District Energy

Tim Kay
AECOM

Delivered by:

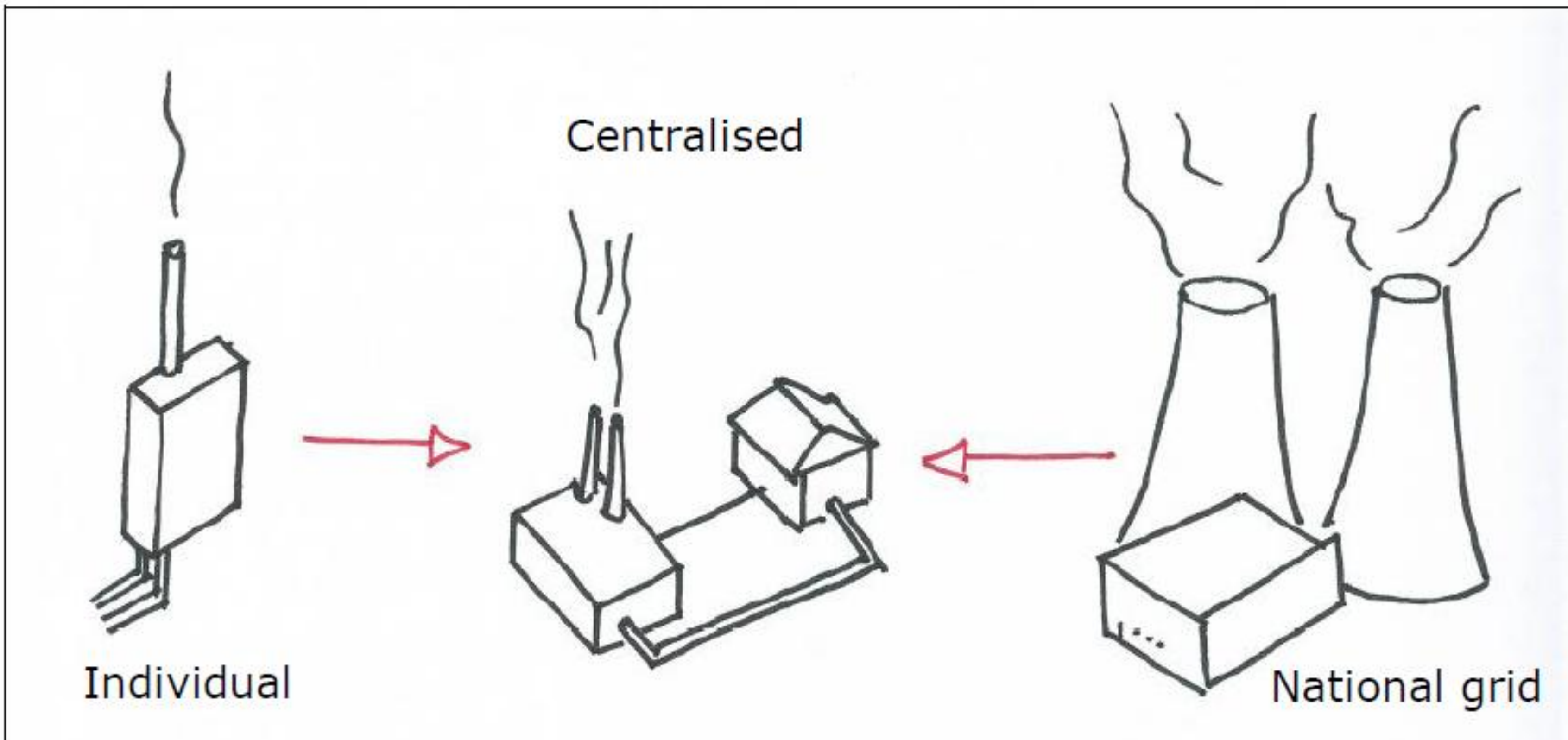
NWIEP | CLASP. Envirolink Quantum AECOM

District energy overview

- Sharing of energy through a distribution network
- Electrical network… we already have one!
- Heating networks/cooling networks
- Other energy networks (heat pumps shared water loop)
- Key considerations:
  - Technical aspects
  - Financial aspects
  - Planning considerations

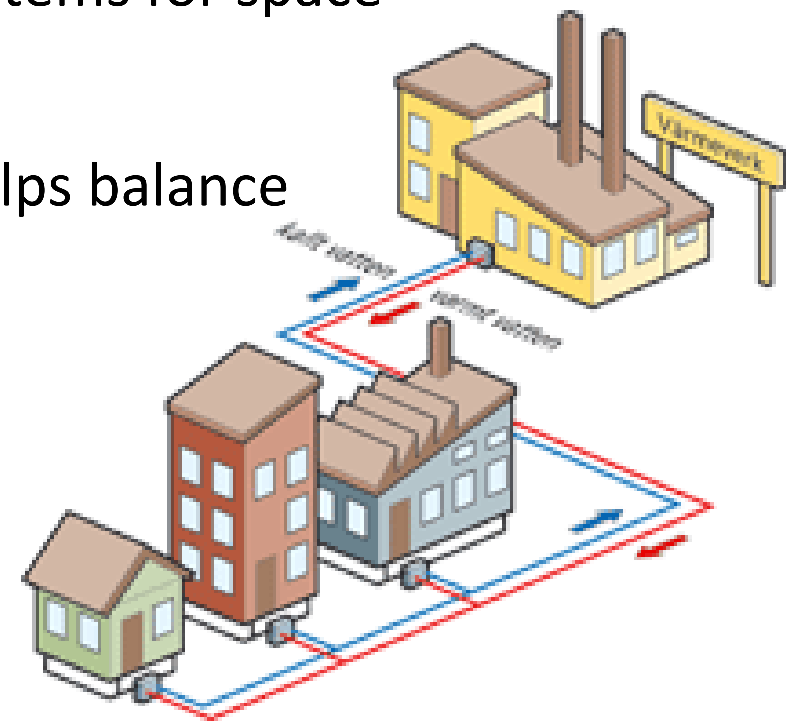
Centralised/Decentralised energy

Terminology…



What is a heat network?

- Heat is generated at a central source
- Distributed using hot water through pipework
- Heat is transferred into individual properties through a heat exchanger
- Then used in conventional heating systems for space heating and hot water
- Potential use of absorption cooling helps balance summer base load
- District heating
  - Denmark: >60%
  - UK: <1%



Heat generation technologies

Heat networks can be supplied with heat from a diverse range of sources:

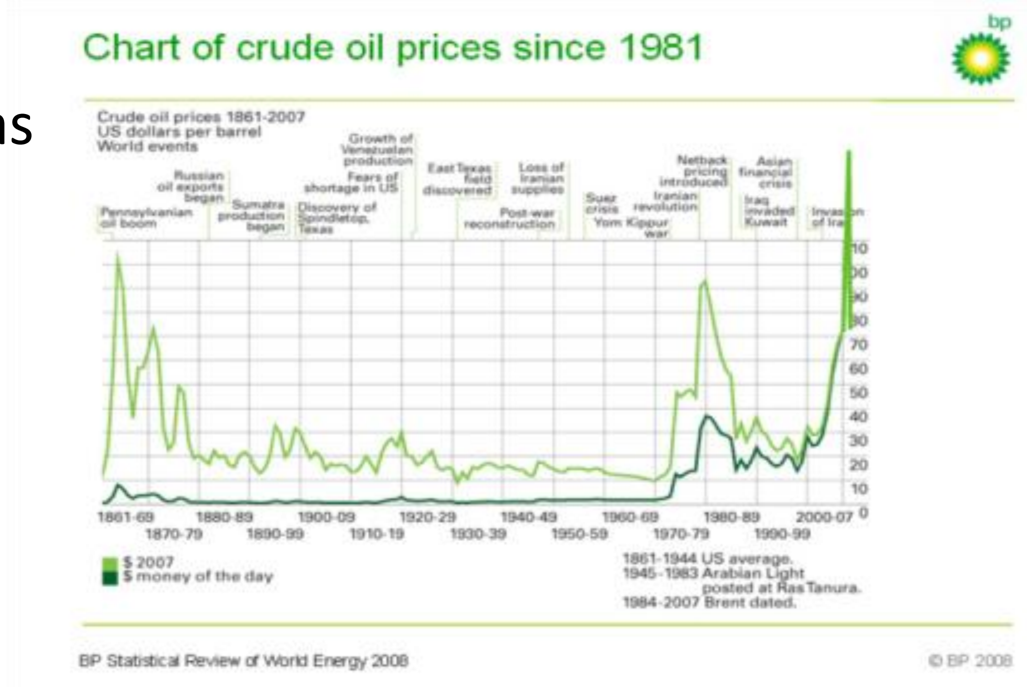
- Gas boilers
- Gas-fired CHP units
- Biomass and biogas fuelled boilers and CHP plants
- Energy from Waste (EfW) facilities
- Power stations
- Fuel cells
- Geothermal sources
- Solar thermal arrays

What are the advantages of a heat network?

- Allows waste heat to be recovered locally rather than dumped as is common practice at electrical power stations
- Reduction in carbon emissions
- Larger scale plant can operate more efficiently
- Economies of scale
- Greater fuel purchasing power
- Maintenance cost associated with plant will be reduced
- Increased usable space in buildings
- Single piece of equipment determines CO_2 for multiple end users
- Demonstrated to offer the highest levels of carbon savings under the domestic zero carbon consultation

What are the advantages of a heat network?

