Heat Networks

a brief introduction

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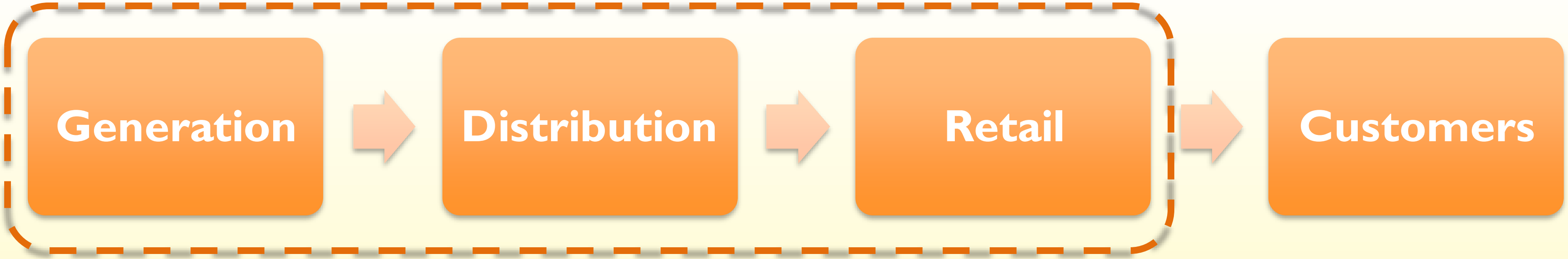
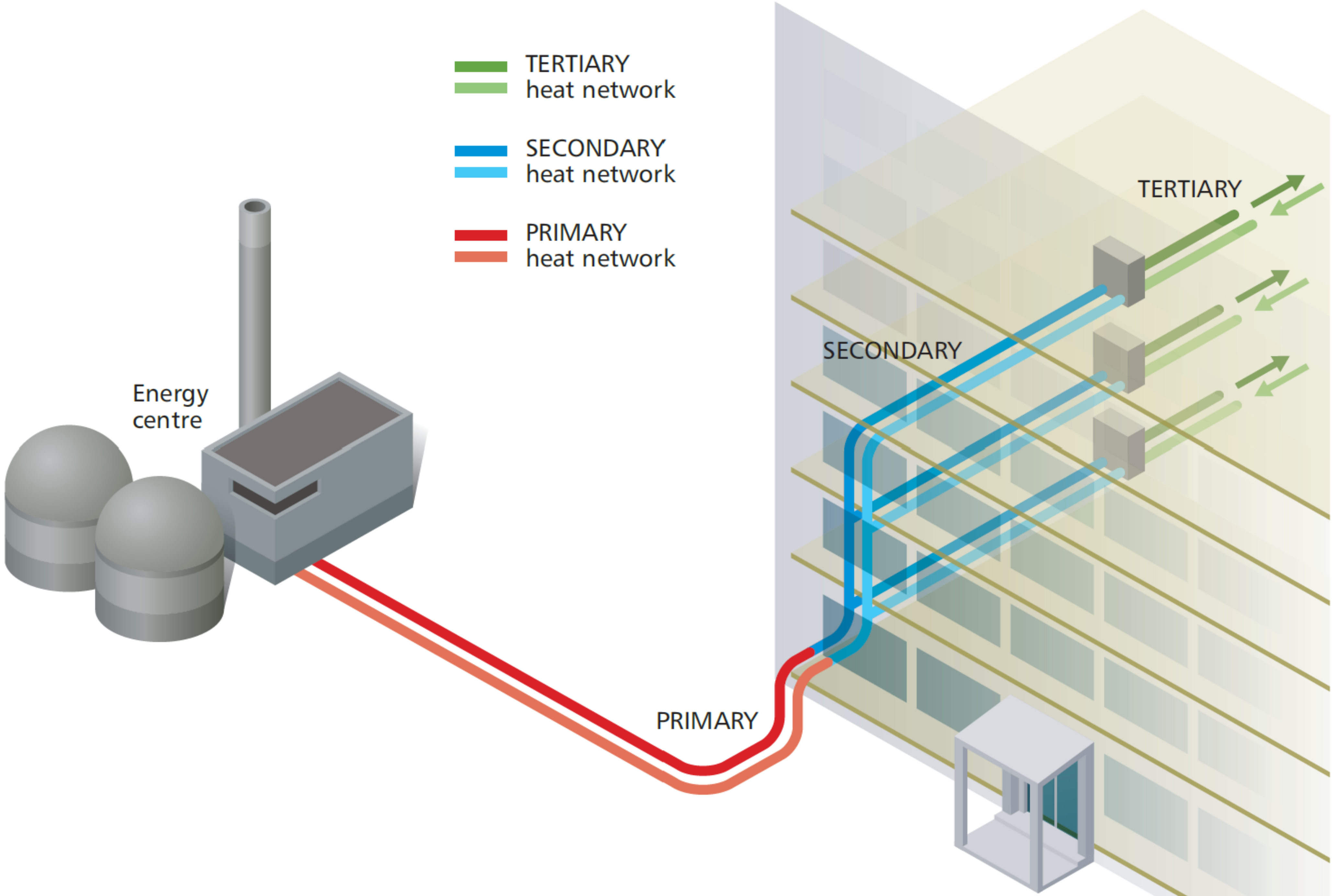
RBKC

