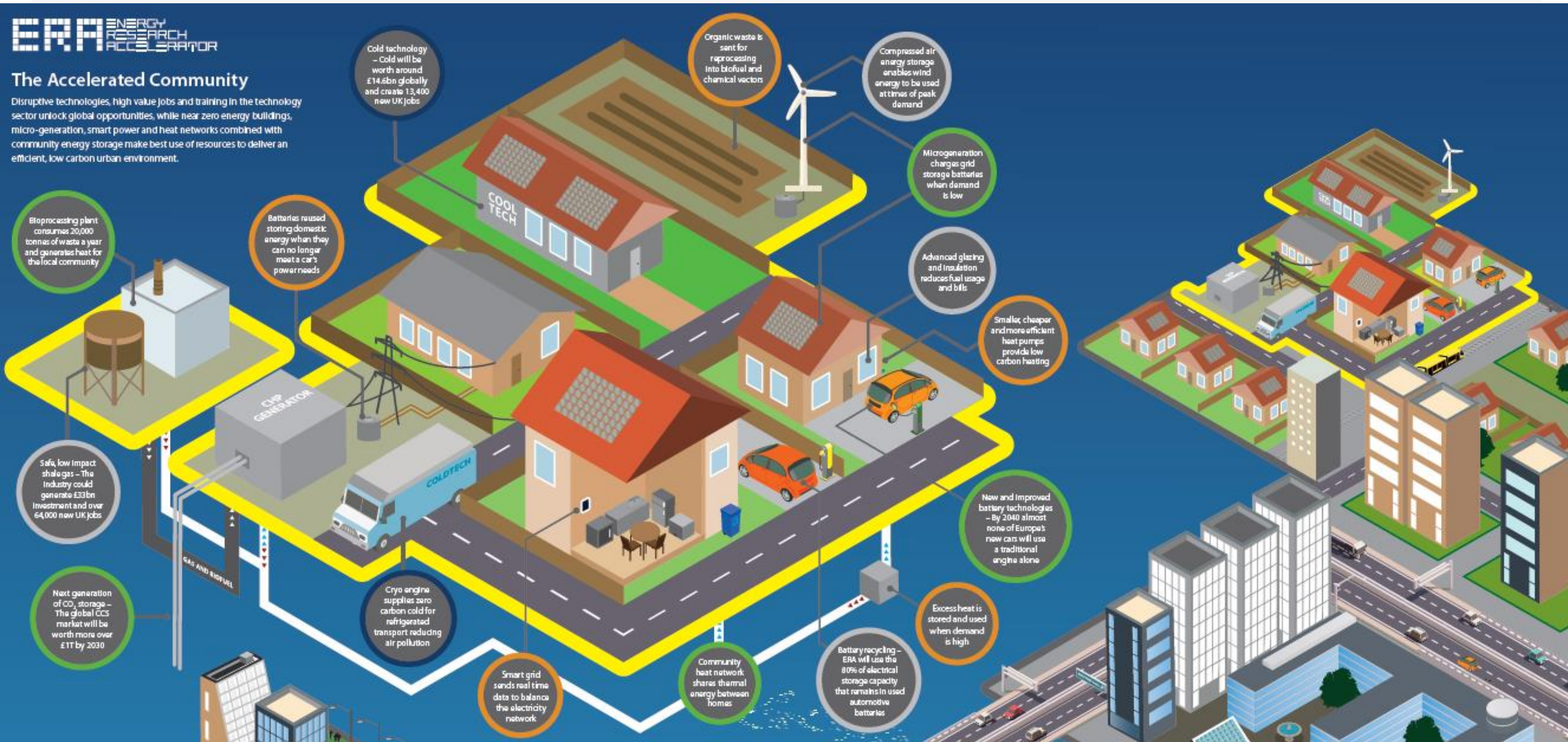
ERA ENERGY RESEARCH ACCELERATOR



ERA Energy Research Accelerator

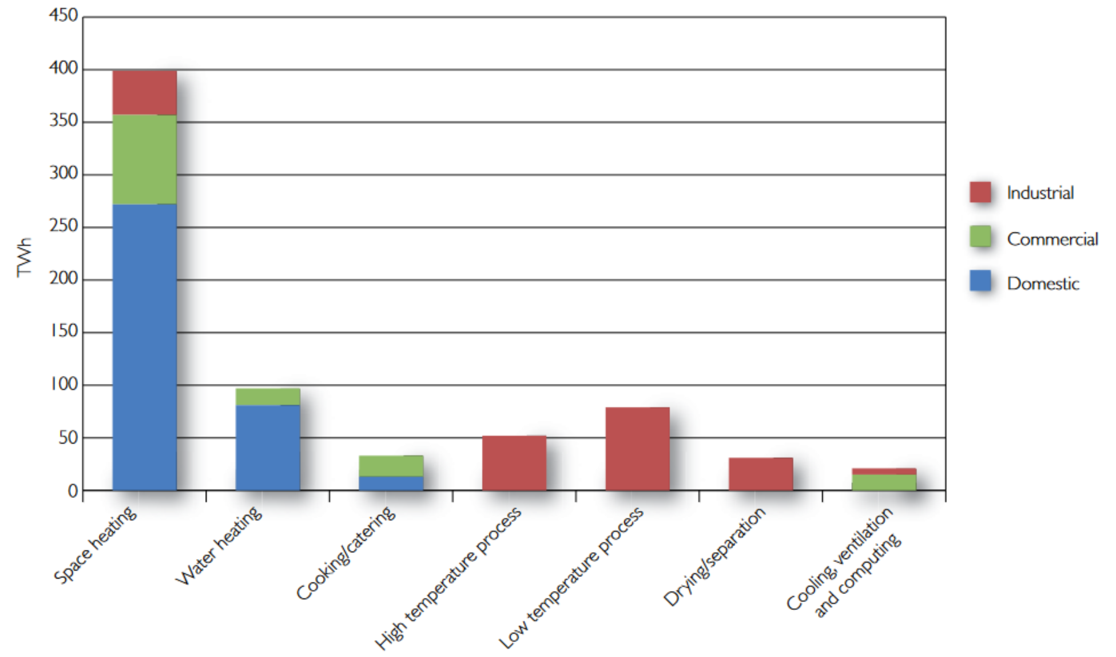
T-ERA: Aston, Birmingham, Loughborough, Warwick, MTC

Why Thermal – The Challenge

- "there has been a historic failure to get to grips with one enormous part of the energy jigsaw; the supply of low carbon heat. " **DECC Secretary of State**