- Less reliance on gas supplies and less impact from rising gas prices
- Effective tool against fuel poverty
- Network can be extended by simply adding more ‘heat sources’ along the way



- Allows a broad range of energy generation technologies to work together to meet demand for heat (e.g. low carbon baseload technology plus cheaper ‘top-up boilers’)
- Provide renewable energy to buildings where it may not otherwise be viable

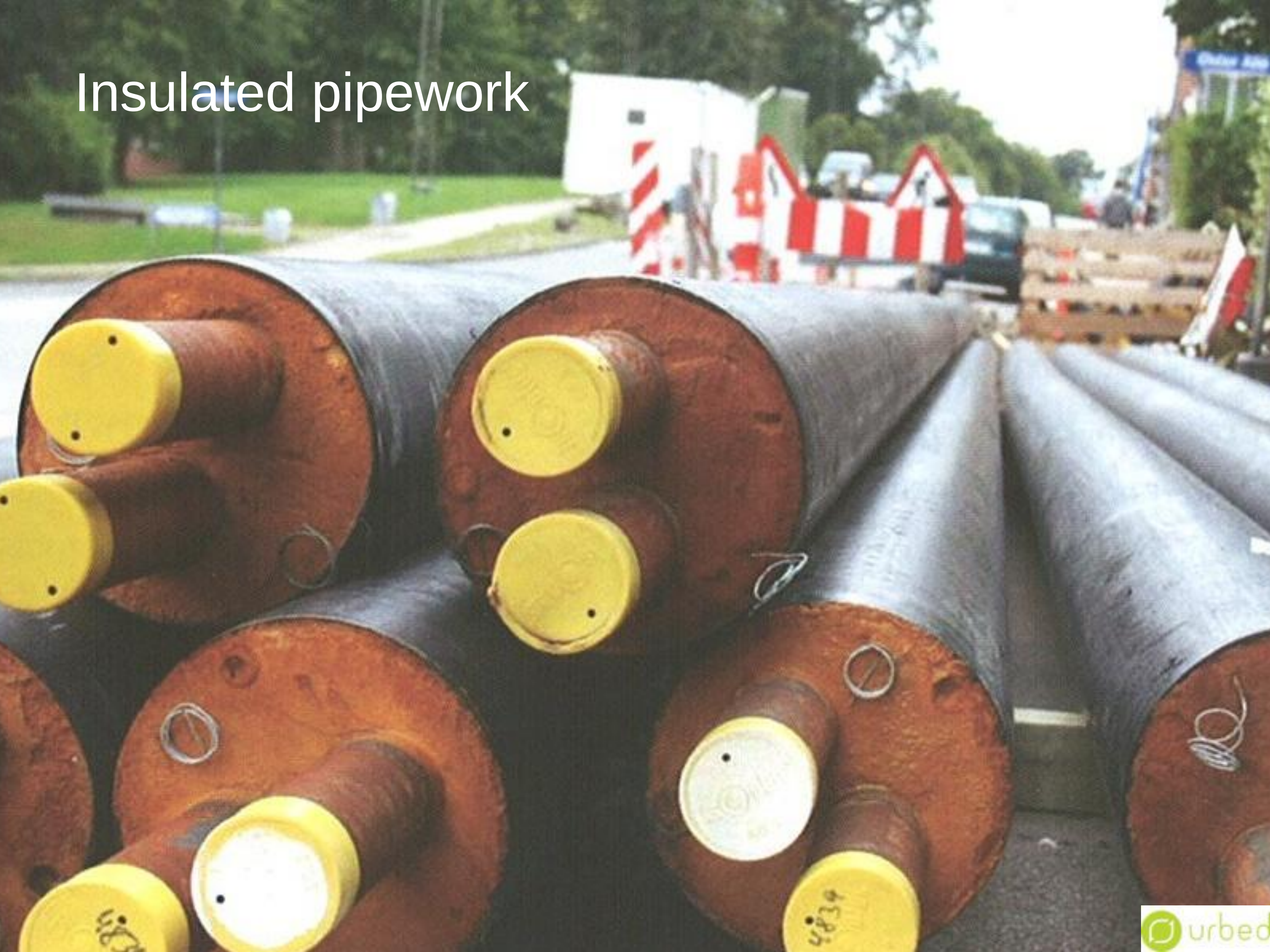
What are the disadvantages of a heat network?

- Long term commitment – capital investment required
- Financial viability may depend on interest from a number of other stakeholders
- Likely to need a coordinating body (public or private) or collaboration between multiple building owners/occupiers
- Less suited to low density areas
- Projected future reduction in electrical grid CO_2 emissions
- Fear of the unknown/perception:
  - Perception of old inefficient systems
  - Heat metering rather than gas bills
  - Investment into heat network rather than investment in individual boiler plant
  - Paying for a service rather than owning and operating

    (not British culture!)

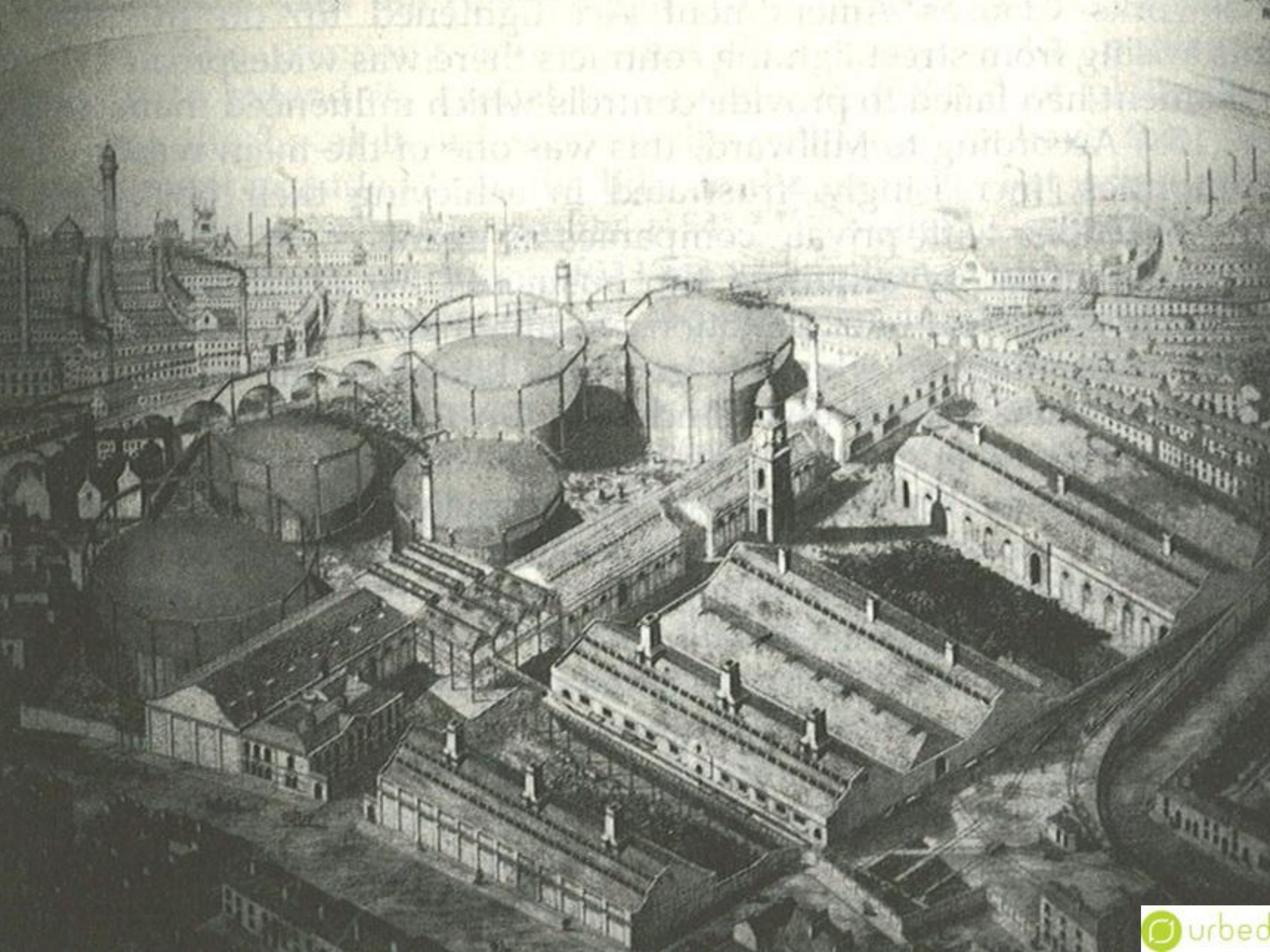
Energy centres

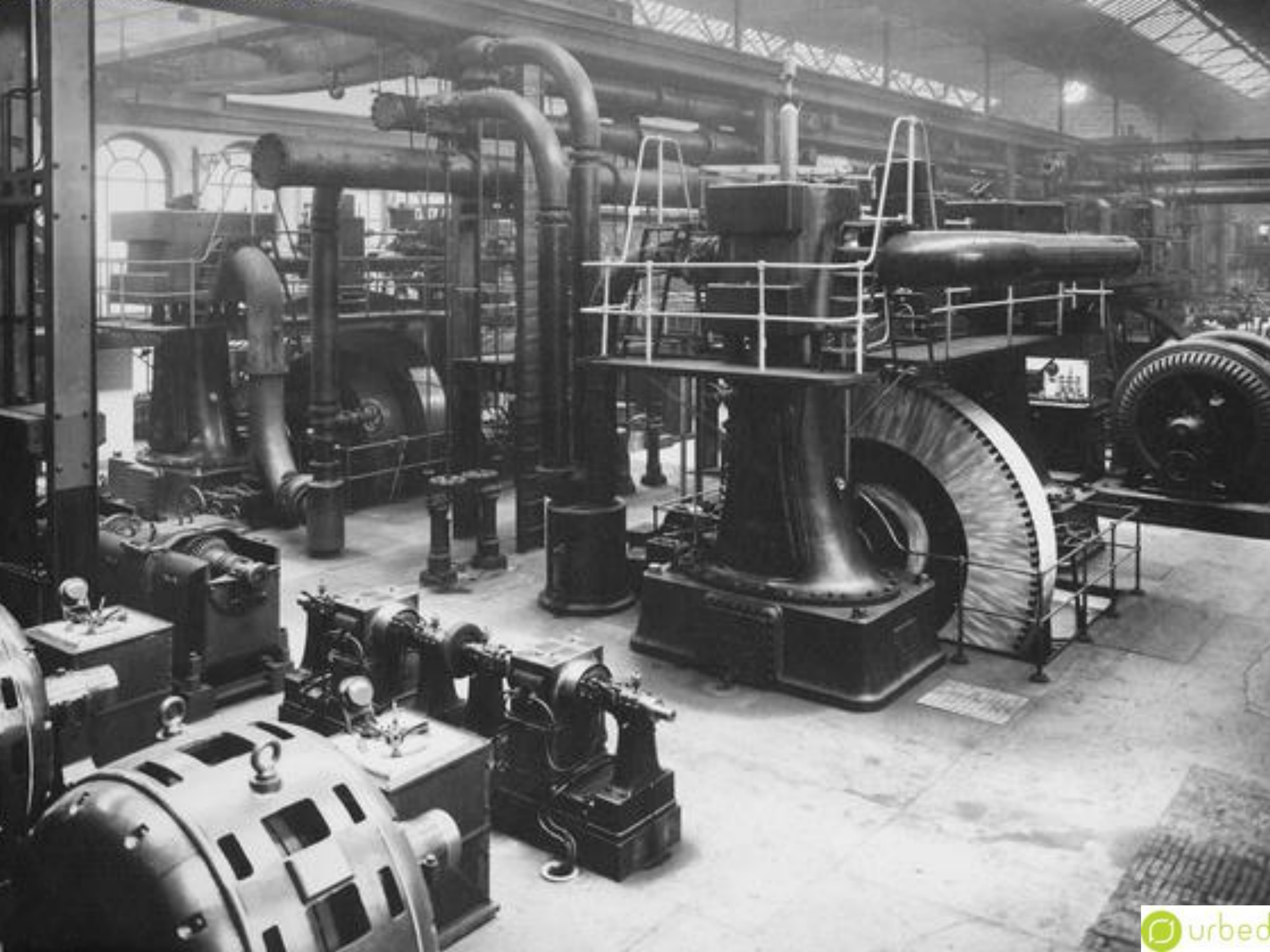
Insulated pipework



Before we look at design issues, let's look at the development of district energy infrastructure in the context of previous infrastructure development…