All energy systems have three functions



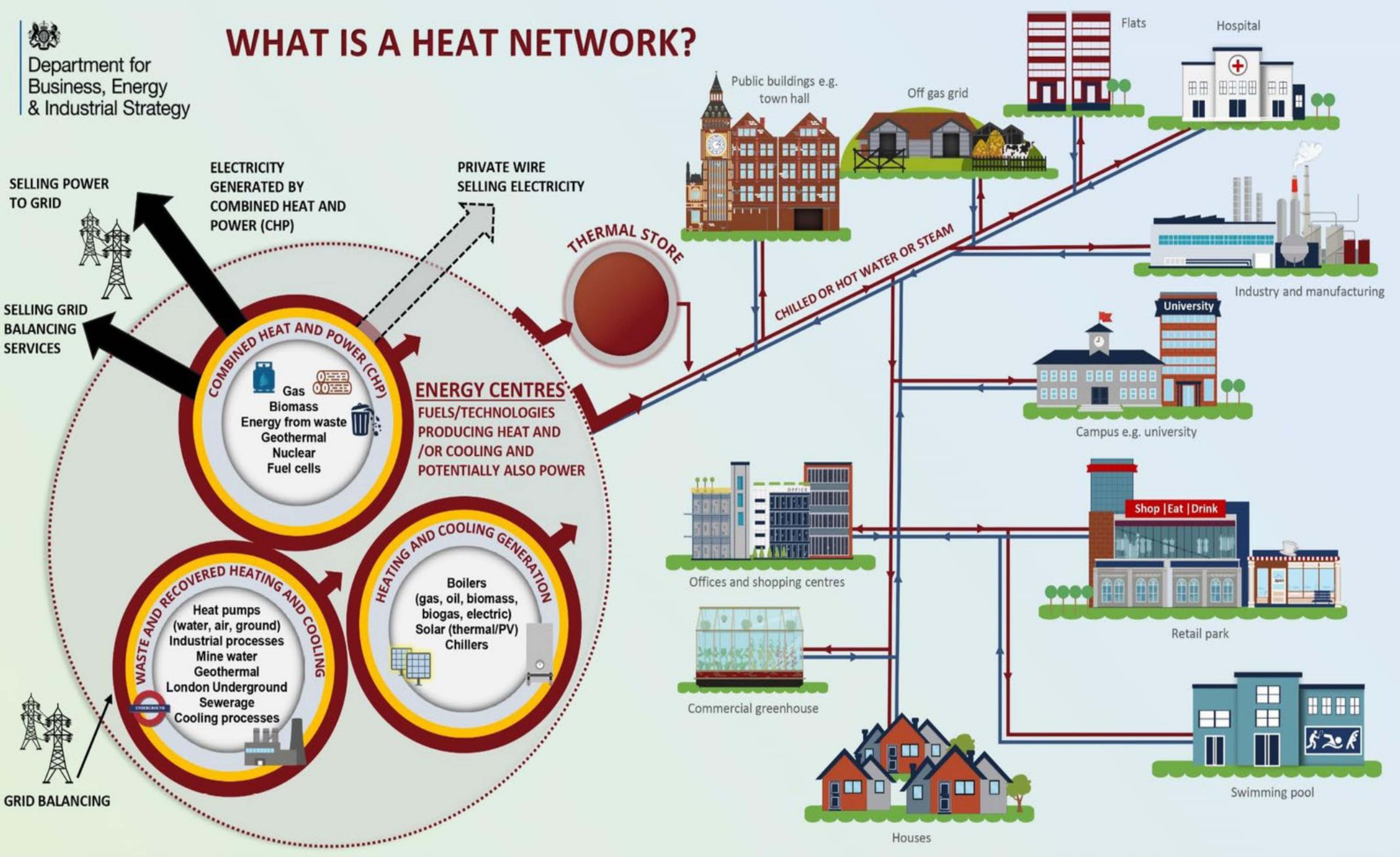

TERTIARY
heat network
SECONDARY
heat network
PRIMARY
heat network
TERTIARY
SECONDARY
Energy
centre
PRIMARY