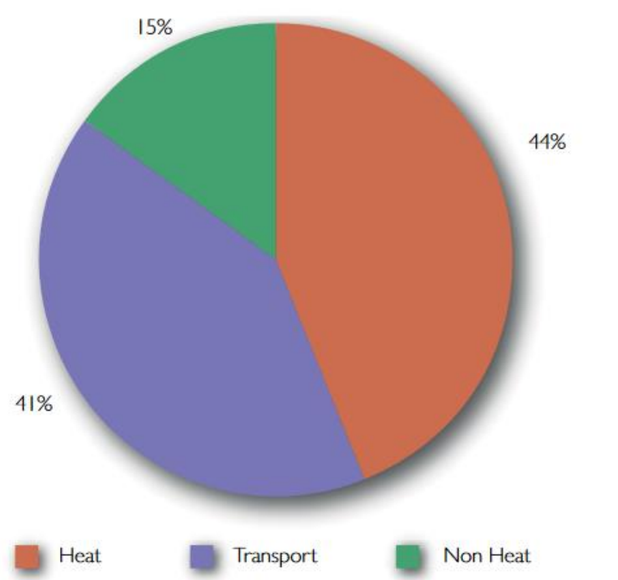
- "we spend £32 billion a year on heating. It accounts for around a third of our greenhouse gas emissions. Without changing the way we produce and consume heat, we will not meet our long-term climate change target. To get there, we are going to have to change the way we generate, distribute and use heat in buildings and industry." **The Future of Heating: Meeting the challenge, DECC report 2013**

Chart 2: Energy consumption for heating by sub-sector and end-use in TWh (2011)



Source: DECC

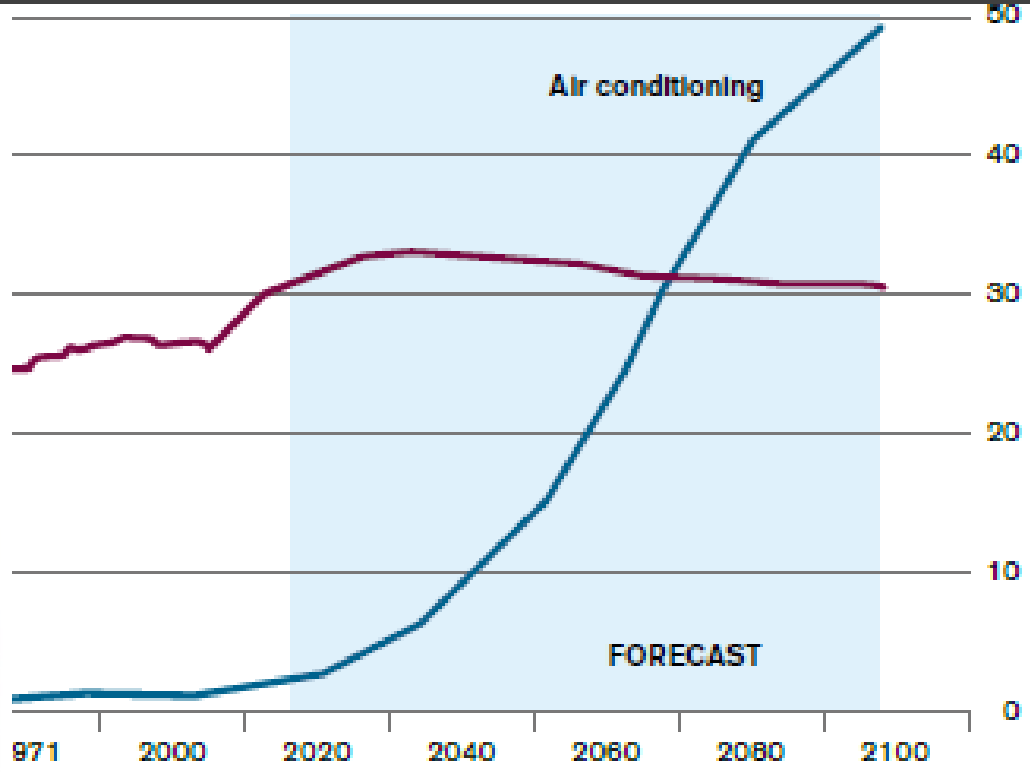
Chart 1: Energy Usage for Heat, Non Heat and Transport, 2011



Source: DECC

District Heating

Why Thermal – The Challenge

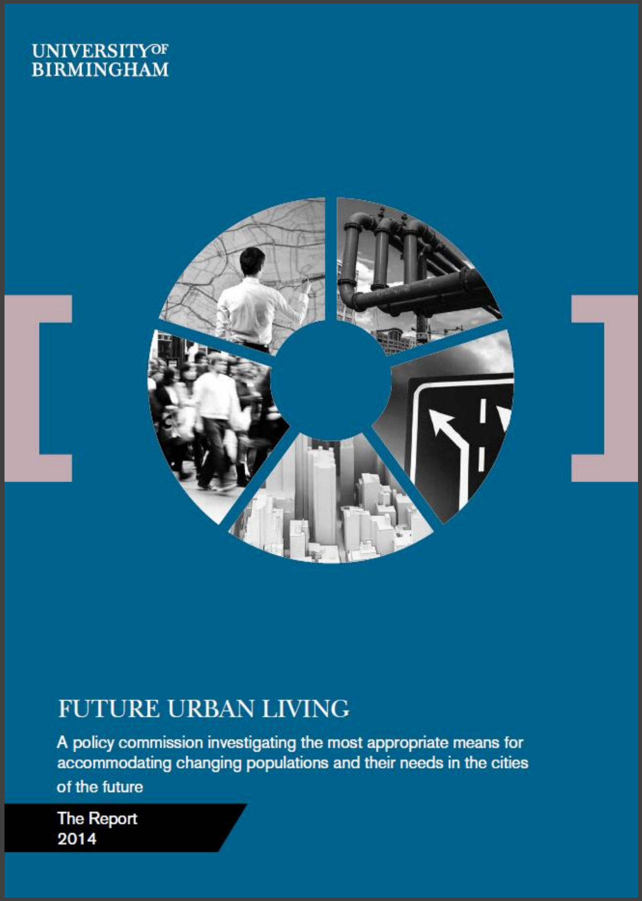


In 2010 Chinese consumers bought 50 million air conditioning units; more than the entire of the US current domestic air conditioning fleet