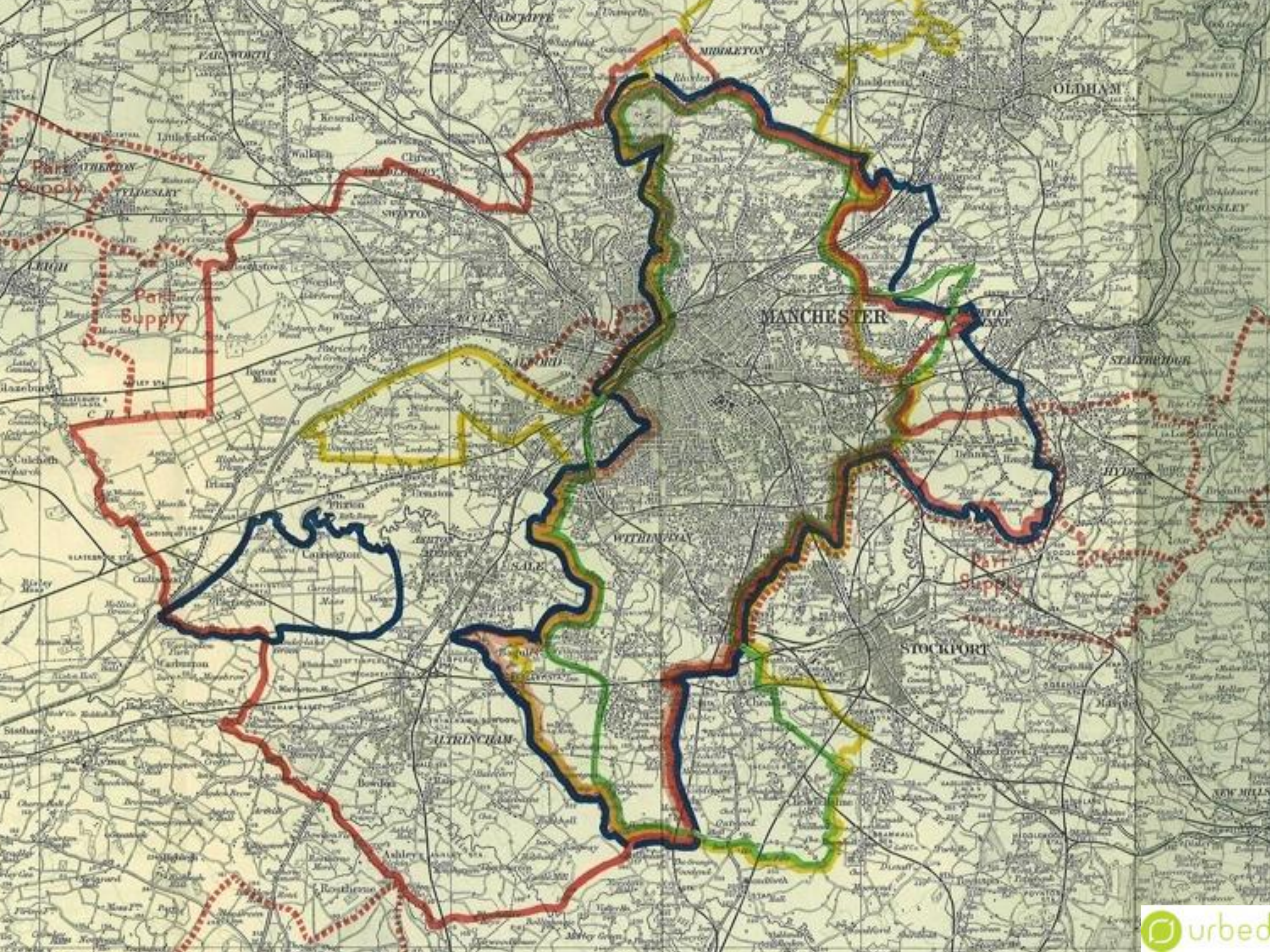

SITE OF
FIRST MANCHESTER GAS WORKS
FIRST MUNICIPAL GAS INSTALLATION IN
THE WORLD TO SELL GAS TO THE PUBLIC.
ERECTED BY THE COMMISSIONERS
OF POLICE
1817
32






GLOV
19
TRADE
MANCH
GLOV
MA
GLOVE
GLOVE
TRADE


(c) Manchester Libraries

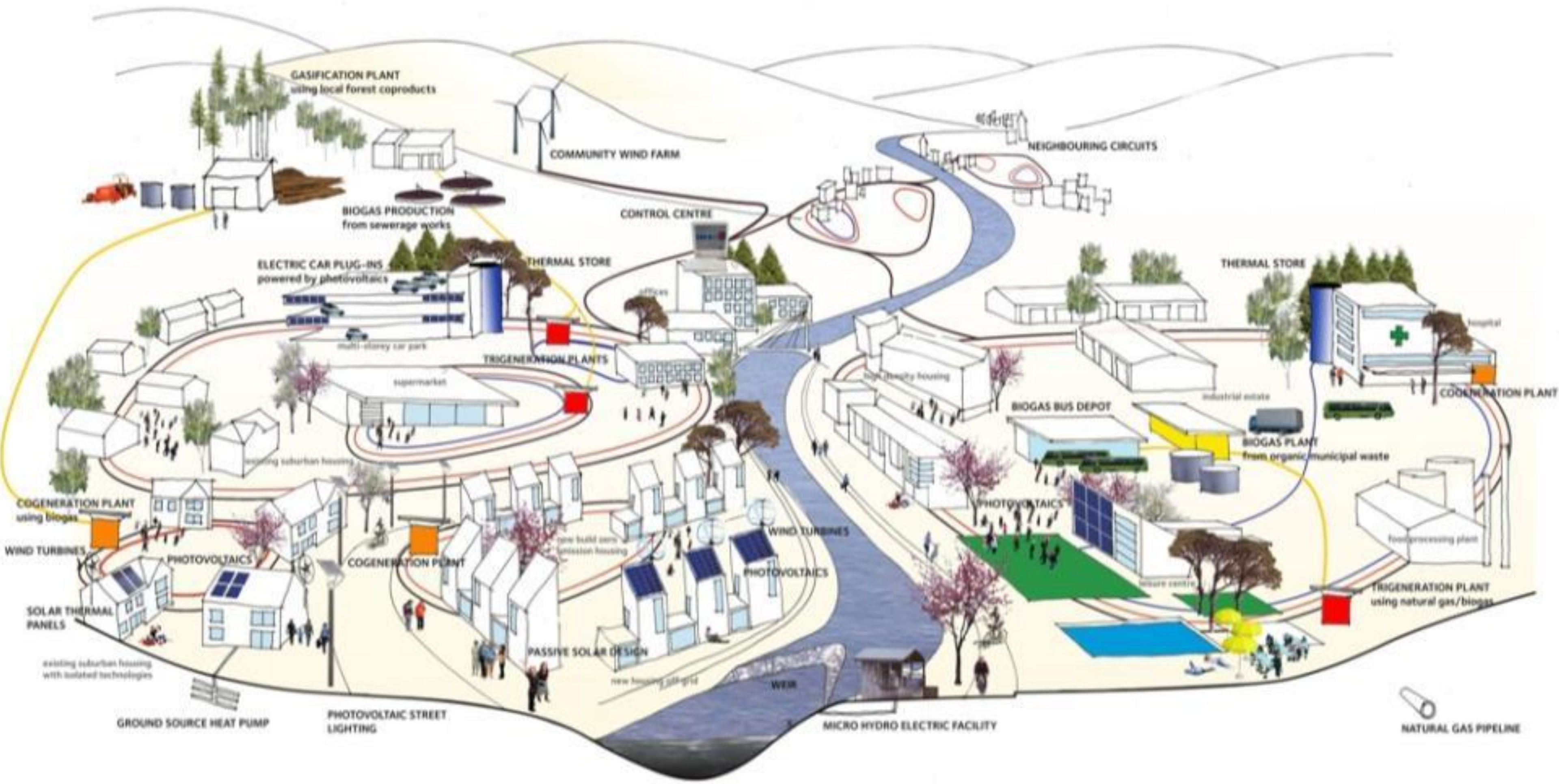


MIDDLETON
OLDHAM
FARNWORTH
ATHERTON
TYLDESLEY
Part Supply
LEIGH
Part Supply
MANCHESTER
STALYBRIDGE
MOSSLEY
HYDE
WITHINGTON
SALE
Carrington
Part Supply
STOCKPORT
ALTRINCHAM
NEW MILLS