Heat Networks - functions

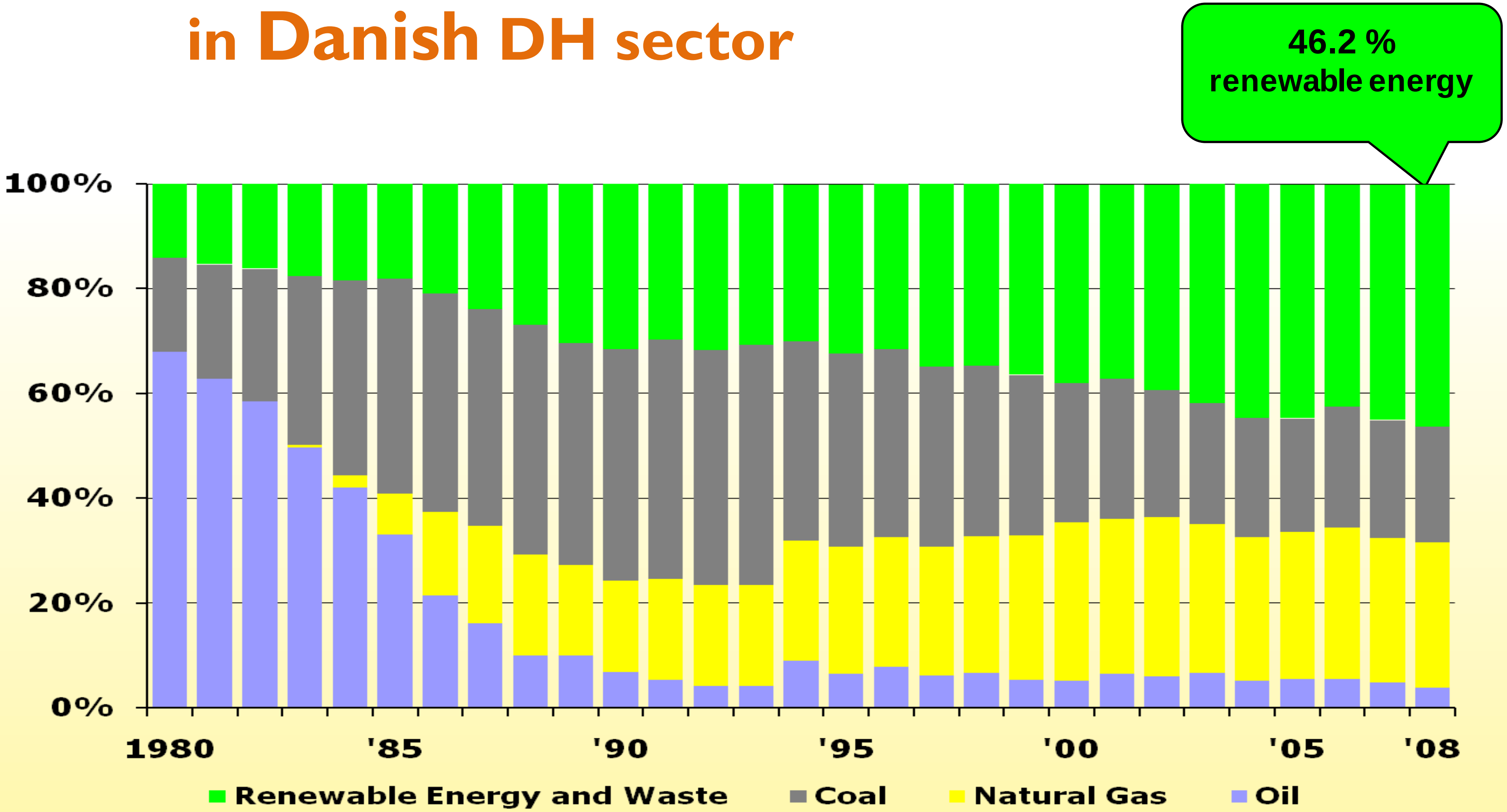
Generation

Distribution

Retail


Department for Business, Energy & Industrial Strategy
WHAT IS A HEAT NETWORK?
SELLING POWER TO GRID
ELECTRICITY GENERATED BY COMBINED HEAT AND POWER (CHP)
PRIVATE WIRE SELLING ELECTRICITY
SELLING GRID BALANCING SERVICES
COMBINED HEAT AND POWER (CHP)
Gas
Biomass
Energy from waste
Geothermal
Nuclear
Fuel cells
THERMAL STORE
ENERGY CENTRES
FUELS/TECHNOLOGIES PRODUCING HEAT AND /OR COOLING AND POTENTIALLY ALSO POWER
CHILLED OR HOT WATER OR STEAM
HEATING AND COOLING GENERATION
Boilers
(gas, oil, biomass, biogas, electric)
Solar (thermal/PV)
Chillers
WASTE AND RECOVERED HEATING AND COOLING
Heat pumps
(water, air, ground)
Industrial processes
Mine water
Geothermal
London Underground
Sewerage
Cooling processes
GRID BALANCING
Public buildings e.g. town hall
Off gas grid
Flats
Hospital
Industry and manufacturing
University
Campus e.g. university
Offices and shopping centres
Shop | Eat | Drink
Retail park
Commercial greenhouse
Swimming pool
Houses

Gross energy consumption in Danish DH sector



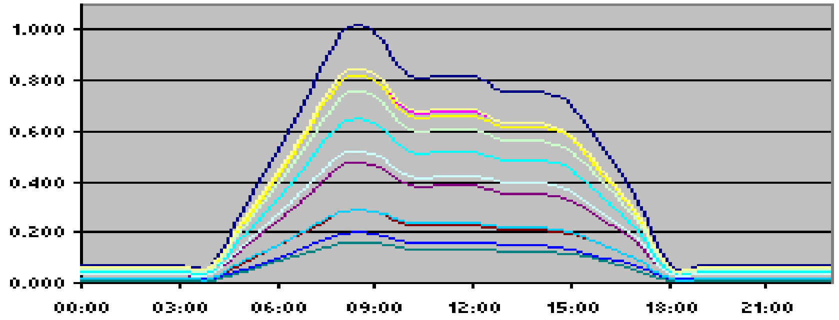
www.ens.dk

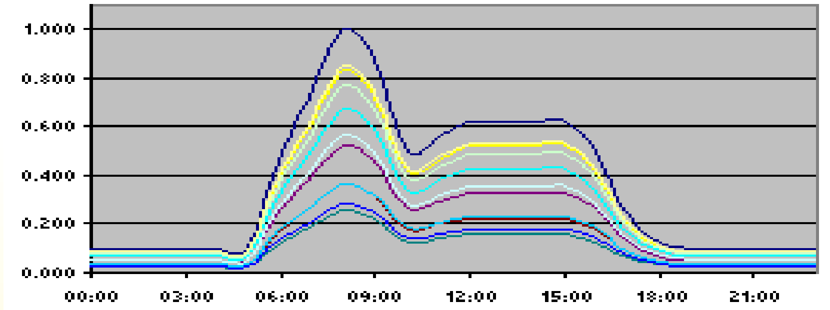
Key Requirements for Heat Networks

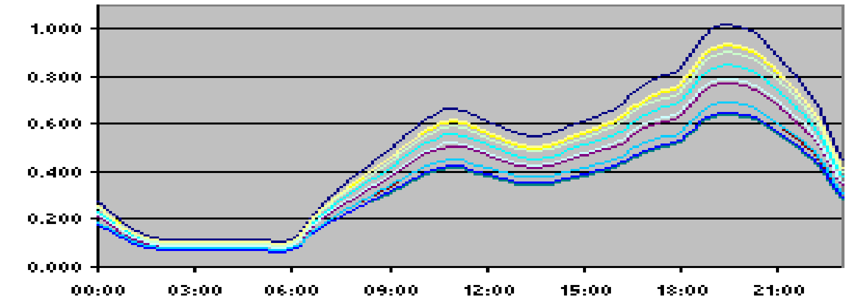
- **Heat Density**
  - Building density
  - Age of building (insulation specification)

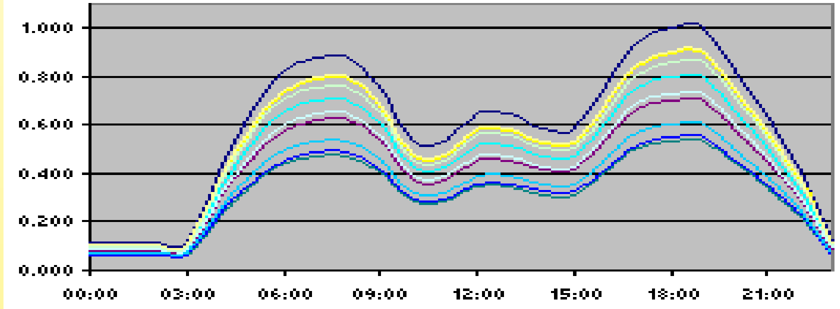
- **Load Diversity**
  - Retail
  - Commercial
  - Assembly and Leisure
  - Residential

- **Anchor loads**
  - High and steady demand
  - Hospitals, hotels, leisure centres with pools, prisons universities
  - Typically public institutional buildings