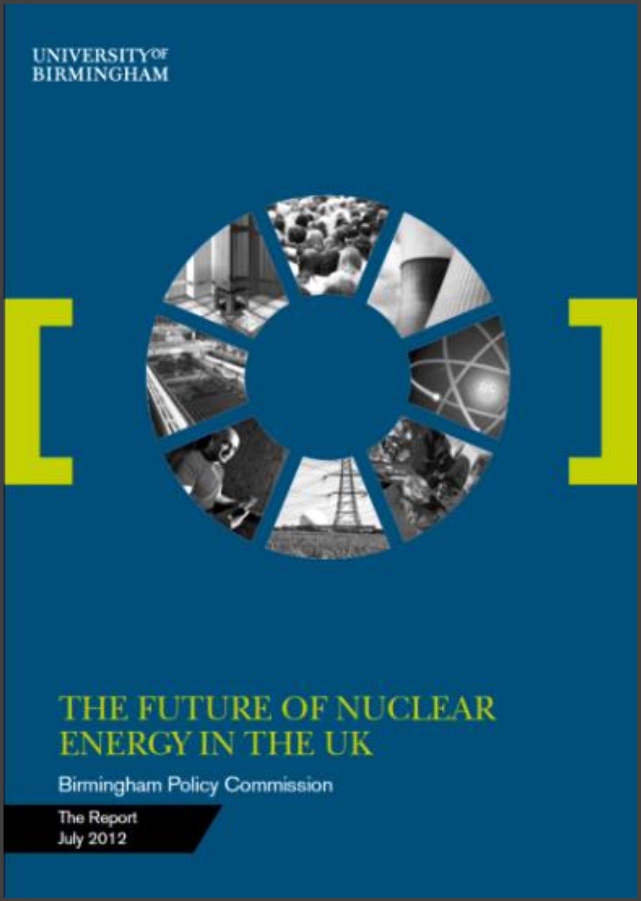
Policy Commissions

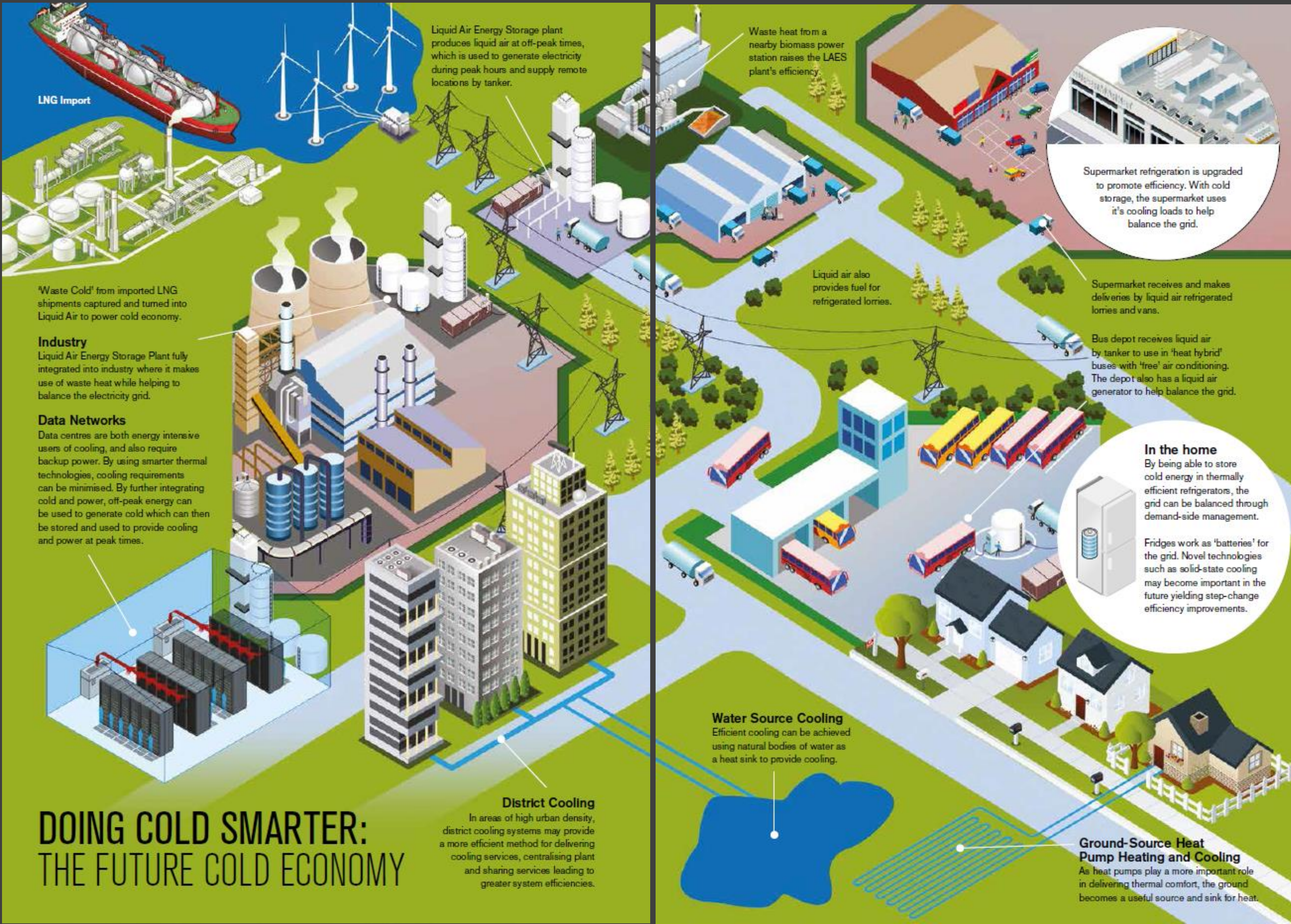
2015

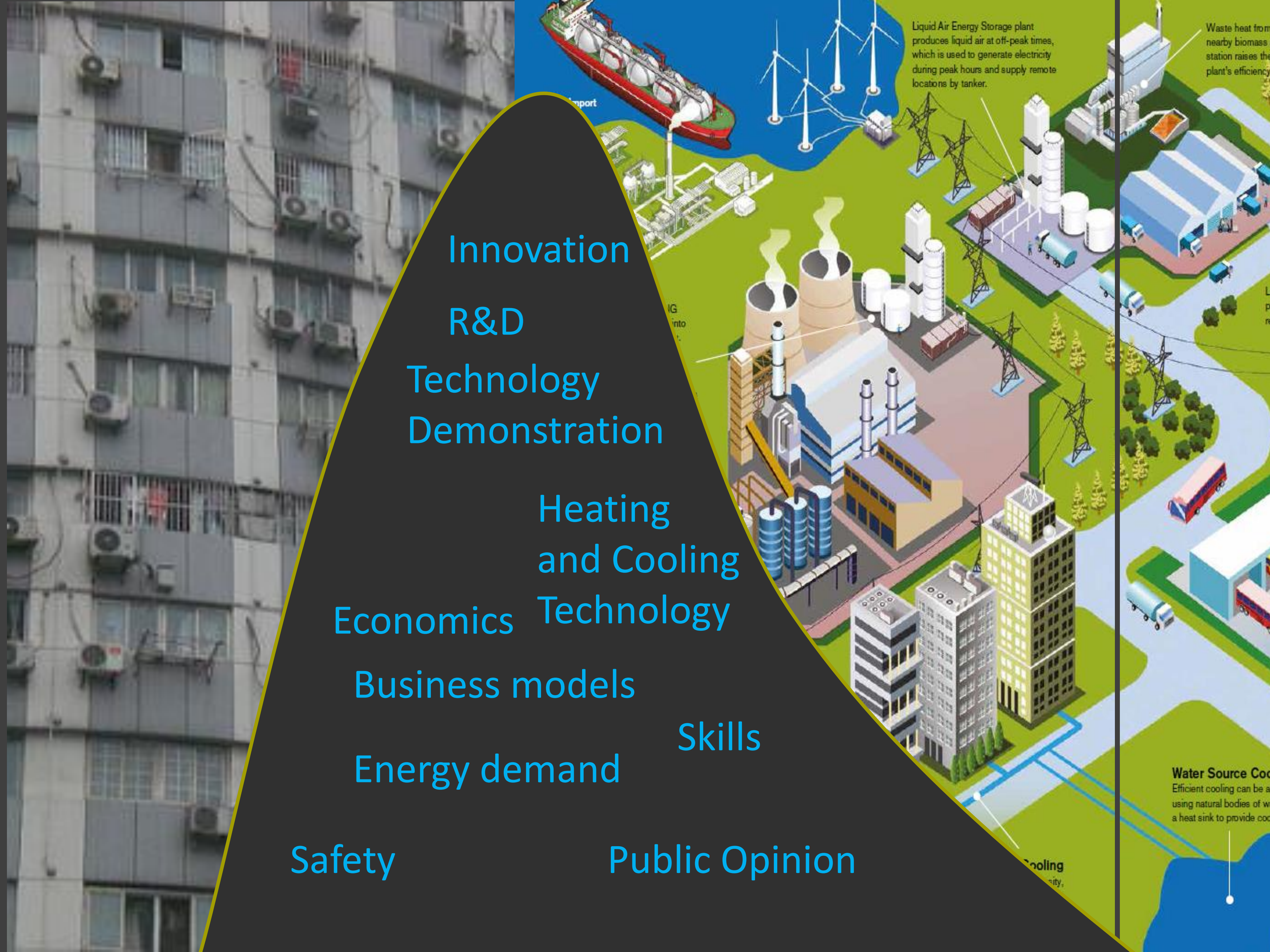
2014



2012

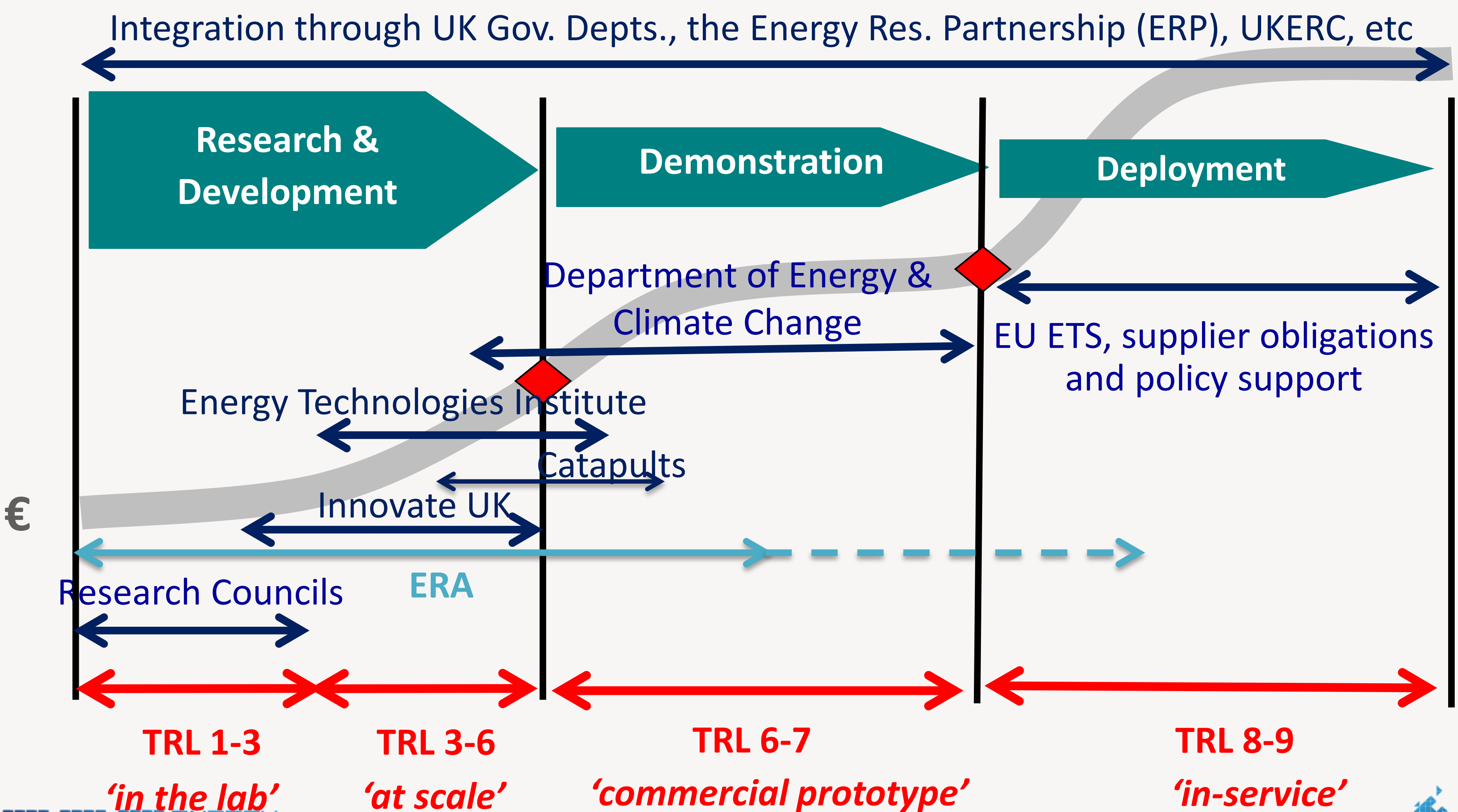



LNG Import
Liquid Air Energy Storage plant produces liquid air at off-peak times, which is used to generate electricity during peak hours and supply remote locations by tanker.
'Waste Cold' from imported LNG shipments captured and turned into Liquid Air to power cold economy.
Industry
Liquid Air Energy Storage Plant fully integrated into industry where it makes use of waste heat while helping to balance the electricity grid.
Data Networks
Data centres are both energy intensive users of cooling, and also require backup power. By using smarter thermal technologies, cooling requirements can be minimised. By further integrating cold and power, off-peak energy can be used to generate cold which can then be stored and used to provide cooling and power at peak times.
DOING COLD SMARTER:
THE FUTURE COLD ECONOMY
District Cooling
In areas of high urban density, district cooling systems may provide a more efficient method for delivering cooling services, centralising plant and sharing services leading to greater system efficiencies.
Waste heat from a nearby biomass power station raises the LAES plant's efficiency.
Supermarket refrigeration is upgraded to promote efficiency. With cold storage, the supermarket uses it's cooling loads to help balance the grid.
Liquid air also provides fuel for refrigerated lorries.
Supermarket receives and makes deliveries by liquid air refrigerated lorries and vans.
Bus depot receives liquid air by tanker to use in 'heat hybrid' buses with 'free' air conditioning. The depot also has a liquid air generator to help balance the grid.
In the home
By being able to store cold energy in thermally efficient refrigerators, the grid can be balanced through demand-side management.
Fridges work as 'batteries' for the grid. Novel technologies such as solid-state cooling may become important in the future yielding step-change efficiency improvements.
Water Source Cooling
Efficient cooling can be achieved using natural bodies of water as a heat sink to provide cooling.
Ground-Source Heat Pump Heating and Cooling
As heat pumps play a more important role in delivering thermal comfort, the ground becomes a useful source and sink for heat.