urbed

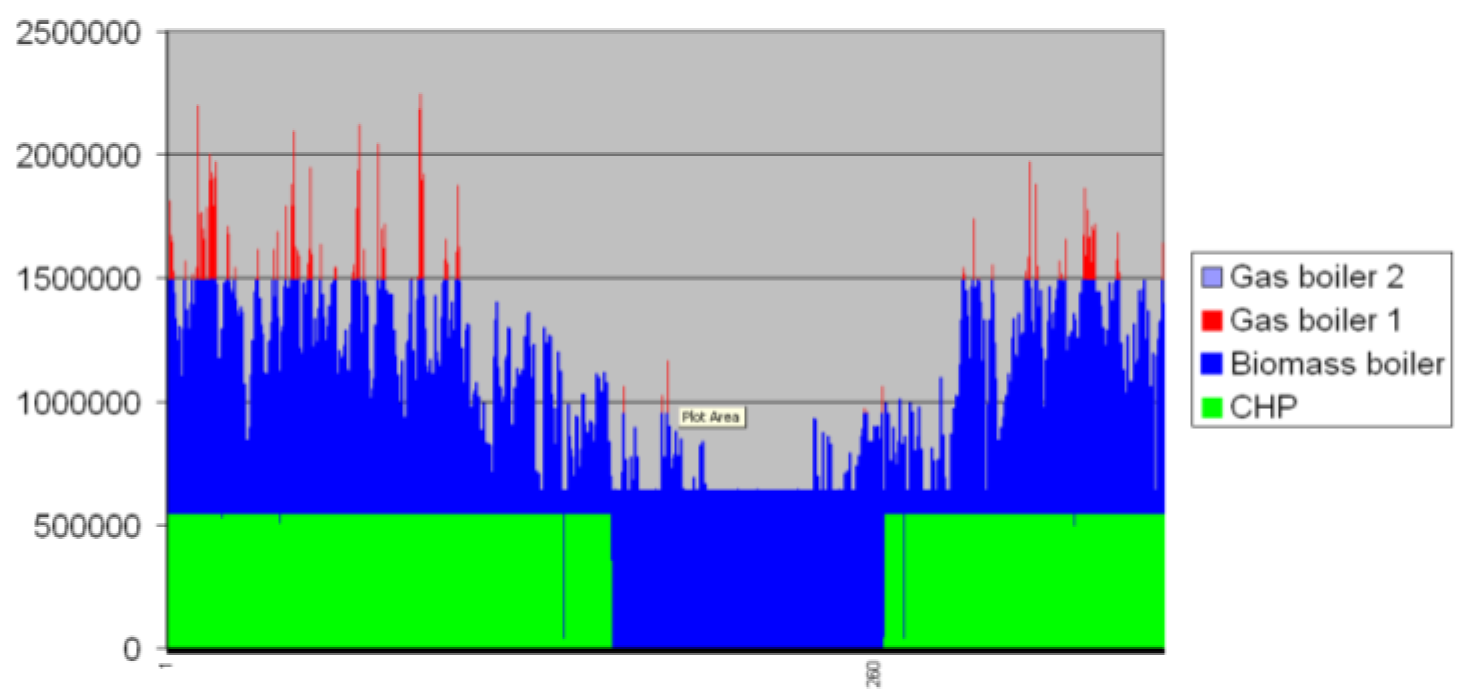
urbed

Decentralised energy vision



Design issues

- Heat demand – annual energy, demand profile, peak demands
- Optimising demands for maximum return (building mix, buffer vessels)
- Diversity
- Suitability for infrastructure installation
- Range of heat sources available (greater range available at larger scale)



Energy/Heat Mapping

Take a variety of forms

Considerations:

- Anchor buildings
- Heat density
- Heat clusters

Maps can be used to show:

- Peak demand
- Annual energy consumption
- Heat density
- Timeline of changes
- Future development
- Building level
- MLSOA level

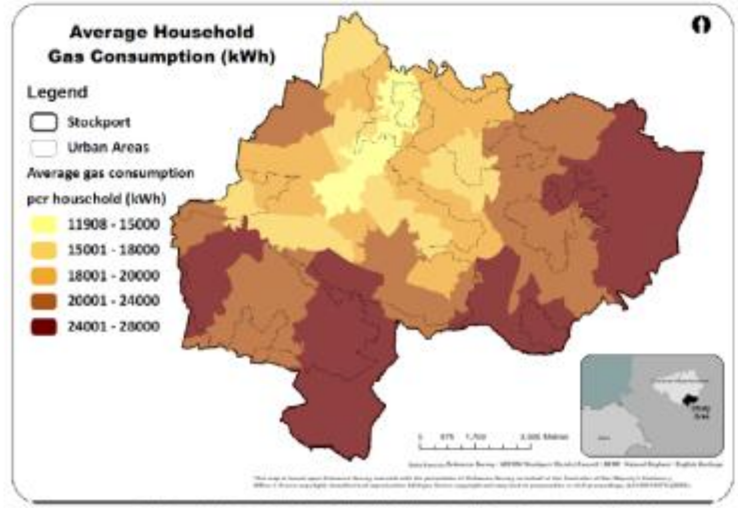
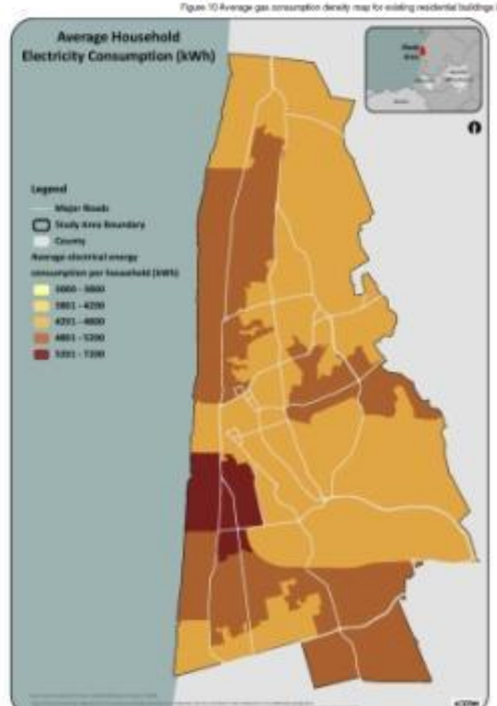
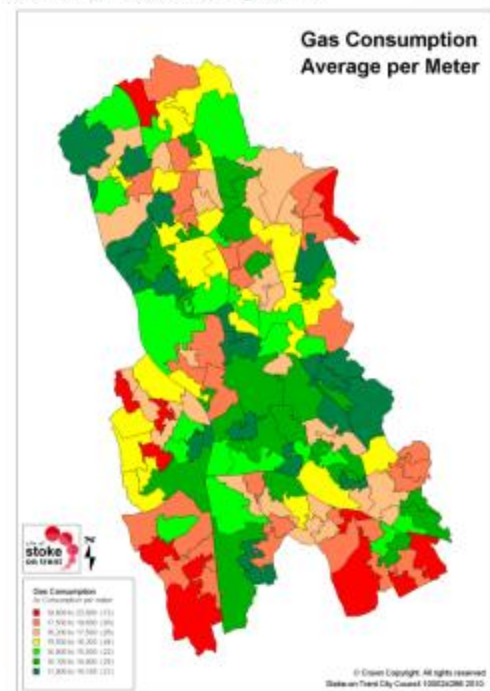
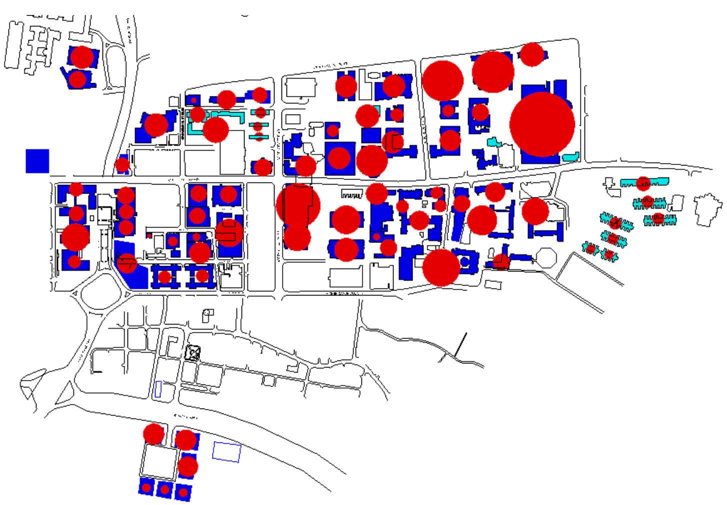


Figure 10 Average gas consumption density map for existing residential buildings in Stockport, 2009, in MWh per household (Source: Stockport energy model, AECOM)



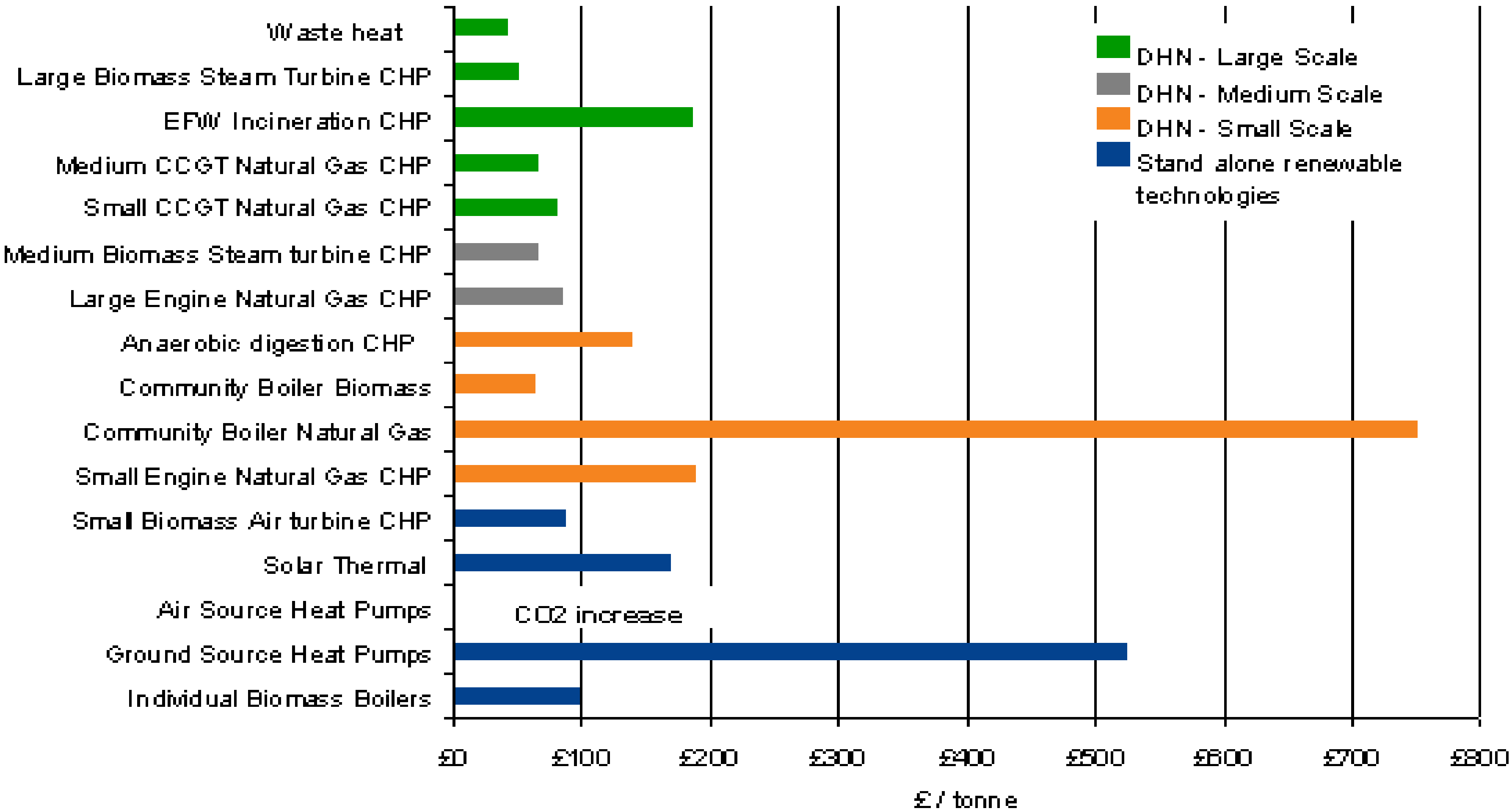




Rules of thumb

- Costs (**a rough guide only!**)
  - Plant
    - Gas boilers: £50-£150/kW_{th}
    - Gas CHP: £500-£1,500/kW_{th}
    - Biomass heating: £350-£800/kW_{th}
    - Biomass CHP: £2,000-£4,000/kW_{th}
  - Network infrastructure
    - Typical pipe diameters in the range of 100-500mm diameter (100kW – 100MW)
    - £500-£5,000/m length
  - Heat Interface Unit (HIU) and meter
    - Approx £2,000/dwelling
- Typical network sizes:
  - 200 townhouses: 1-3MW_{th}
  - Hospital: 10—50MW_{th}