History

- Networks utilising geothermal in Pompeii (pre-79AD), France (14thC) Boise, Idaho (19thC)
- Successful commercial network established in 1877 by Birdsill Holly (the founder of district heating) in Lockport New York

1st Generation	• 19th C. Coal generation, steam (120ºC+) distribution in concrete ducts • 19 US 'cities by 1881. 'Legacy' systems eg Manhattan
2nd Generation	• 1930's on. Coal. Pressurised 100ºC+ water. Steel pipes in concrete ducts • Soviet and Eastern Europe 100ºC+

3rd Generation	• 1970's on. Mixed gen incl EfW. Pre-insulated pipes <100ºC water
	  • Scandinavia. Develops technology and exports world wide
	  • Reaction to OPEC Oil Price Shock

4th Generation	• 2000 on. Low carbon CHP gen incl waste heat. Thermal storage Pre-insulated pipes >70ºC water. Integration with power grid
	  • Scandinavia and exports world wide
	  • Response to challenge of climate change

5th Generation	• 2010 on. Ambient loop. 10 - 25ºC drawing on ground heat, mine water or aquifer. Air pump in each building. Heat + cooling sharing
	  • Heerlen, Netherlands, London South Bank University
	  • Commercially challenging

History in the UK

- 1622 Dutch inventor Cornelius Drebbel proposes district heat for London.
- 1901 South Manchester Loop – Bloom Street Power Station
- 1922 Two steam heat networks in Dundee
- 1950 Churchill Gardens Pimlico London fed by Battersea Power Station. Driver - air quality
- 1950 – 70's Council housing building boom
  - Most systems in London and coal belts in North of England and Scotland
- 1970 – 90's Post OPEC oil price shock UK brings ashore gas from North Sea
  - Many systems de-commissioned and replaced by individual gas boilers
- Some new networks in Sheffield + Nottingham (EfW), Southampton (geothermal)
- 2000 onwards – growing awareness of link between energy, carbon & climate change
- 2002 Aberdeen Heat & Power. Driver - Home Energy Conservation Act
- 2003 Birmingham District Energy Co. Driver - financial savings. Replicated Leicester 2011
- 2004 GLA London Plan – heat hierarchy prioritises heat networks
  - Strengthened in 2008, 2011 and 2021
- 2008 Climate Change Act. 80% carbon reduction by 2050. Upgraded to 100% in 2019.
  - Establishes Committee on Climate Change as statutory adviser
- 2012 Bunhill Heat Network, LB Islington
- 2013 DECC '*The Future of Heating*'. First UK heat policy doc.
  - Heat networks identified as major platform. Key role for local authorities in making them happen
  - Establishes Heat Network Delivery Unit
- 2015 Heat Network Investment Project - £320m capital funding programme
- 2016 Energetik established by LB Enfield

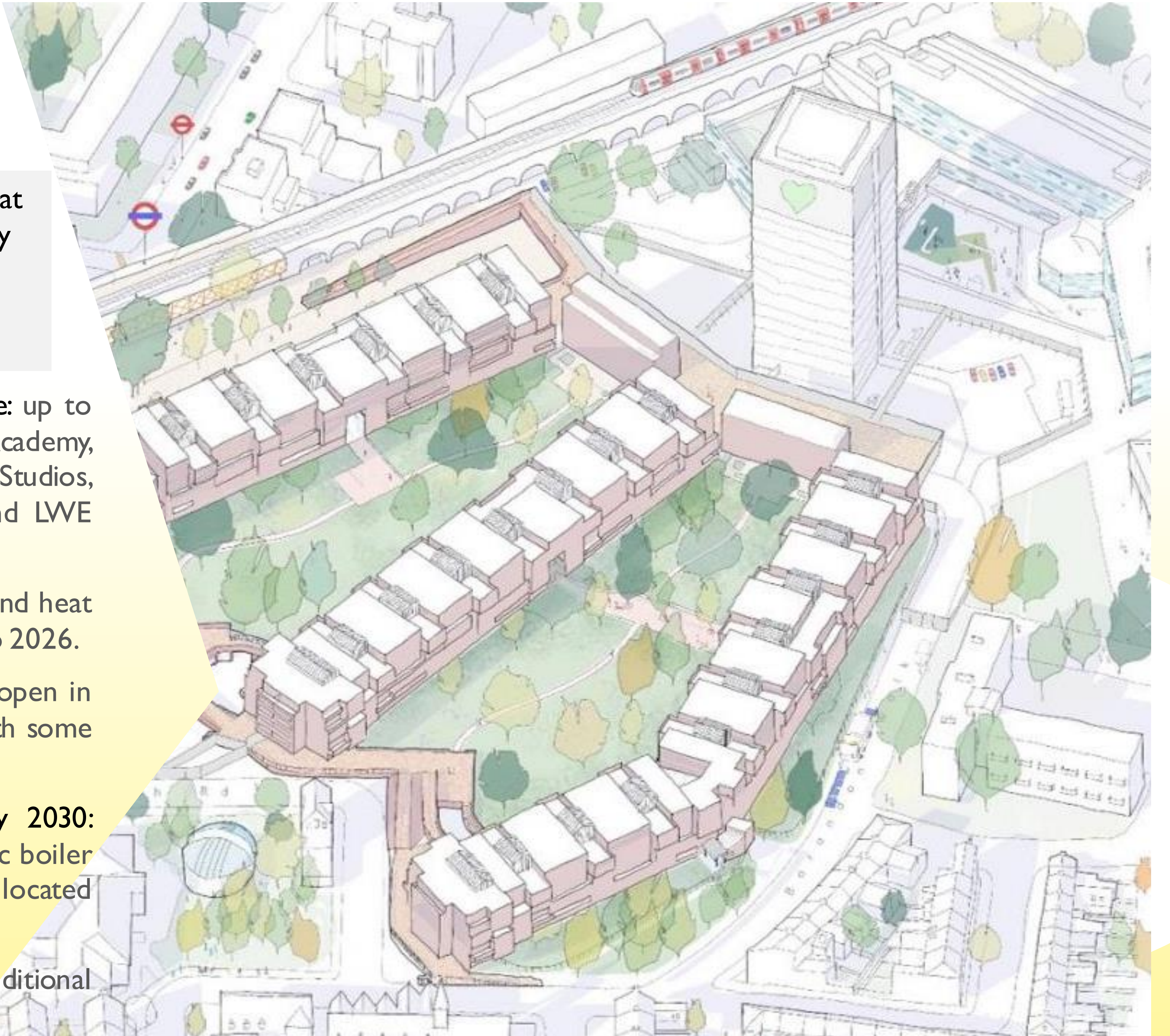
Many UK towns & cities are developing heat networks