Liquid Air Energy Storage plant produces liquid air at off-peak times, which is used to generate electricity during peak hours and supply remote locations by tanker.
Innovation
R&D
Technology
Demonstration
Heating
and Cooling
Technology
Economics
Business models
Skills
Energy demand
Safety
Public Opinion

Energy Innovation Landscape



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Phase 1: T-ERA

Thermal Energy R&D

Thermal Insulation Challenges

- Development of novel thin layer thermal barriers
- Moisture management
- Smart thermal insulation
- Embedded thermal intelligence
- Integration of storage and insulation
- Re-engineering of existing thermal insulation materials
- Development of manufacturing and maintenance approaches for thermal energy deployment

Heat and Cold

Thermal Technologies

- Heat pumps (air, ground, water (incl. waste)
- Solar to thermal
- Fuel-cells
- Gas boilers
- Bio-digestion
- PV to thermo-chemical to heat
- District heating
- Combined Heat and power
- Cryogenic systems

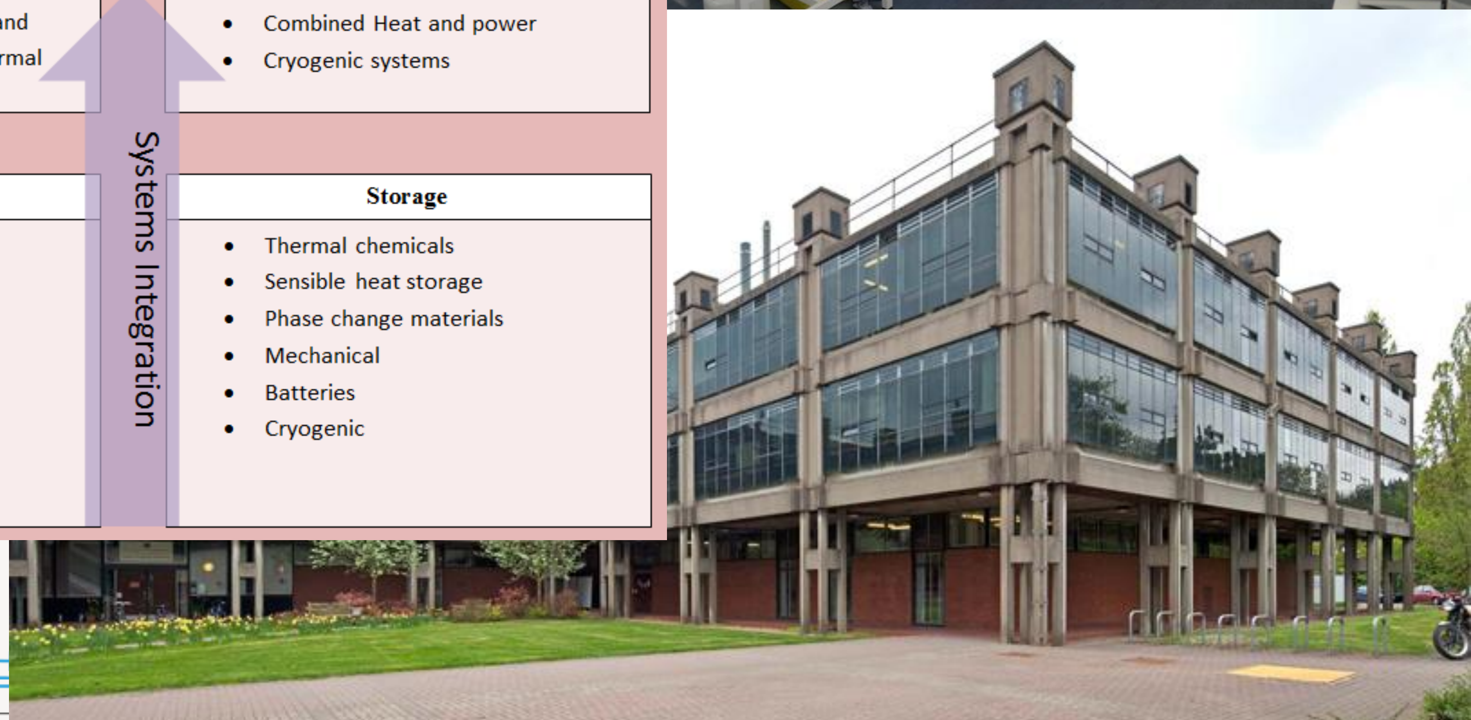
Systems Integration

Energy vectors

- Gas
- Electricity
- Hydrogen
- Thermal fluids/gases
- Liquid gas
- Compressed air
- Biodiesel
- Waste

Storage

- Thermal chemicals
- Sensible heat storage
- Phase change materials
- Mechanical
- Batteries
- Cryogenic



