DISTRICT ENERGY AND SMART NETWORKS

HEAT NETWORK PARTNERSHIP

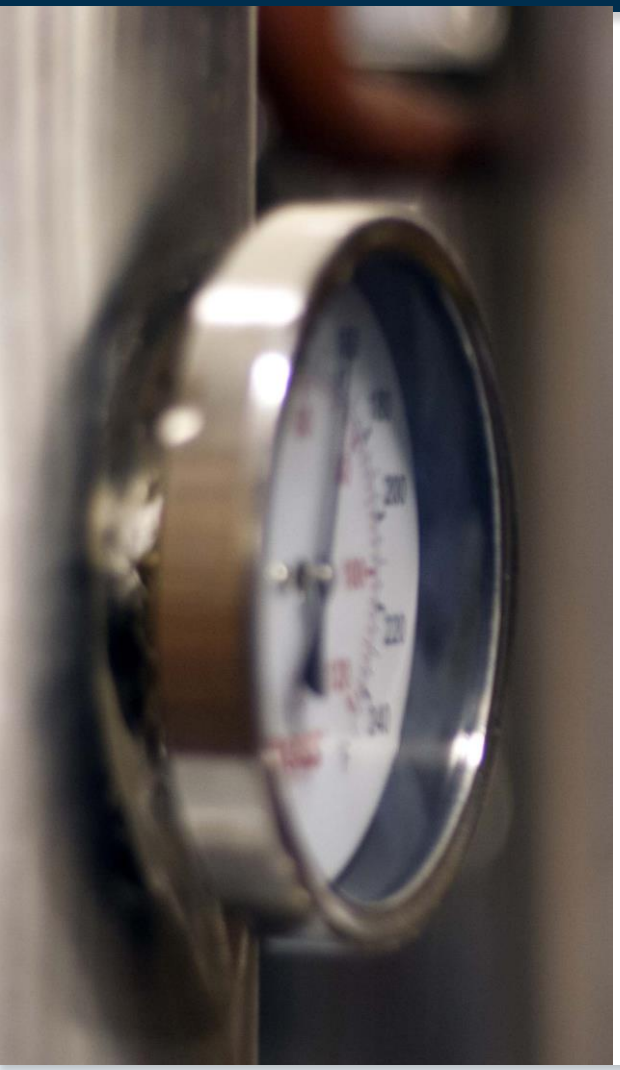
DISTRICT HEATING WORKSHOPS: TECHNICAL

Dominic Bowers
Director, Energy Solutions

28th May 2014

PARSONS BRINCKERHOFF

Contents



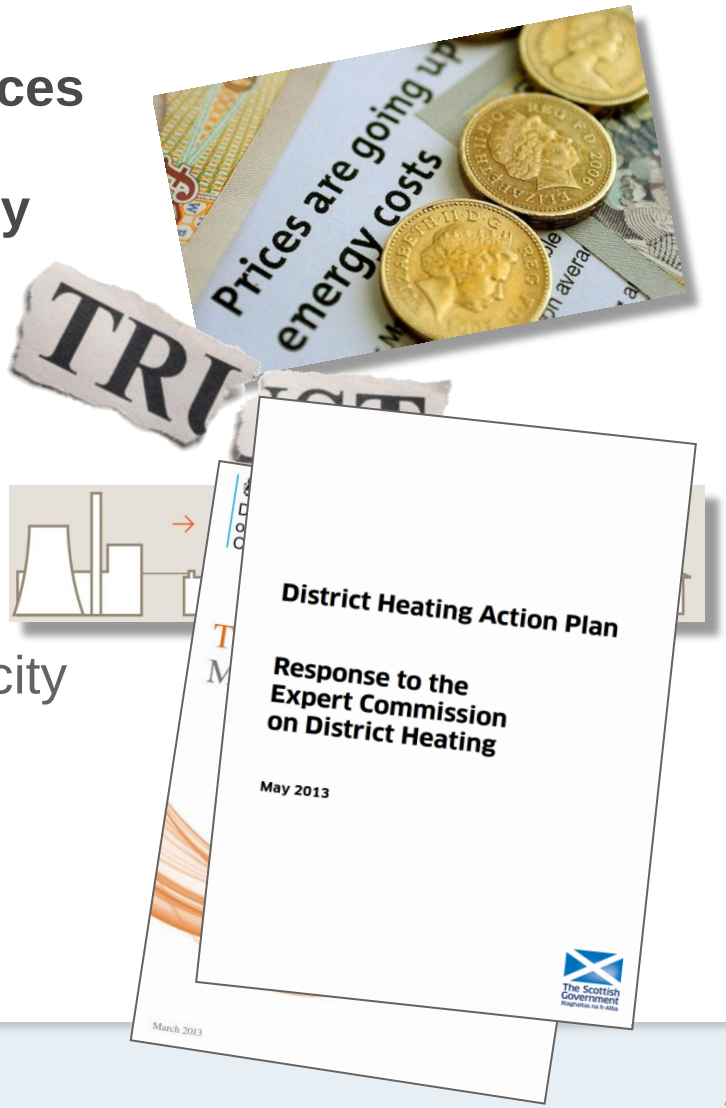
1. What do we mean by ‘district energy’
2. Why it’s relevant now
3. LA role in developing local energy projects
4. Case studies
5. Making it smart !
6. Q&A