Heat network plants in other cities

Notting Dale Heat Network

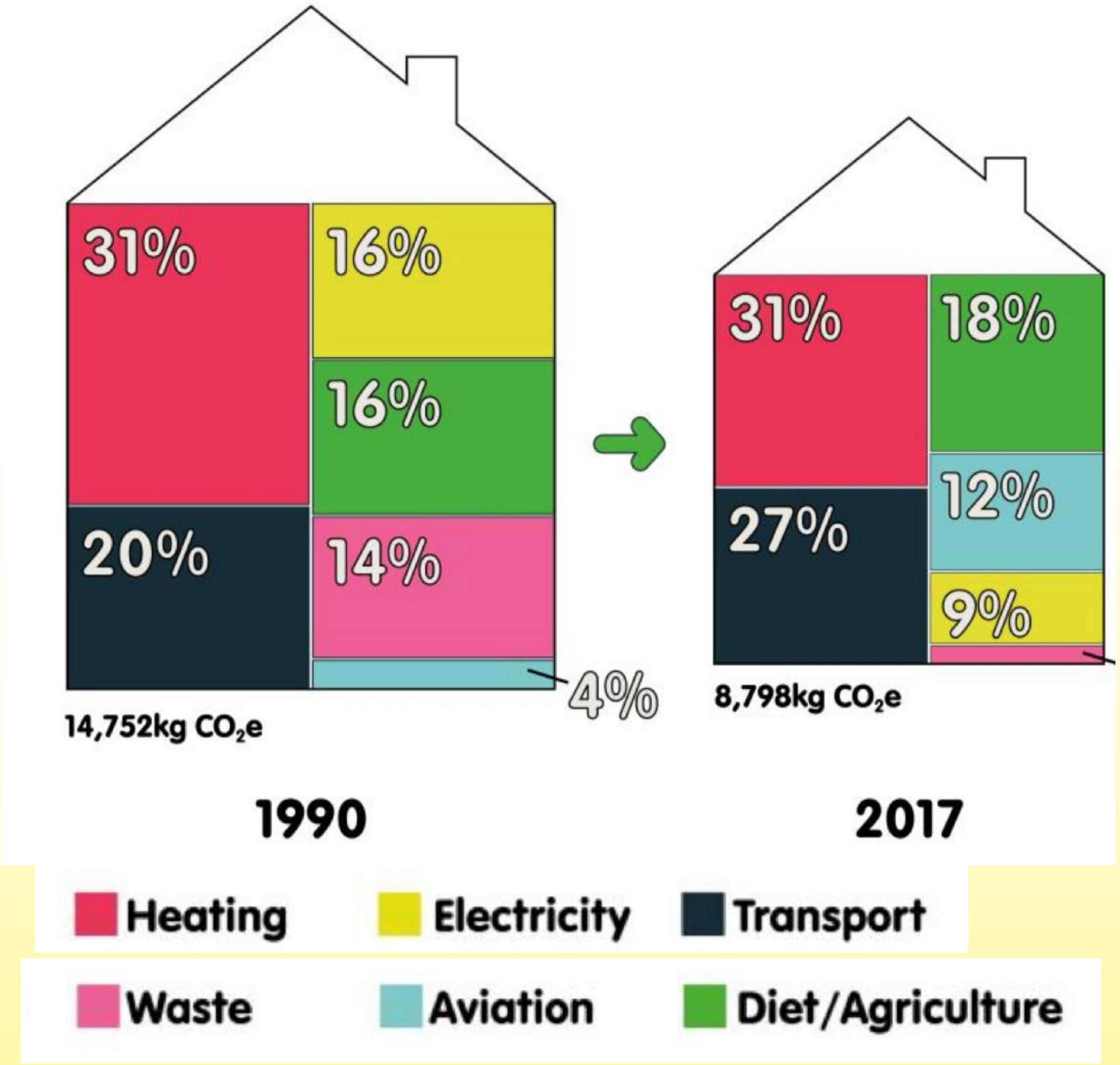
Vision: the zero-carbon Notting Dale Heat Network will put residents first, rely solely on renewable heat sources, and provide affordable heating and hot water whilst tackling fuel poverty.

- Core scheme @ Lancaster West Estate: up to 826 homes, Kensington Aldridge Academy, Kensington Leisure Centre, Baseline Studios, North Kensington Resource Centre and LWE Community Centre.
- Co-designed with residents: new pipes and heat controls installed in homes from 2022 to 2026.
- New renewable energy centre: due to open in April 2024. Mainly renewable energy with some gas from 2024 to 2030.
- 100% renewable zero-carbon heat by 2030: large Air Source Heat Pump and electric boiler in a new energy centre, which could be located behind Kensington Leisure Centre.
- Phase 2 expansion: possible 500-800 additional Council homes in Notting Dale ward.