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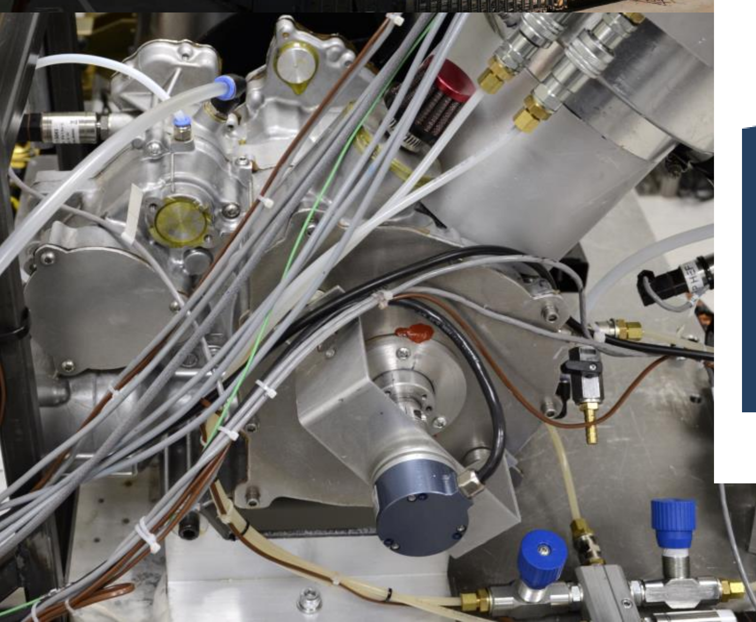
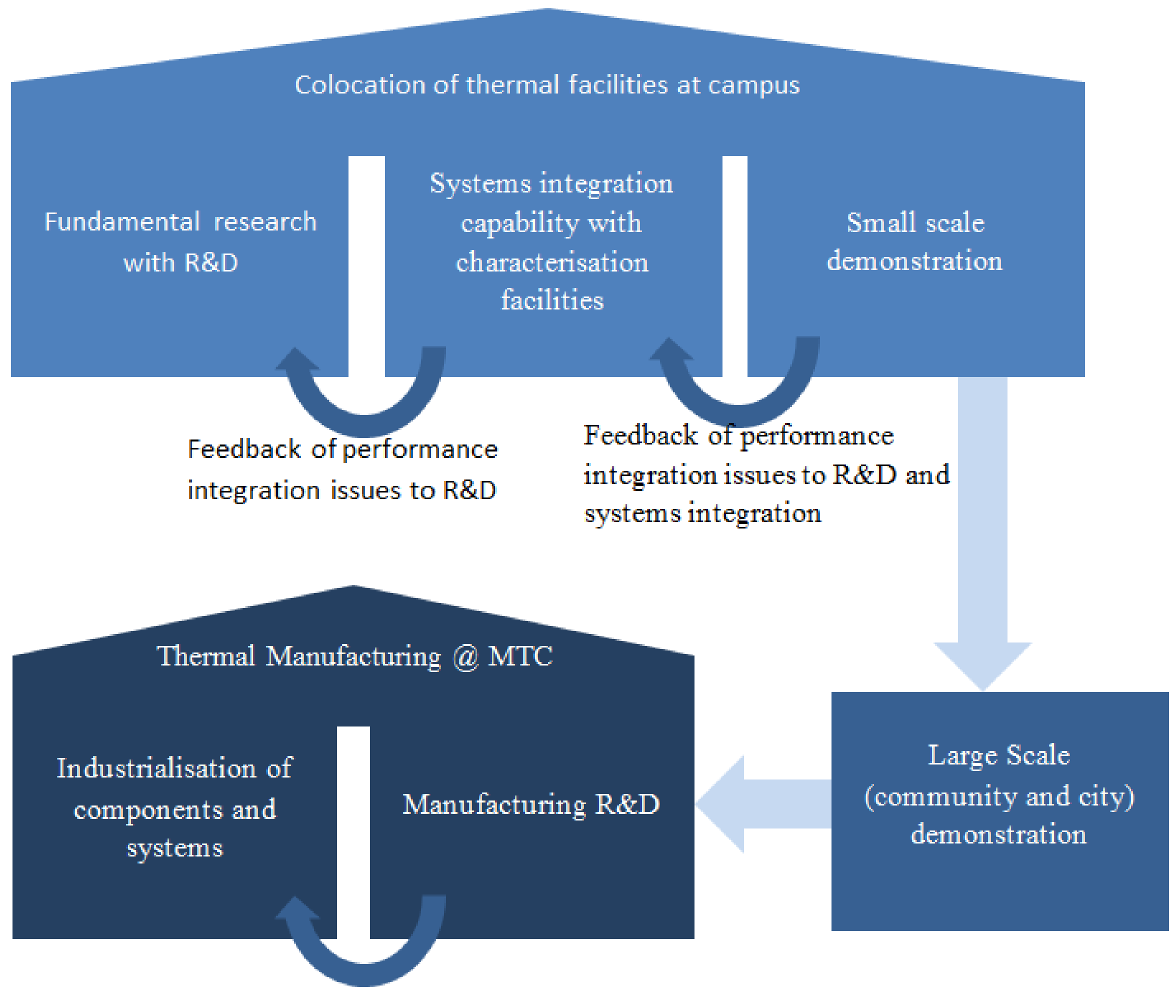
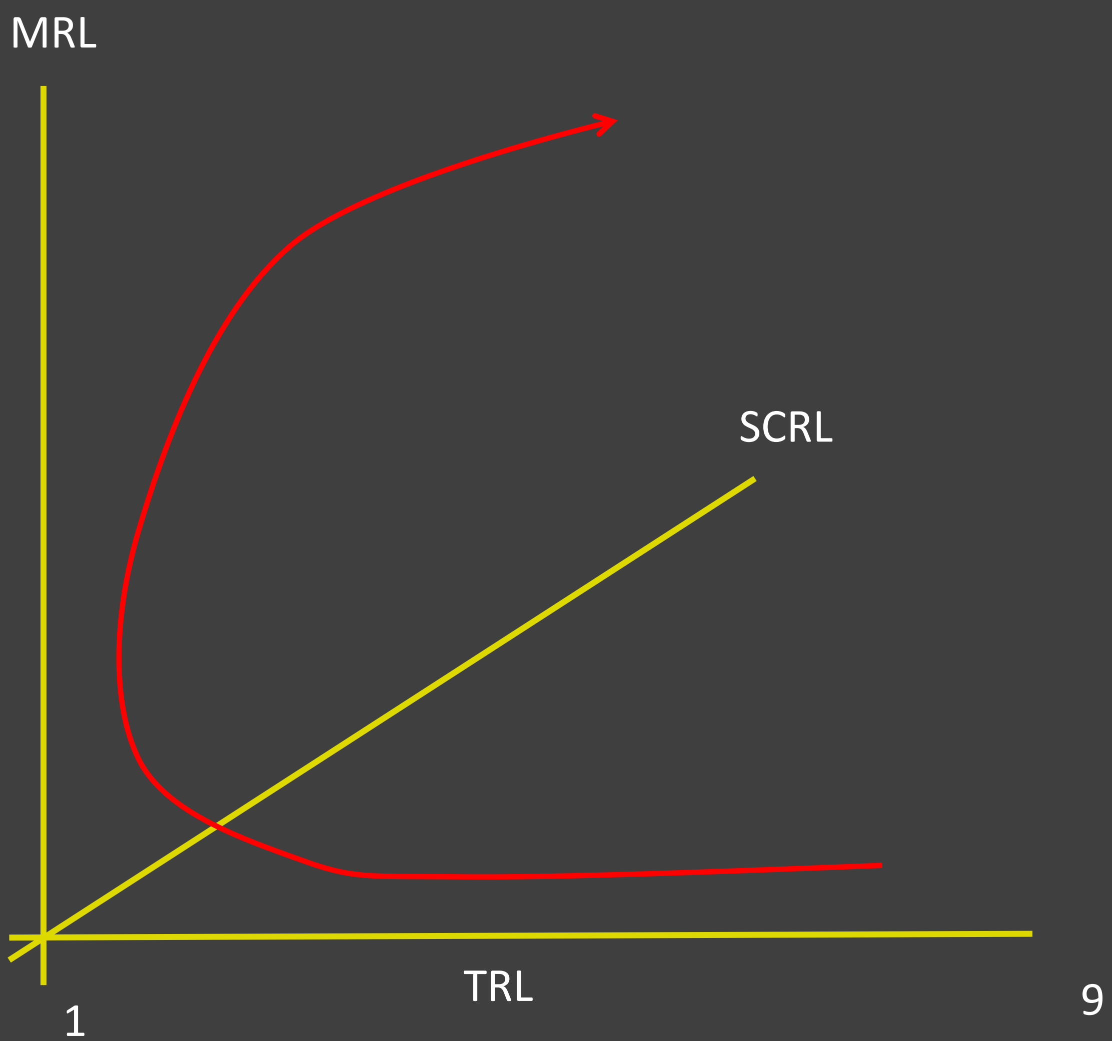
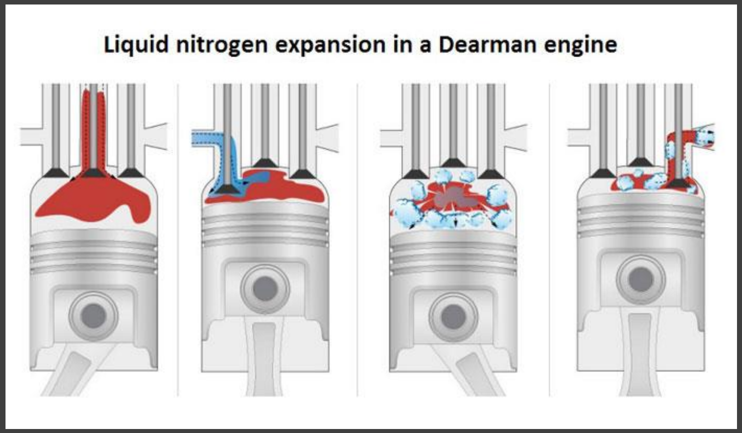
Phase 1 Capital Investments: T-ERA