Potential carbon savings



Potential carbon savings

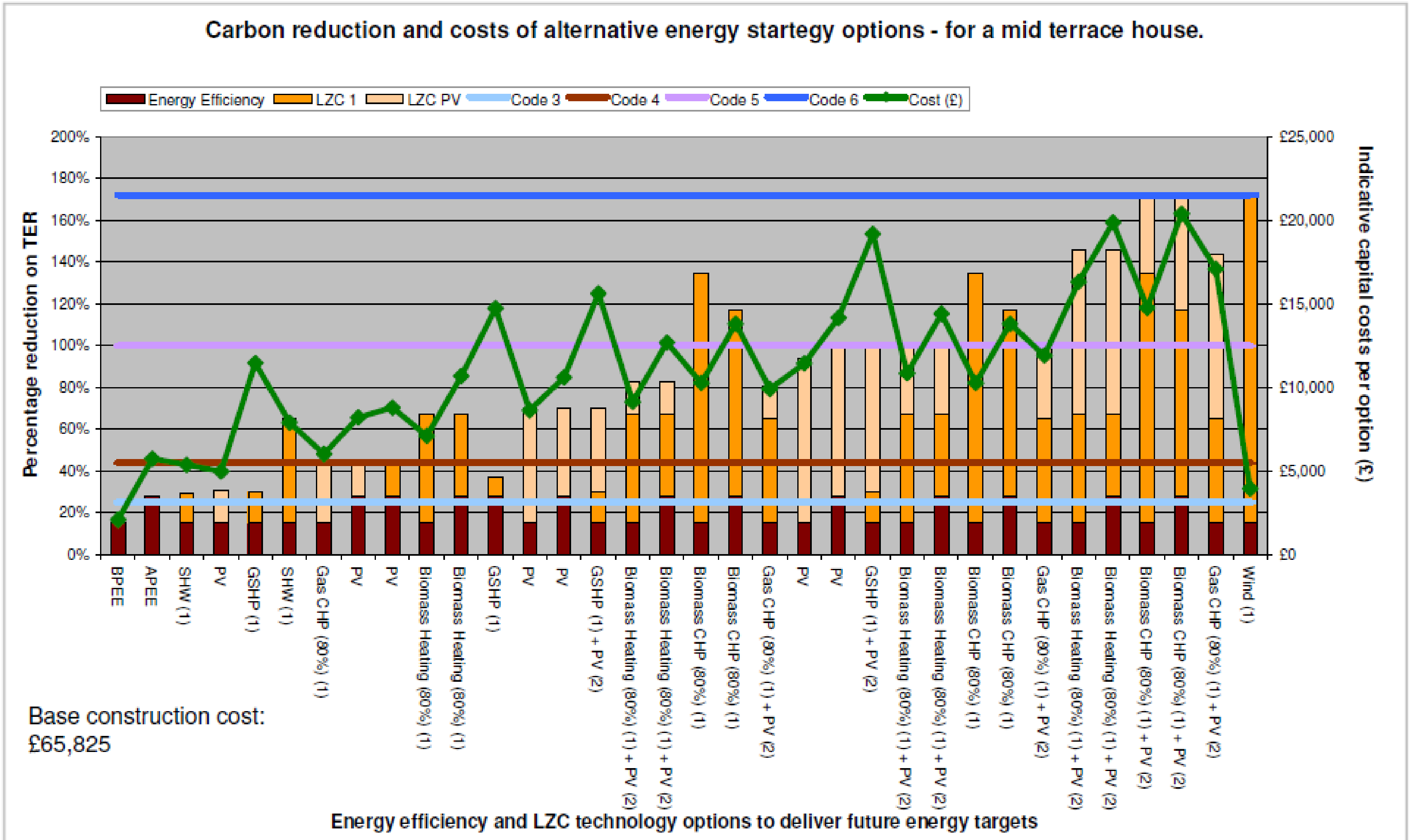


Figure 37. Relative cost of different technologies for a terraced house to meet various code levels[30]

Key

BPEE = Best Practice Energy Efficiency

APEE = Advance Practice Energy Efficiency

SHW = Solar Hot Water

PV = Photovoltaics

GSHP = Ground Source Heat Pumps

CHP = Combined Heat and Power

---

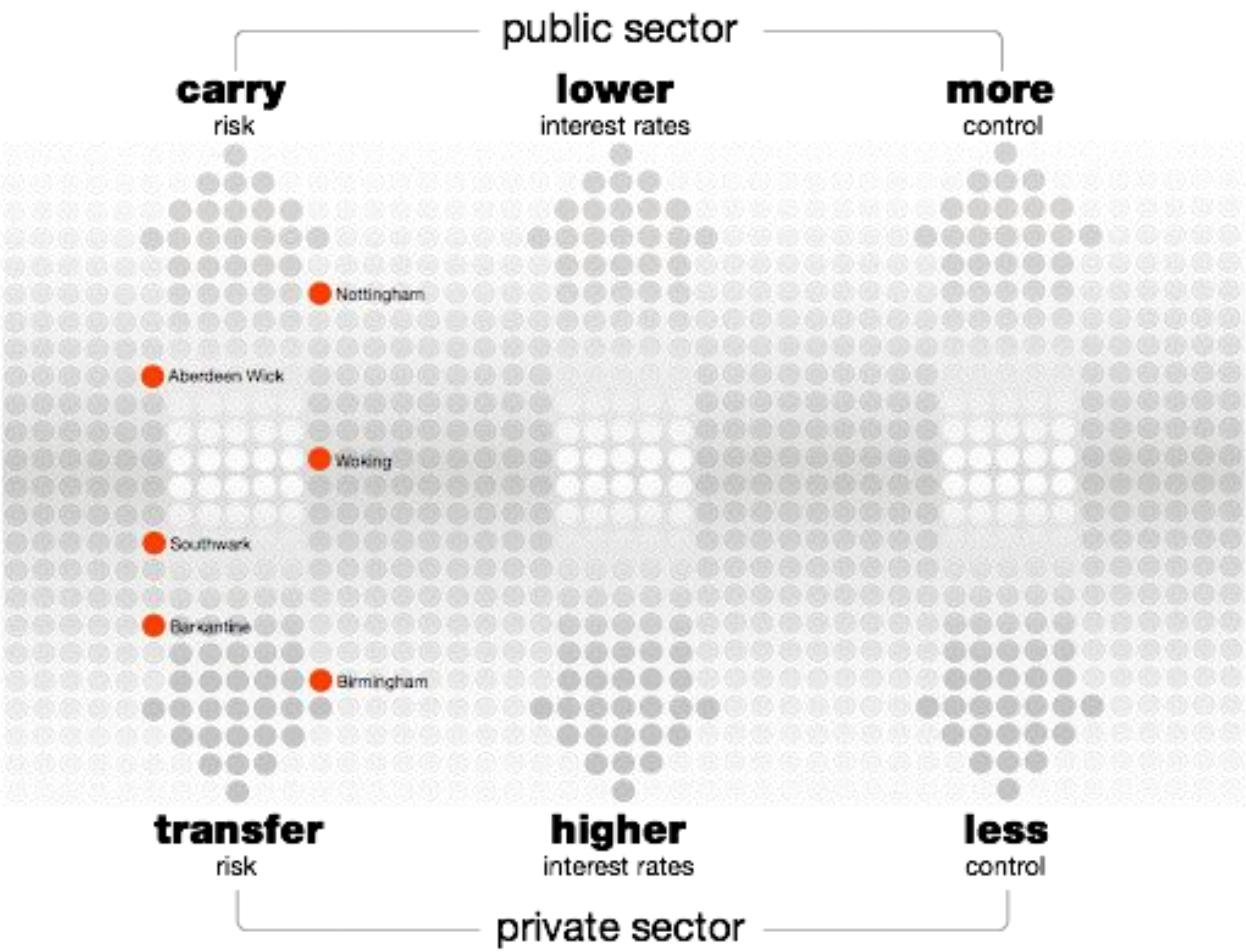
[30] Costs derived from in-house AECOM data from work undertaken with Cyril Sweett for DCLG

Table 18 – Urban Regeneration – end-terrace

Technology Combination	Target CO_2 reduction (% 2006 TER)	Carbon reduction (vs. Part L 2006)	Residual CO_2 - electricity (tpa)	Residual CO_2 -other (tpa)	Total residual CO_2 (tpa)	Capital cost premium
BPEE alone	25%	15%	1.22	1.34	2.56	£2,179
APEE alone	25%	31%	1.25	1.06	2.30	£5,485
SHW + BPEE	25%	30%	1.22	1.10	2.32	£5,450
PV + BPEE	25%	26%	1.04	1.34	2.38	£5,063
GSHP +BPEE	25%	40%	1.66	0.50	2.15	£10,123
Gas CHP (80%) with BPEE	44%	45%	-0.41	2.48	2.07	£7,795
PV + BPEE	44%	44%	0.74	1.34	2.08	£7,875
PV + APEE	44%	44%	1.02	1.06	2.08	£8,587
SHW + APEE	44%	45%	1.24	0.81	2.05	£8,539
Biomass heating (80%) + BPEE	44%	68%	1.04	0.63	1.66	£6,993
Biomass heating (80%) + APEE	44%	69%	1.12	0.52	1.65	£10,244
GSHP +APEE	44%	48%	1.57	0.43	2.00	£13,108
PV + BPEE	70%	69%	0.31	1.34	1.65	£11,525
PV + APEE	70%	70%	0.57	1.06	1.63	£12,267
GSHP + PV + BPEE	70%	70%	1.14	0.50	1.63	£14,917
Biomass heating (80%) + PV + BPEE	70%	79%	0.86	0.63	1.49	£9,043
Biomass heating (80%) + PV + APEE	70%	80%	0.94	0.52	1.47	£12,253
Biomass CHP (80%) + BPEE	70%	117%	0.05	0.78	0.83	£10,695
Biomass CHP (80%) + APEE	70%	105%	0.40	0.64	1.04	£13,904
Gas CHP (80%)+ PV + BPEE	70%	70%	-0.84	2.48	1.63	£12,077
PV + BPEE	100%	69%	0.31	1.34	1.65	£11,525
PV + APEE	100%	84%	0.33	1.06	1.39	£14,735
GSHP + PV + BPEE	100%	93%	0.74	0.50	1.24	£18,947
Biomass heating (80%) + PV + BPEE	100%	100%	0.49	0.63	1.12	£12,433
Biomass heating (80%) + PV + APEE	100%	100%	0.60	0.52	1.12	£15,458
Biomass CHP (80%) + BPEE	100%	117%	0.05	0.78	0.83	£10,695
Biomass CHP (80%) + APEE	100%	105%	0.40	0.64	1.04	£13,904
Gas CHP (80%)+ PV + BPEE	100%	98%	-1.32	2.48	1.15	£16,983
Biomass heating (80%) + PV + BPEE	Zero carbon	122%	0.13	0.63	0.75	£16,218
Biomass heating (80%) + PV + APEE	Zero carbon	123%	0.21	0.52	0.73	£19,428
Biomass CHP (80%) + PV + BPEE	Zero carbon	166%	-0.78	0.78	0.00	£19,231
Biomass CHP (80%) + PV + APEE	Zero carbon	158%	-0.51	0.64	0.13	£23,250
Gas CHP (80%)+ PV + BPEE	Zero carbon	98%	-1.32	2.48	1.15	£16,983