Carbon Emissions and Heating

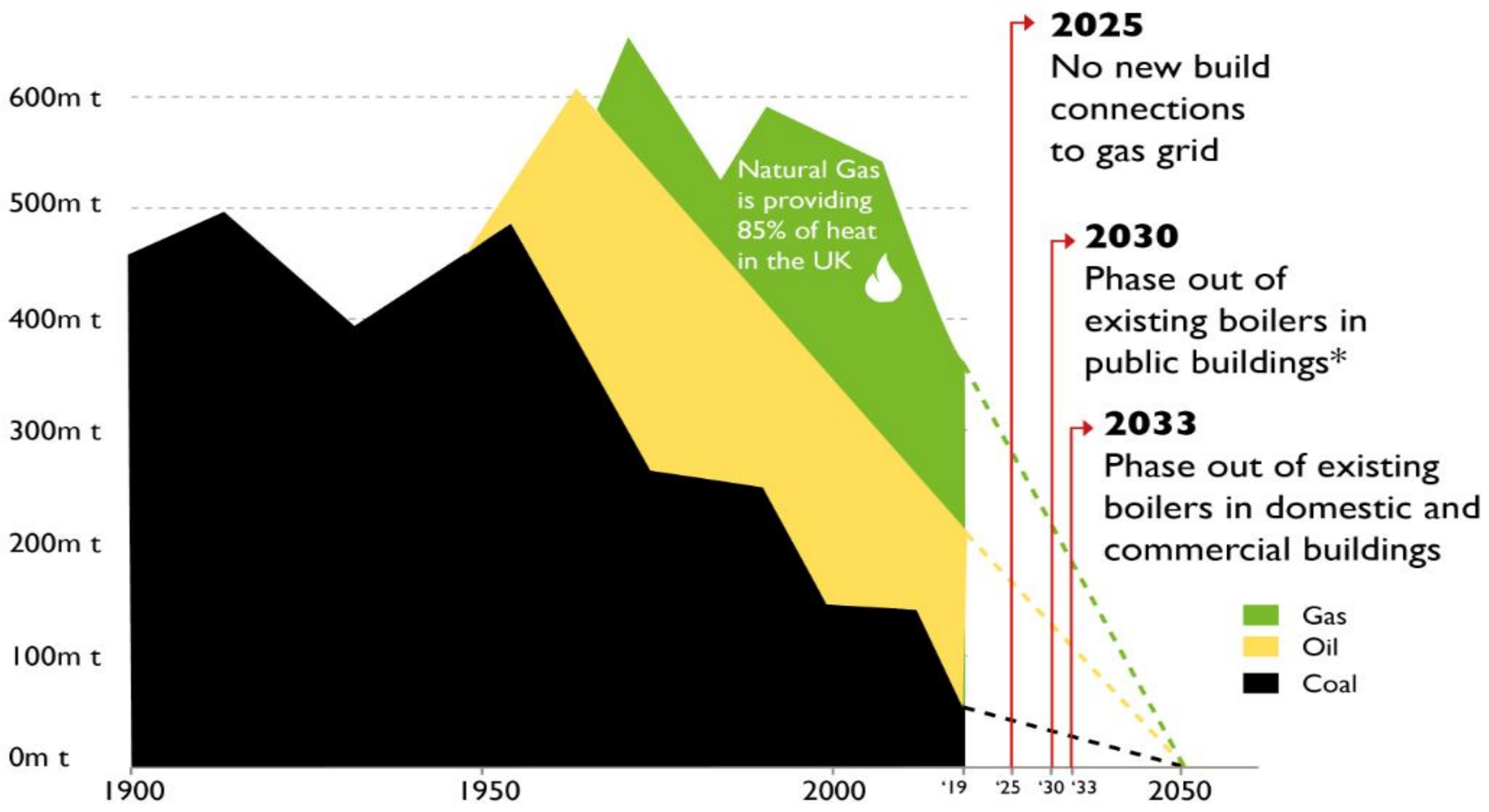
- 2019 Govt commits to net zero by 2050
- Across entire economy – including heat
- Must allow headroom for hard to address sectors – industry, agriculture, shipping & aviation
- 85% of heat produced from fossil gas
- 31% of domestic CO_2 emissions are produced by heating in the average home
- Heat is the most difficult sector to decarbonise. Things haven't changed much in 20 years.



Source: Energy Systems, Low Carbon Home 2017

Gas is being phased out

The Sixth Budget – the UK's Path to Net Zero. Committee on Climate Change. Dec 2020



Data Source: Global Carbon Budget 2020, UK profile

*Phase out does not apply to areas designated for heat network or hydrogen zones

Pathways to Decarbonise Heat

BEIS *Clean Growth Strategy* posits three pathways (Oct 2017):

- **Electrification**
- **Hydrogen**
- **Carbon Extraction**

Committee on Climate Change has identified multiple pathways that are primarily permutations of the above
(Next Steps for UK Heat Policy. CCC. Oct 2016)

Main three are:

- **Hydrogen – repurpose gas grid. Hydrogen boilers in buildings**
- **Electrification – heat pumps or resistive heating within buildings**
- **Hybrid - base demand elec heat pumps. Peak from hydrogen**