District Energy – a definition

- **Generating energy local to its point of use**
- **Distributing over local networks of pipes (district heating) and cables (private wire network)**
- **Supplying local buildings: homes, businesses and the public sector estate**
- **Using locally available sources of energy:**
  - Energy-from-Waste facilities
  - Biomass
  - Waste heat from industrial processes
  - Rejected heat from buildings
- **District Energy = local energy**

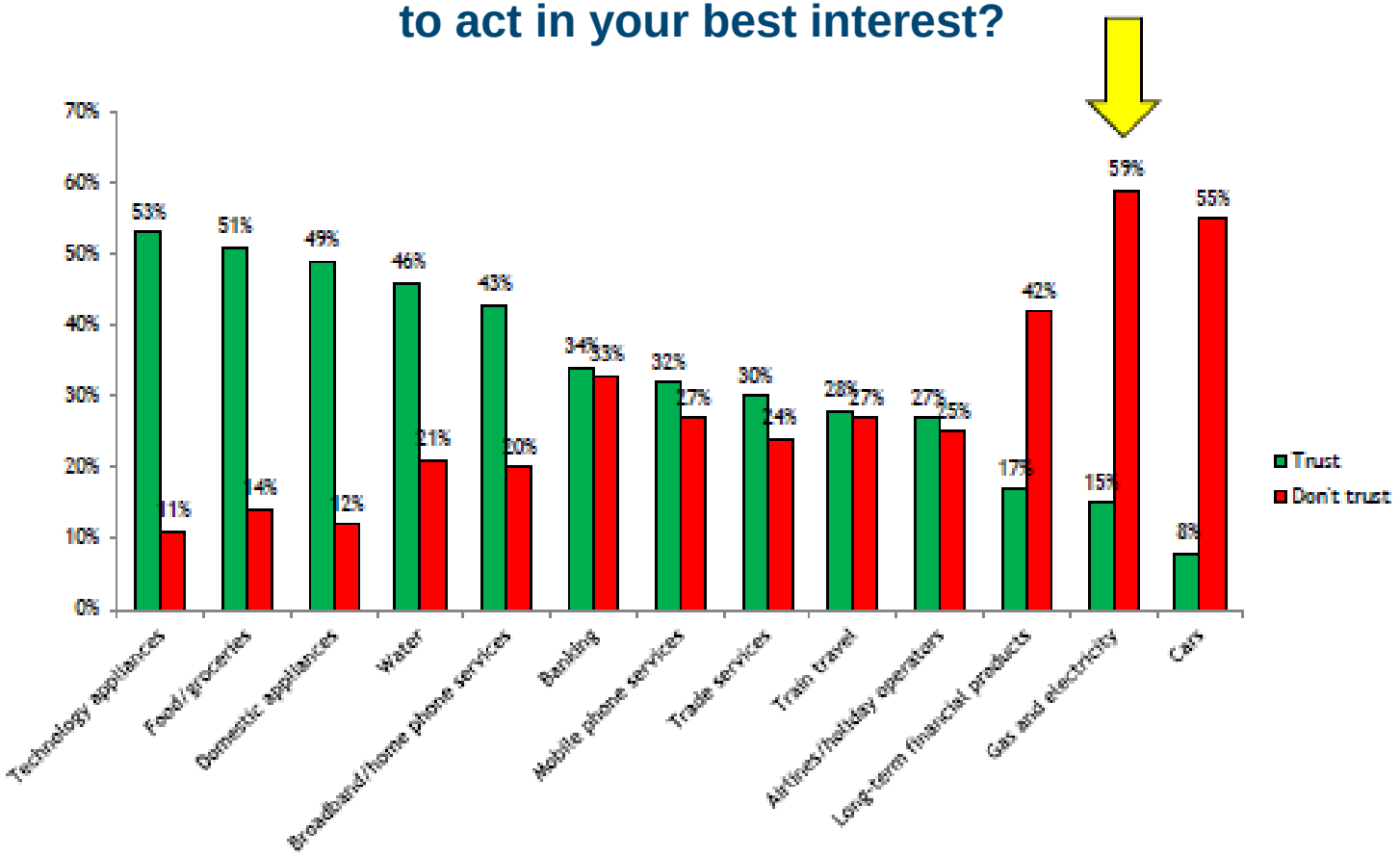
What's the context of 'Local Energy'