Base construction cost (Part L 2006): £71,816

Delivery options



Option 1: Procure private partner

Southampton Geothermal Heating Co

Option 1: Procure private partner

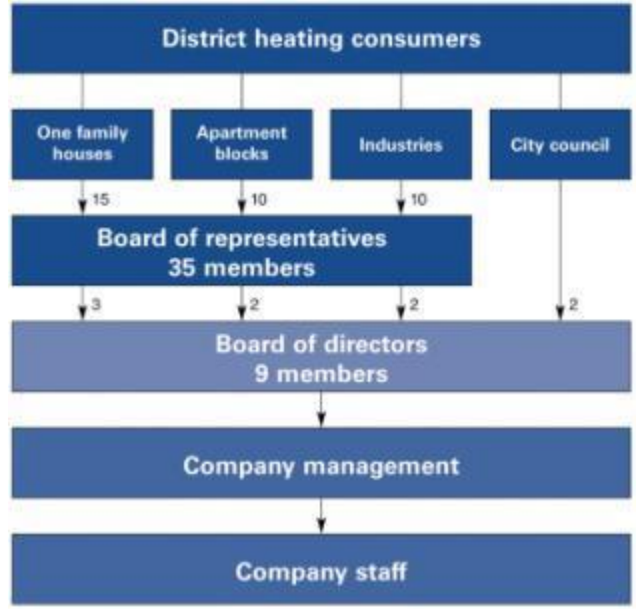
Media City (Elyo Suez)

Option 2: Establish a Special Purpose Vehicle

Aberdeen Heat and Power Co

Option 2: Establish a Special Purpose Vehicle

Mutual structure



Option 3: Council led project

Enviroenergy, Thameswey

urbed

District energy planning policy

- A number of Local Authorities currently have (or are in the process of adopting) policies on district energy
- Planning policy is a key tool in developing energy networks to create a structured coordinated approach to reducing carbon emissions cost effectively
- E.g. Stockport Council
  - Policy SD-3: Delivering the Energy Opportunities Plans
    - Identifies areas where networks should be developed or connected to
    - Identifies areas less suitable for networks that are more likely to pursue other alternatives
    - Applies stretched targets beyond minimum Building Regs to encourage early action and ‘gear up’ to future changes in building Regs
  - Policy SD-4: District Heating
    - Developments should seek to make use of waste heat or energy networks before considering other technology options
    - Minimum threshold size of 100 dwellings or 10,000m^2 commercial development
  - Policy SD-5: Community Owned Energy
    - Supporting and actively encouraging community-owned energy schemes such as hydro and wind schemes

Considerations for Local Authorities

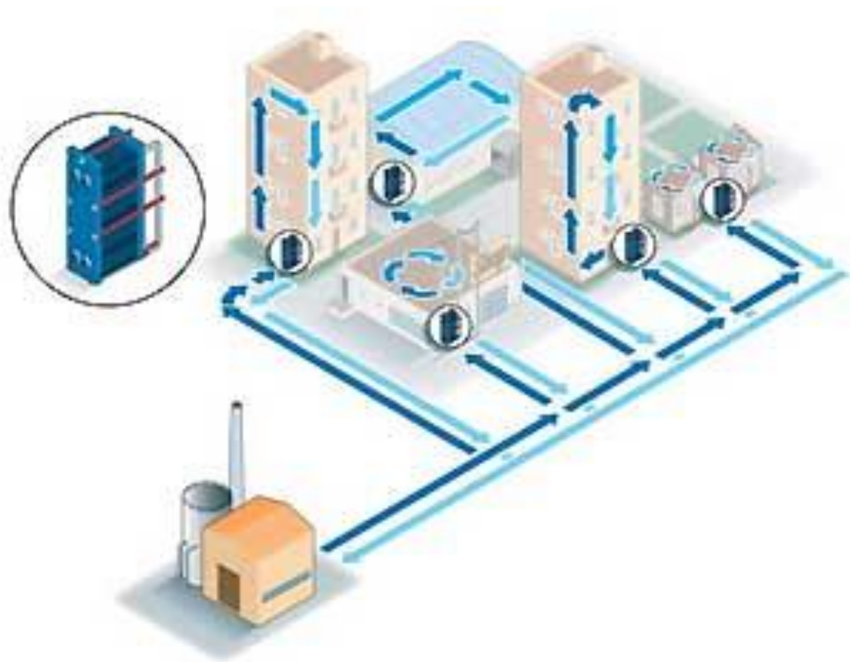
- Policy
- Sustainability checklists?
- Support & guidance
- Sharing of experiences and expertise between Authorities
- Sharing of professional services through ‘packaging’ projects (e.g. AGMA region)
- Planning issues (land ownership, pipework routing, location of energy centre, air quality, access for fuel deliveries, etc.)
- Coordinating “seed capital” and contributions from “buy-out funds” or “allowable solutions”

Other ongoing support

- Planning teams
- Regeneration teams
- Senior management
- Council members
- Technical consultants
- Financial consultants
- ESCos
- Finance providers
- Investors
- Individual leaders!

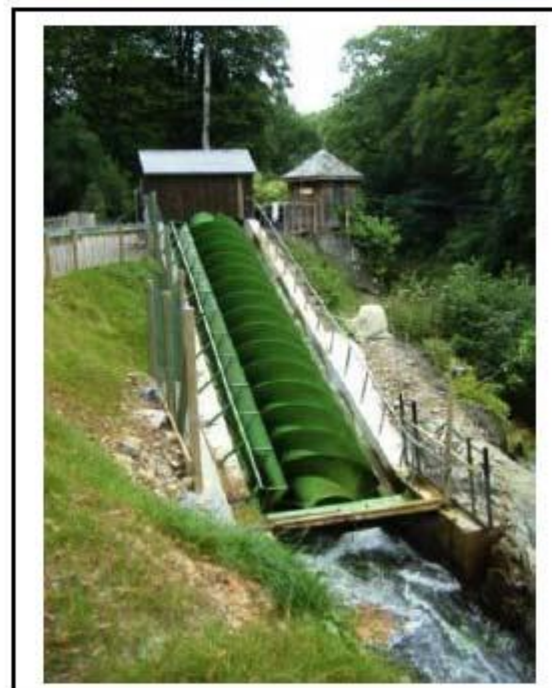
Other Energy Networks - District Cooling

- District cooling using centralised cooling plant
- District cooling via district heating and absorption chillers
- Considerations:
  - Do we want to encourage the use of comfort cooling as a replacement for good design?
  - We need to acknowledge changes in building uses and demands



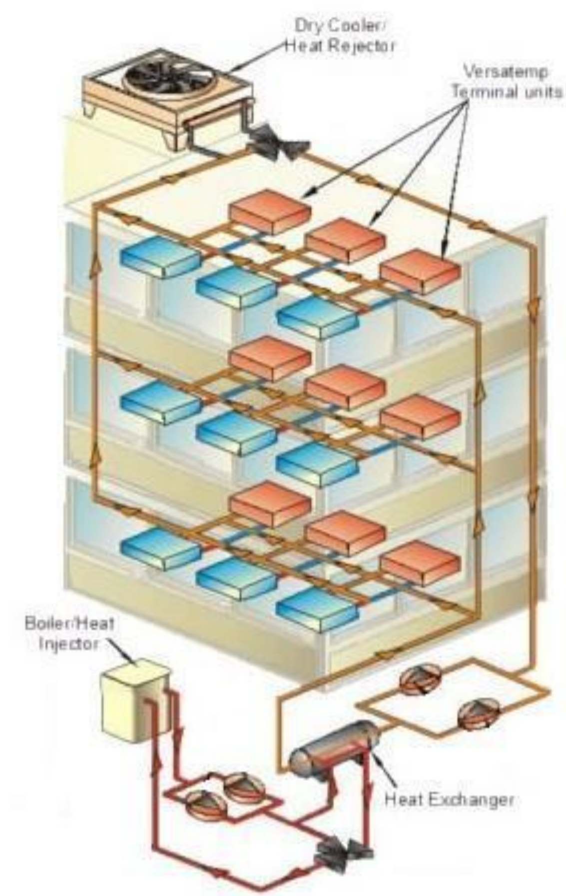
Other Energy Networks – Private Wire Electrical Connection

- An energy network can be as simple as connecting a remote electrical generation scheme to a series of end users, e.g.
  - PV array
  - Hydro scheme
  - Wind turbine(s)