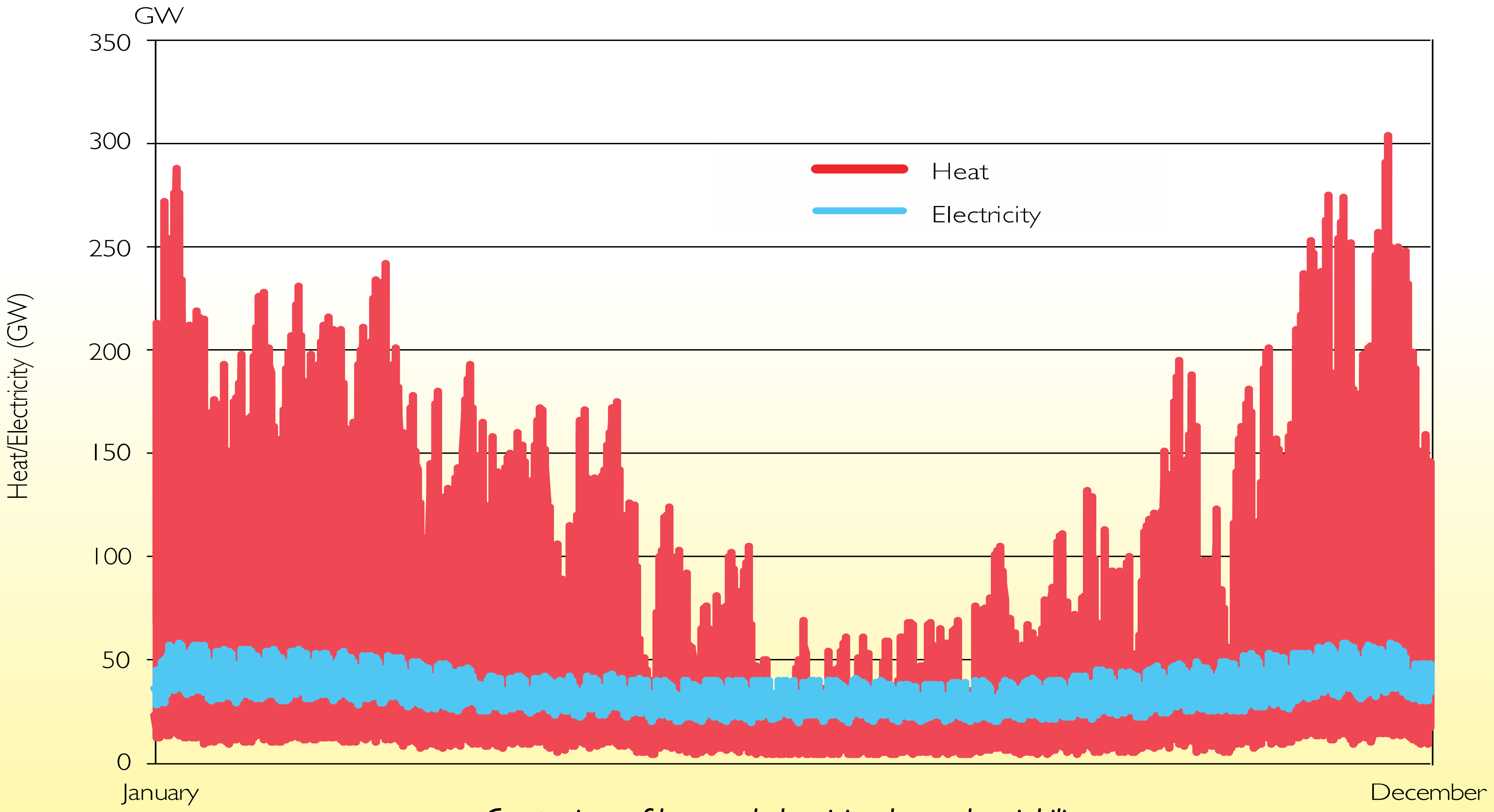
Pathways

Electrification	Hydrogen
• Heat pumps 250 – 400% efficient	• Gas boiler as with existing arrangement
• 1 unit elec produces 2 - 4 units heat	• 80% efficient in converting gas to heat
• Prioritised as high efficiency require less upstream upgrades	• Higher volume of gas needed for same calorific value as methane (+ one third)
• Uses high cost electricity	• Small molecule pernicious in exploiting leaks
• Nor power revenues (as with CHP)	• Burner need to be adjusted due to different flame shape – round not pointed
• Produces steady temperature. Best with high insulation of building fabric	• Entire boiler may need to be replaced

• Can't adjust rapidly to meet surge peaks – *Beast from the East*	• Hydrogen created by:
	  • Blue hydrogen – steam reformation of methane. Carbon stripped out for CCS
	  • Green hydrogen – electrolysis to split water (H_2O) molecule

• Costly + bulky kit v gas boilers (approx £16k per dwelling)	
• Air source needs intake kit outside building	
• Costs reduce as market vol increases	• Hydrogen generation, distribution + supply not currently available nationwide
• Presently market ready and available	• Anticipated 2035

Heat variability



Comparison of heat and electricity demand variability across a year (domestic and commercial) – 2010