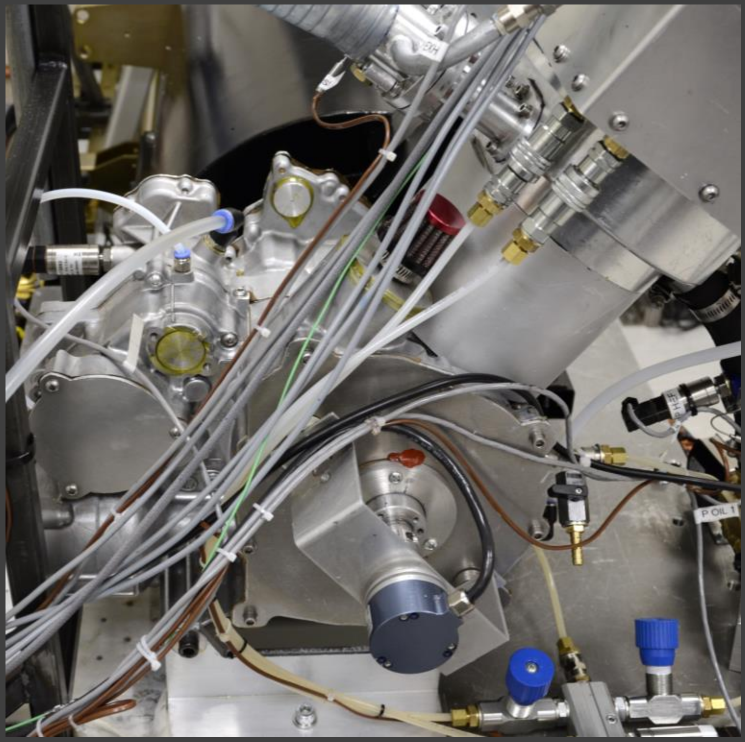




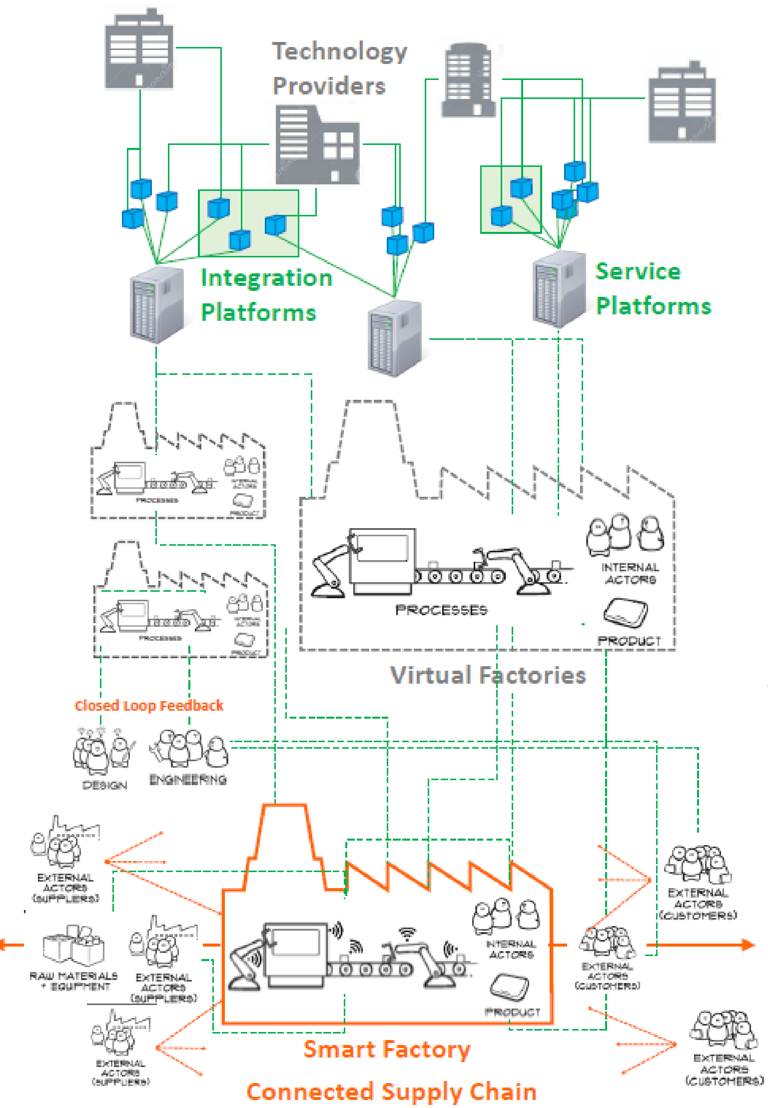
Manufacturing







FUTURE SUPPLY NETWORKS



TECHNOLOGY AREAS

Enablers

Information Solutions, Advanced Analytics and Intelligence as a Service

Service Platforms for Service Provision and Connectivity

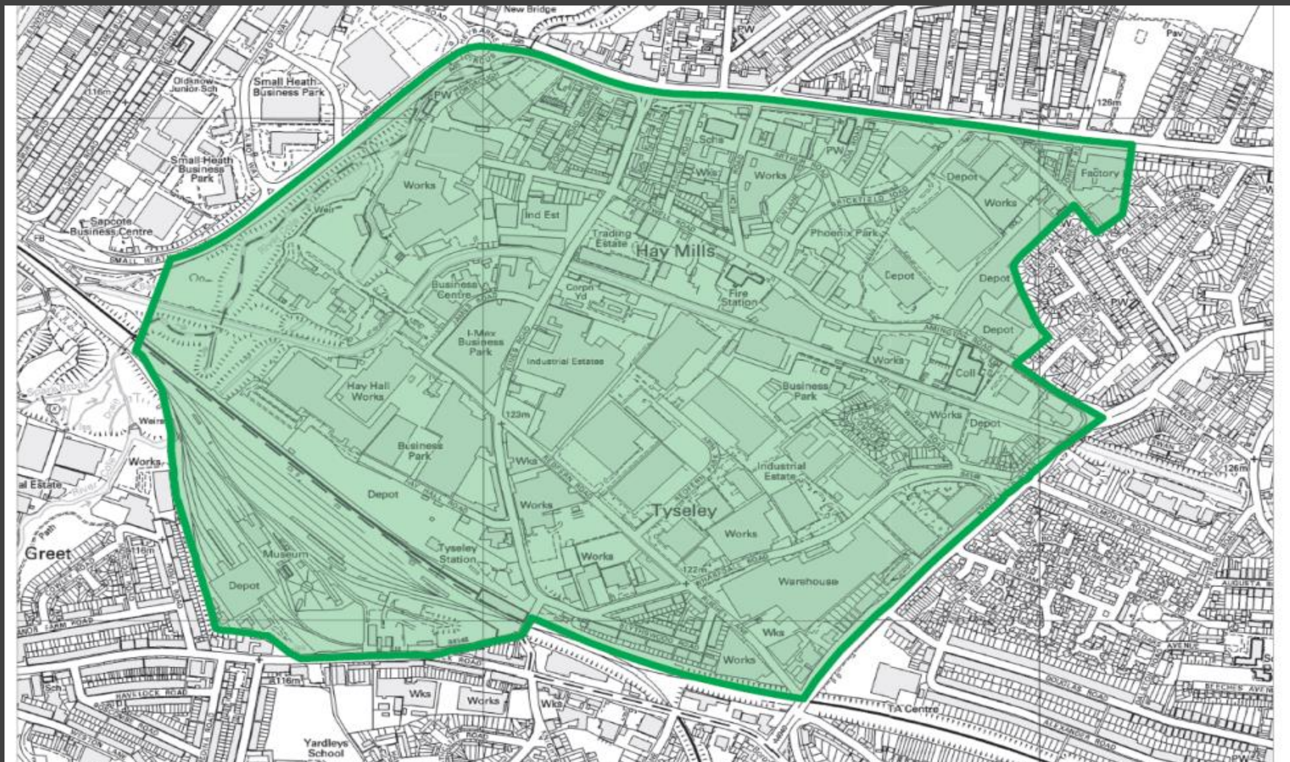
Horizontal Communications as Enablers of Networks and Connectivity

Virtual Factories as Test Beds and Enablers of Informatics Services

Autonomous Robotics and Control

Cyber-Physical Production Systems

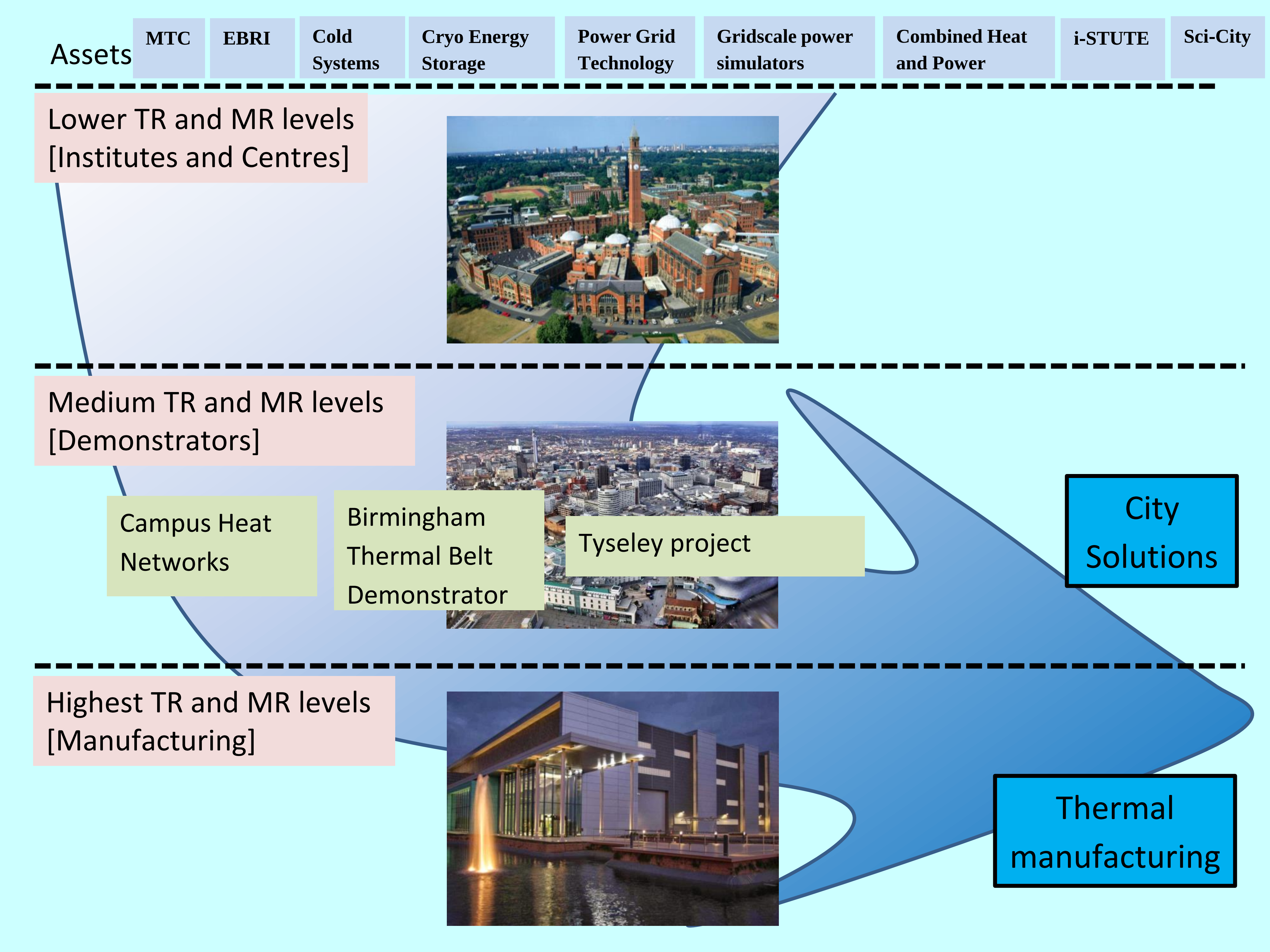
Tyseley



In 1996 Veolia built a state-of-the-art Energy Recovery Facility (ERF) in Tyseley, which takes 350,000 tonnes of Birmingham's rubbish each year and converts it into electricity. 23.5 tonnes of rubbish per hour. It has a turbo-generator which exports 25MW to the National Grid,

230 businesses and around 100 hectares of traditional industrial and employment land. Overall some 5,000 people are employed in Tyseley.

The new Birmingham Bio Power Plant gasification technology to generate electricity from recovered wood waste. The 10.3MW biomass power project is being developed by Carbonarius, The new renewable power plant cost £47.8m.


Assets
MTC
EBRI
Cold Systems
Cryo Energy Storage
Power Grid Technology
Gridscale power simulators
Combined Heat and Power
i-STUTE
Sci-City
Lower TR and MR levels [Institutes and Centres]
Medium TR and MR levels [Demonstrators]
Campus Heat Networks
Birmingham Thermal Belt Demonstrator
Tyseley project
City Solutions
Highest TR and MR levels [Manufacturing]
Thermal manufacturing

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