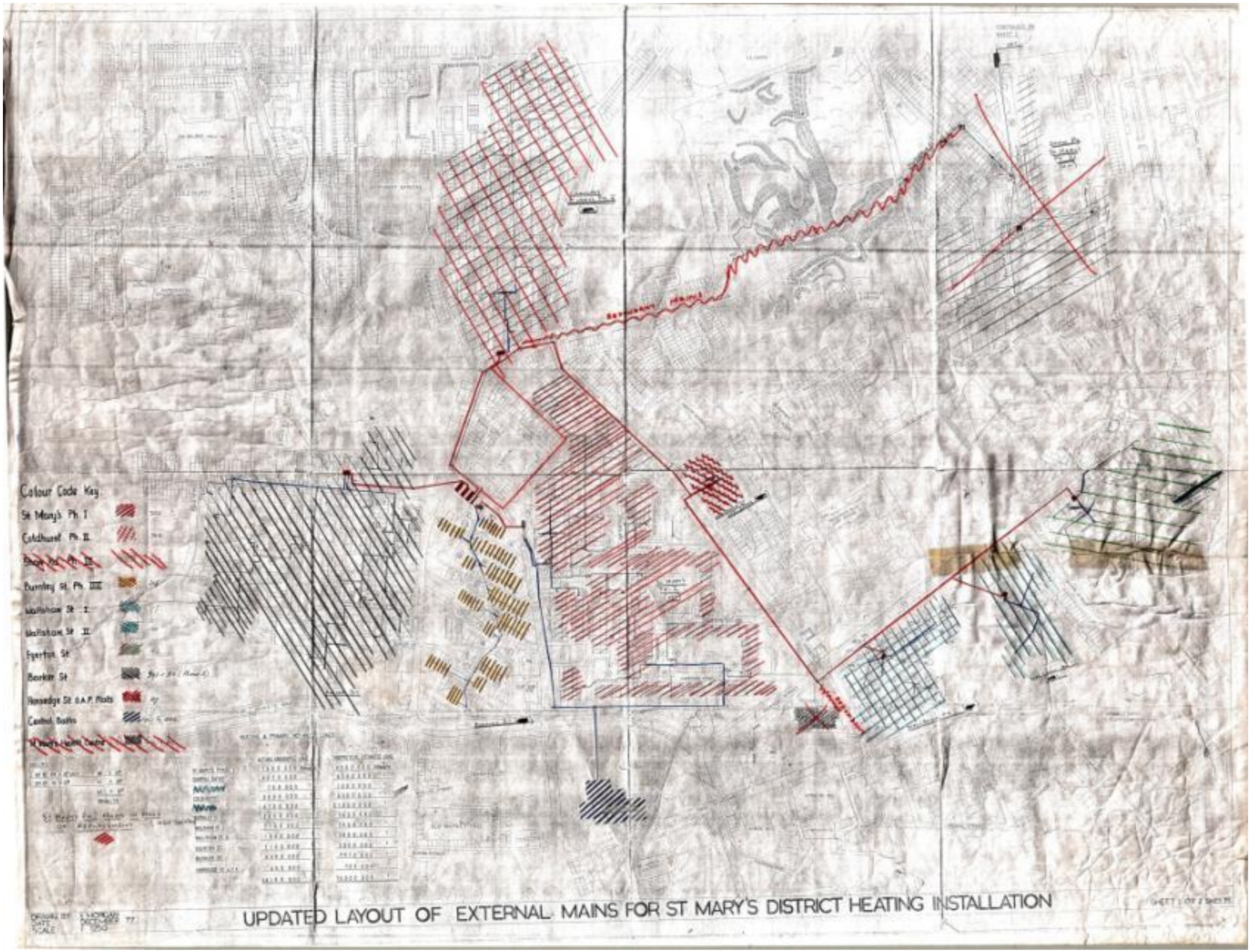


Other Energy Networks – Shared Water Loop with Heat Pump

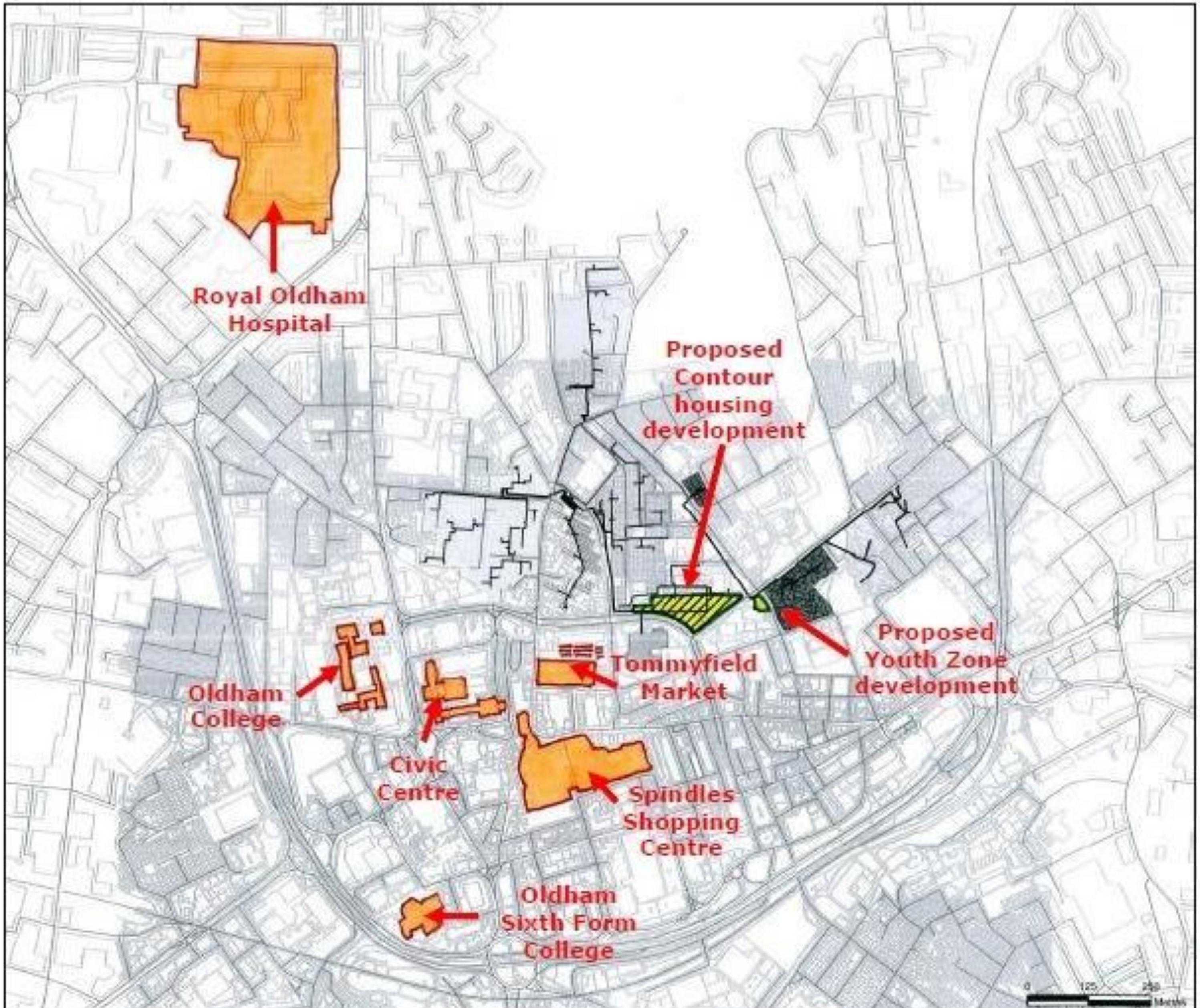
- Shared energy loop using water loop as a medium for transferring heating and cooling between buildings
- Heat pumps used to exchange heat and cooling with the water loop
- Mix of heating and cooling demands across the system create sharing (transfer) of heat and cooling to point of demand thereby giving high CoPs



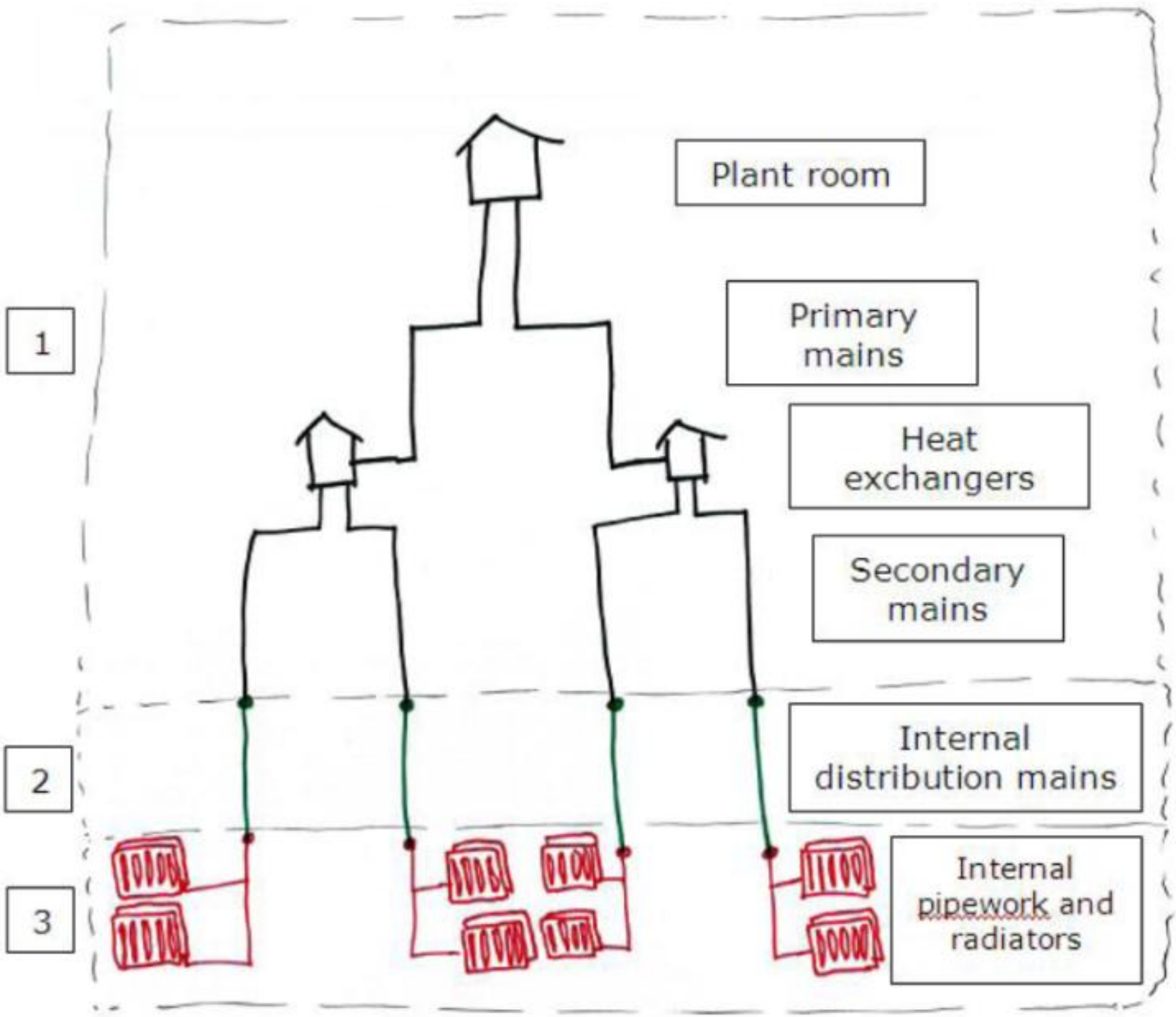
Oldham St Mary's District Heating Network