Source: Imperial College London

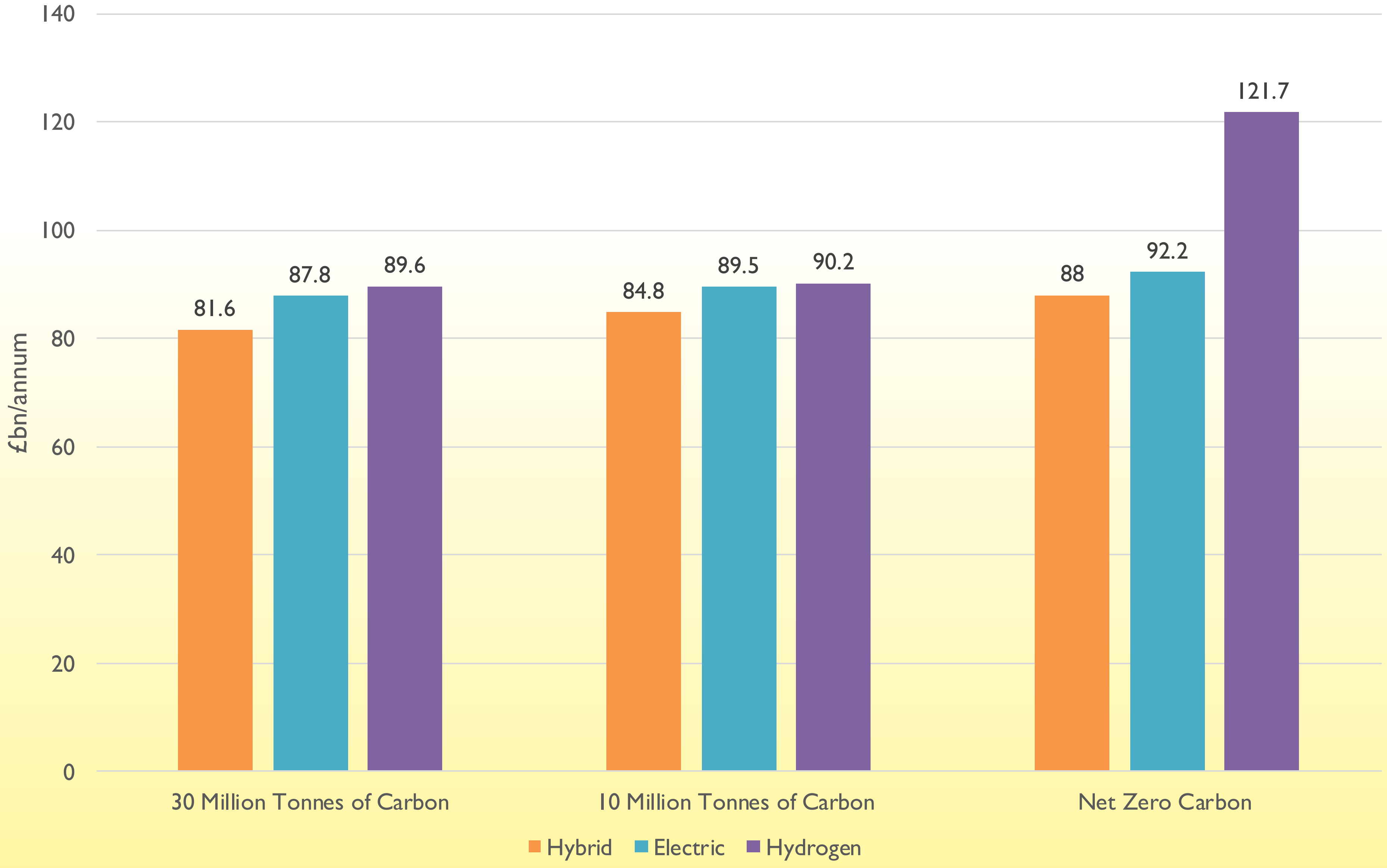
Hybrid Pathway

- Base load - elec heat pumps. Peak load - hydrogen
- Hybrid individual house units under development – very bulky
- Limited to on-gas grid properties
- Can achieve net zero carbon at reasonable cost
- Imperial College London identifies as most cost effective.
- Reduces need/cost for distr/gen upgrades to meet peak
- Requires biogas or hydrogen
- Least uncertainty

Heat networks ideal for hybrid deployment

- Central plant room can contain various generation technologies using different fuels
- Designed to meet both peak and base load
- Easily incorporates additional back-up generation incl thermal storage
- Can 'blend' heat from these technologies with waste and environmental heat
- Once connected no disruption for residents on retrofitting new or replacement technologies

Costs



All pathways dominated by capex not opex.

Hydrogen pathway increases closer to net zero due to need to flip from blue to green hydrogen (increased power gen + distr needed to supply electrolysis process)

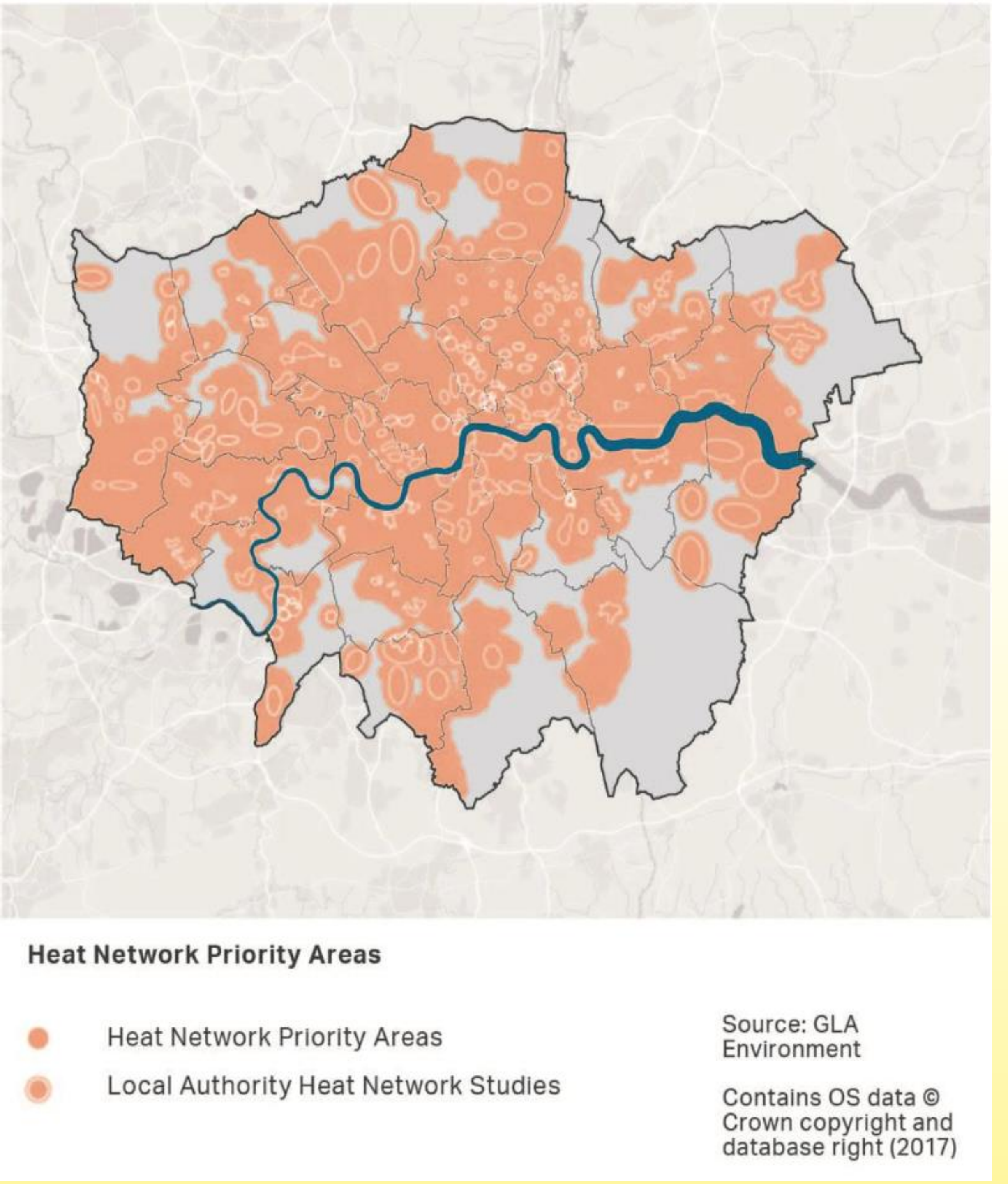
All pathways benefit from whole system integration

Source: Imperial College London 2018

What pathway for which areas?

- Draft London Plan (adoption by GLA in 2021) to introduce Heat Network Priority Areas.
- RBK&C entirely in a Heat Network Priority Area
- Energy White Paper. Dec 2020

"We will support Local Authorities to designate new heat network zones, no later than 2025. Zoning entails the identification of areas which can be readily connected to a low-carbon heat network and mandating connection unless it is not cost-effective to do so. The certainty of connection for projects, which zoning affords, will ensure that heat networks are better able to grow and deliver lower cost, clean heat for consumers. We will consider how local heat network zoning can be most effectively integrated with wider local area planning for the environment, infrastructure and place".



Questions?