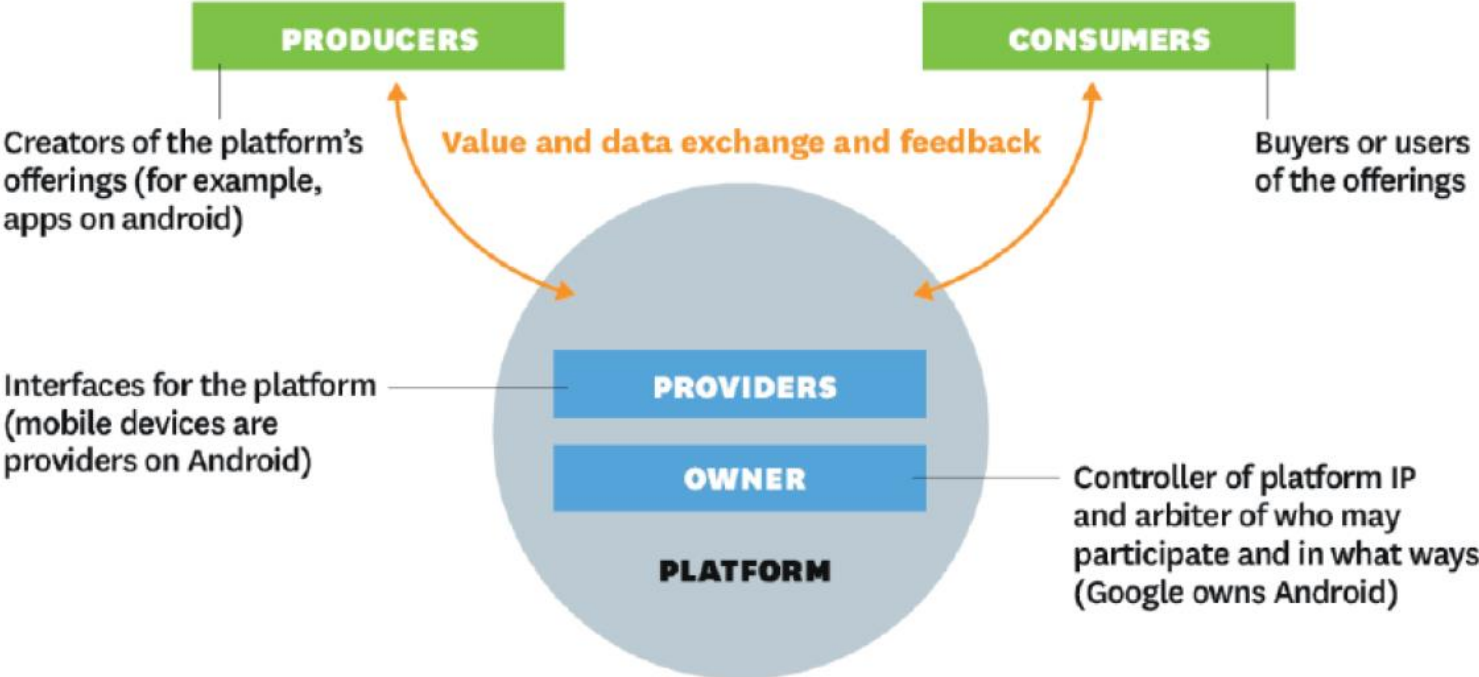
# Fetch.ai are now working on agent characterisation and platform development

- “Design” (performance characterisation) of energy assets (including consuming assets!)
  - An agent-based, model-free, reinforcement learning approach vs the traditional approach of a centralised optimisation formulation
  - Model-free and data-driven
  - Question: how much forecasting is needed if there is a broad and diverse range of energy assets that can collectively respond to demand
- Transaction platform in place (Fetch.AI product)
  - Total Cost optimisation
  - Total Emissions optimisation
  - Run a virtual twin to see what transactions are made vs actual

# Platform Business Model Design in the Transactive Energy Sector (Taggart, 2019)

- Review and classification of the business models of 82 P2P, VPP and TE businesses
- More detailed comparative case analysis of four companies
  - Piclo, Limejump, Electron and PowerLedger
- Three further expert interviews
  - Susan Kennedy, Advanced Microgrid Solutions; Ben Irons, Habitat Energy and Eddie McGoldrick, The Electric Storage Company.

# Platform business models (Van Alstyne et al, 2016)



# Conclusions

- The majority of Transactive Energy Platforms (TEPs) are still experimenting with their business models (BM), with very few to have reached any meaningful scale.
  - This is however to be expected, given the nascent stage of the industry's development
- The value proposition of TEP BMs must rely on factors other than network effects, which do not appear applicable to the sector.
- Platforms do not currently articulate their customer value proposition clearly and have yet not used their BM to create a sustained competitive advantage
- The research concluded that many TEPs do not focus on one customer type, but those targeting larger customers, developing long term contractual relationships appeared to have more success.
- The path to value creation was not visible amongst the majority of TEP BMs – they have not yet formed a revenue strategy.

# We joined the IEA's Demand Side Management Technology Collaboration Program's Global Observatory on Peer-to-Peer, Community Self-Consumption and Transactive Energy models

## *What is the Observatory?*



- The Observatory is a Task under the Demand Side Management Technology Collaboration Programme (DSM TCP) by the **International Energy Agency**
- The Observatory:
  - brings together policymakers, regulators, researchers and industry;
  - is technology-neutral, pre-competitive & has a whole systems focus;
  - is global – drawing lessons from international comparative analysis;
  - focuses on Peer-to-Peer, Community Self-Consumption & Transactive Energy models;
  - is driven by leading research institutions across the world;
  - will maximise impact through informing the work of the IEA and Clean Energy Ministerial.
- **Member countries** so far: Australia, Belgium, Italy, Netherlands, Switzerland, UK and USA (with more countries to join)
- **Total duration:** Three years + six-month reporting phase

# Advancing WP4.3&4 to consider demonstrators and focus on innovation in novel transaction approaches

- **WP4.4: Energy transitions and competing for investment** [WBS Year 1, 4]
  - Low temperature networks as competing investments in the energy transition
  - *Write up Y1 work when have the data on sector profitability that is in hand*
- **WP4.5: Low temp heat networks as an innovation system** [WBS Year 2-4]
  - Assessing market penetration for low temperature networks as an innovation system requiring the cooperation and participation of a network of organisations along with policy and regulatory frameworks, standards and skills development.
  - *Move ahead in focusing on Demonstrators' experience of the new role for low temperature, 5<sup>th</sup> generation heating & cooling networks in net zero, smart local energy systems (SLES): Universities and PFER projects*
  - *Focus on the innovation potential that transactive energy offers for the integration of heating and cooling as two of the multiple energy vectors in a smart, local energy system*