Oldham St Mary's District Heating Network

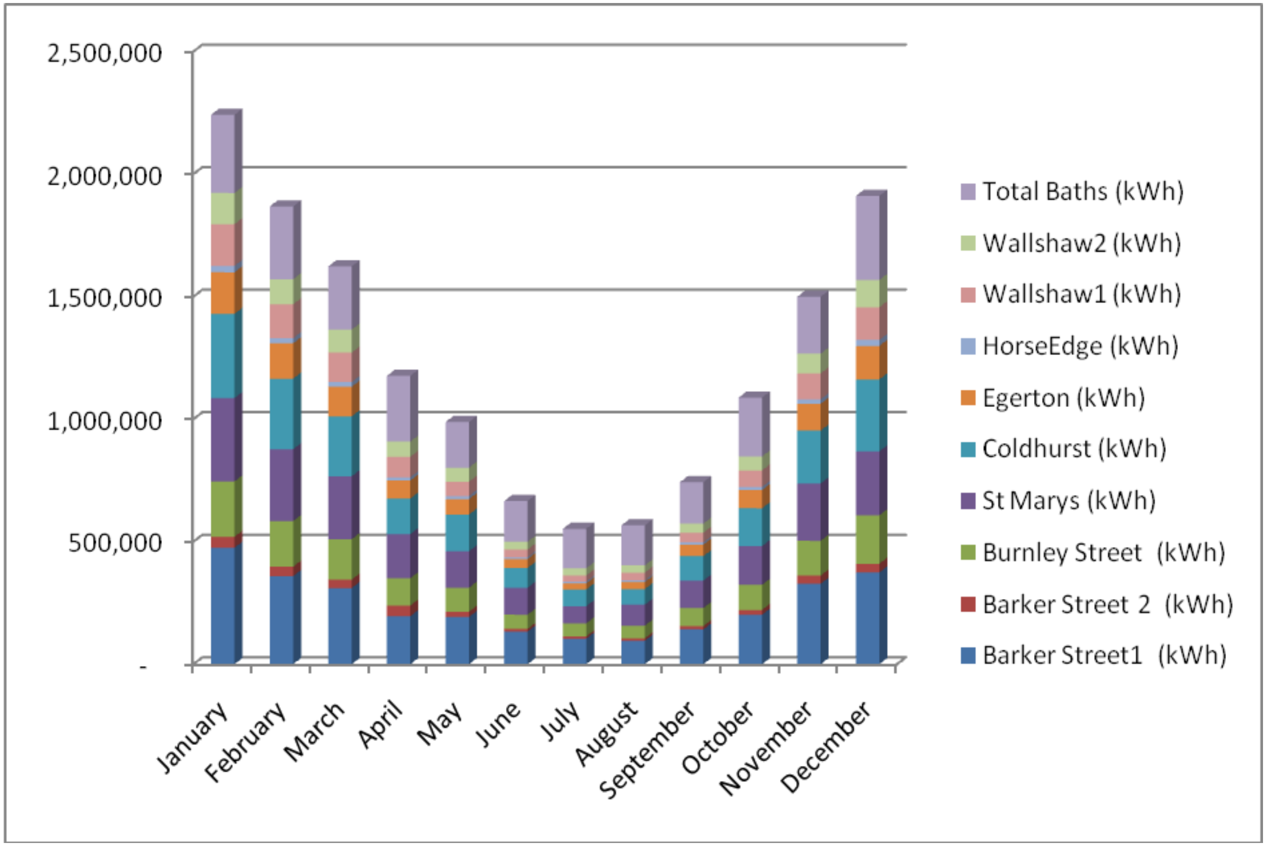


Oldham St Mary's District Heating Network

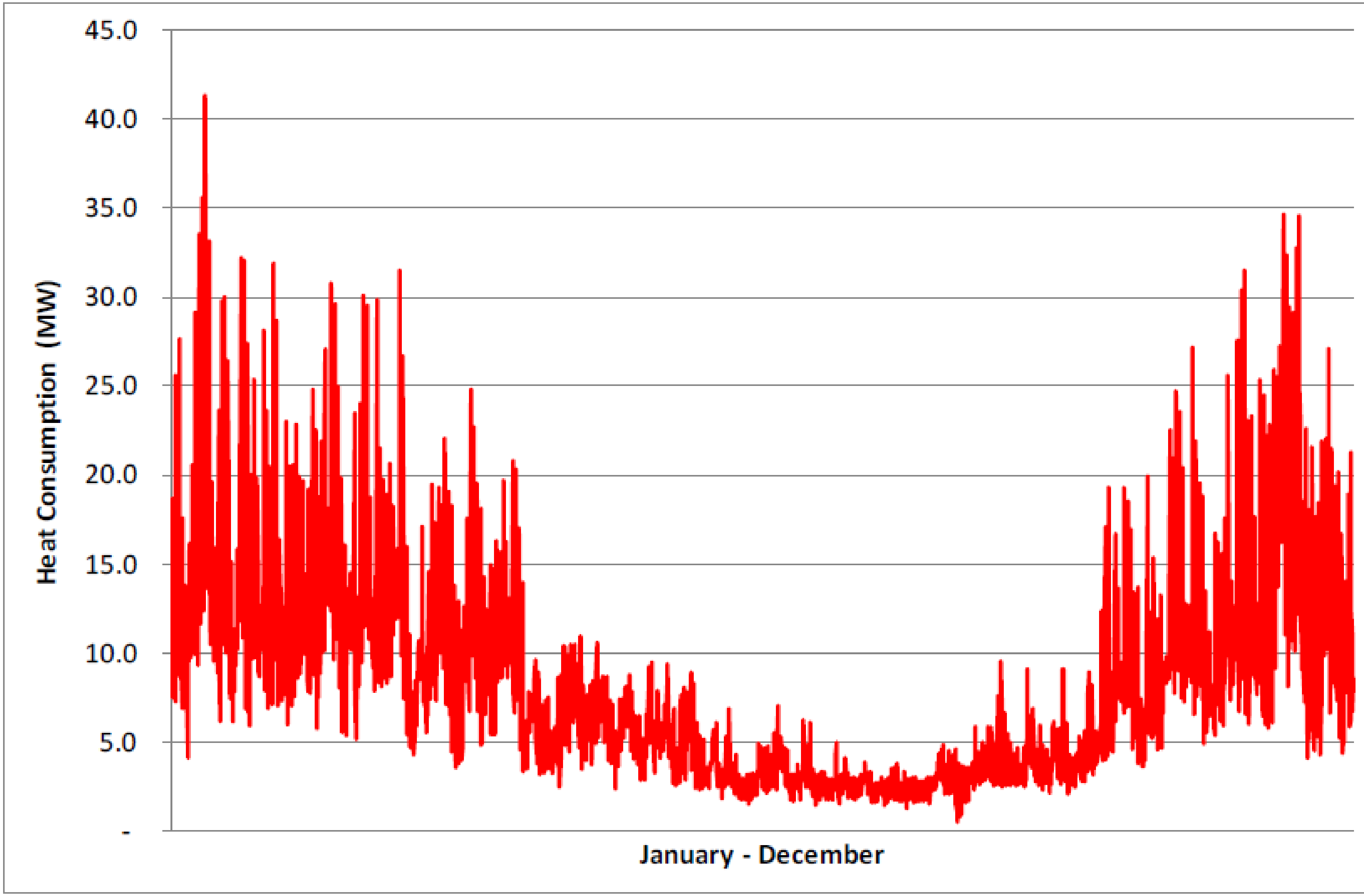


Oldham St Mary's District Heating Network

- 3no. 5.5MW gas-fired boilers
- Current peak requirement around 6MW
- Previously operated using coal
- Interruptible gas supply - Oil backup



Oldham St Mary's District Heating Network



'option 2' expansion

Thoughts on the future of district energy

- Electrical grid decarbonisation
- Will heat network infrastructure become redundant?
- Fuel cells and other new technologies
- Grid infrastructure capacity
  - Hybrid cars
  - Increased electrical demand
- Making use of waste heat
- Forms a part of the **energy mix**
  - The energy mix is something that has been referred to in previous sessions and highlights that there is no single solution and site opportunities and constraints are crucial to the selection of technologies and strategies

Three energy carriers could be used in the future to meet heat demands

- **Electricity** – maximise use of: wind, biomass, tidal, carbon capture, nuclear and then use heat pumps or direct electric heating (Climate Change Committee report) – requires additional capacity for both production and distribution
- **Gas** – inject biogas into existing gas network (National Grid report) – results in most of biogas being used for heating not in CHP so less efficient
- **District Heating** – enables better use of scarce resource as biomass can be used in CHP plant, more renewable electricity available for meeting transport needs, no need to upgrade electricity distribution system
- **We will need to find the optimum mix of all three carriers**

Questions

Delivered by:

NWIEP | CLASP. Envirolink Quantum AECOM

Exercise

Delivered by:

Exercise

The site is an edge of town brownfield urban extension approx. 10ha in size which has been allocated as a strategic site in the recently adopted Allocations Development Plan Document (DPD). It has been allocated for a mixed used development to include:

- Residential use (approx. 200 units),
- small retail units & commercial offices in central location to service local needs (on approx. 1ha of site)
- well integrated public open space & children's play areas

Site is adjacent to an existing primary school and sports centre. The school will need to be refurbished / extended to accommodate the additional pupils which will be generated by the new housing development (a financial contribution to education provision will be secured through the section 106 agreement).

The site is bounded by to a busy A road and a railway line; the site is unconstrained in terms access, but traffic alleviation measures will be required.

There is also a light industrial estate on the other side of railway line; the estate is 75% occupied and includes warehousing, light manufacturing and haulage. Each have different operating hours and one unit has a high process heat demand.

<u>Questions</u>

- How would you begin to assess the suitability of the site for district heating?
- What fuels could be considered and what fuels are likely to be discounted
- What size of heating plant would be required?
- What could be done to maximise the use of low carbon technologies supplying heat to the network?
- What are the carbon benefits likely to be for the area?
- What would be an approximate cost for the scheme?
- How could a planner assist in the development of such a scheme?
- What are the biggest opportunities for such a scheme?
- What are the biggest challenges for the scheme and who can assist with overcoming these challenges
- What support is likely to be needed to develop such a scheme?
- What alternatives are there in this scenario and would is a district heating network the preferred option or is there a better solution

Feedback and discussion

Delivered by:

Wrap up & close

Delivered by:

nwIEP | CLASP. Envirolink Quantum AECOM