- **Continuing upward trend in energy prices**
- **Increasing the incidence of fuel poverty**
- **Lack of trust in the 'Big 6'**
  - Price hikes
  - 'Profiteering' ?
- **Security of supply concerns**
  - Increasing demand / insufficient capacity
- **Government policy**
  - Localism agenda
  - Heat Strategy



The BIG 6

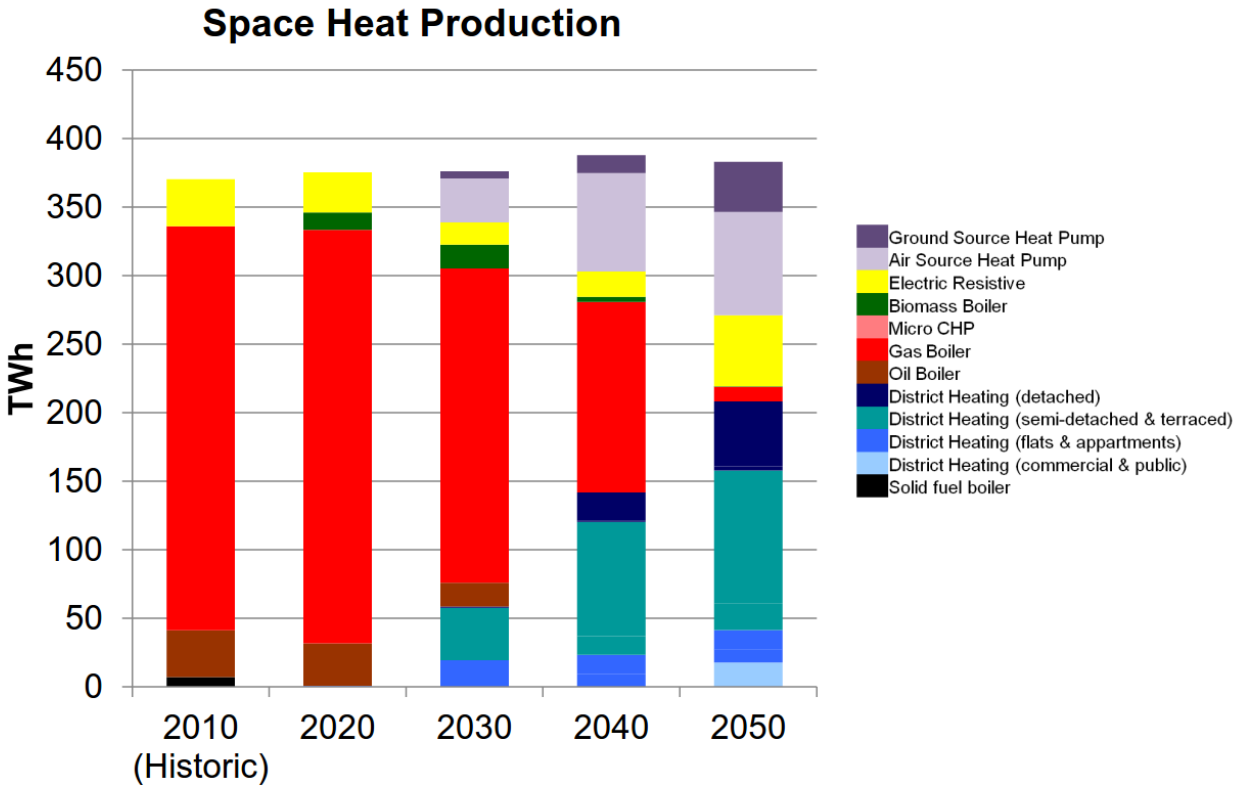
To what extent do you trust or not trust each of the following sectors to act in your best interest?



Why ‘Local Energy’

- **A route to sustainable energy provision**
  - through utilising energy locked up in the waste we produce and converting it to heat and power our communities
- **Uses district energy networks**
  - capture surplus and waste heat and distribute it to homes and offices
- **It’s affordable**
  - more efficient than centrally produced power or grid gas
- **It’s accountable**
  - because it’s locally owned

DE in Heat Strategy



DB v3.2 / Optimiser v3.2

Local authority role

- **Addresses statutory obligations**
- **Manage a property portfolio**
- **Major energy user/buyer**
- **Data holder/aggregator for own estate and others**
- **Trusted supplier**
- **Stakeholder manager**
- **Access to funding:** DHLS/ REIF / ECO / GIB / PPP

Case studies

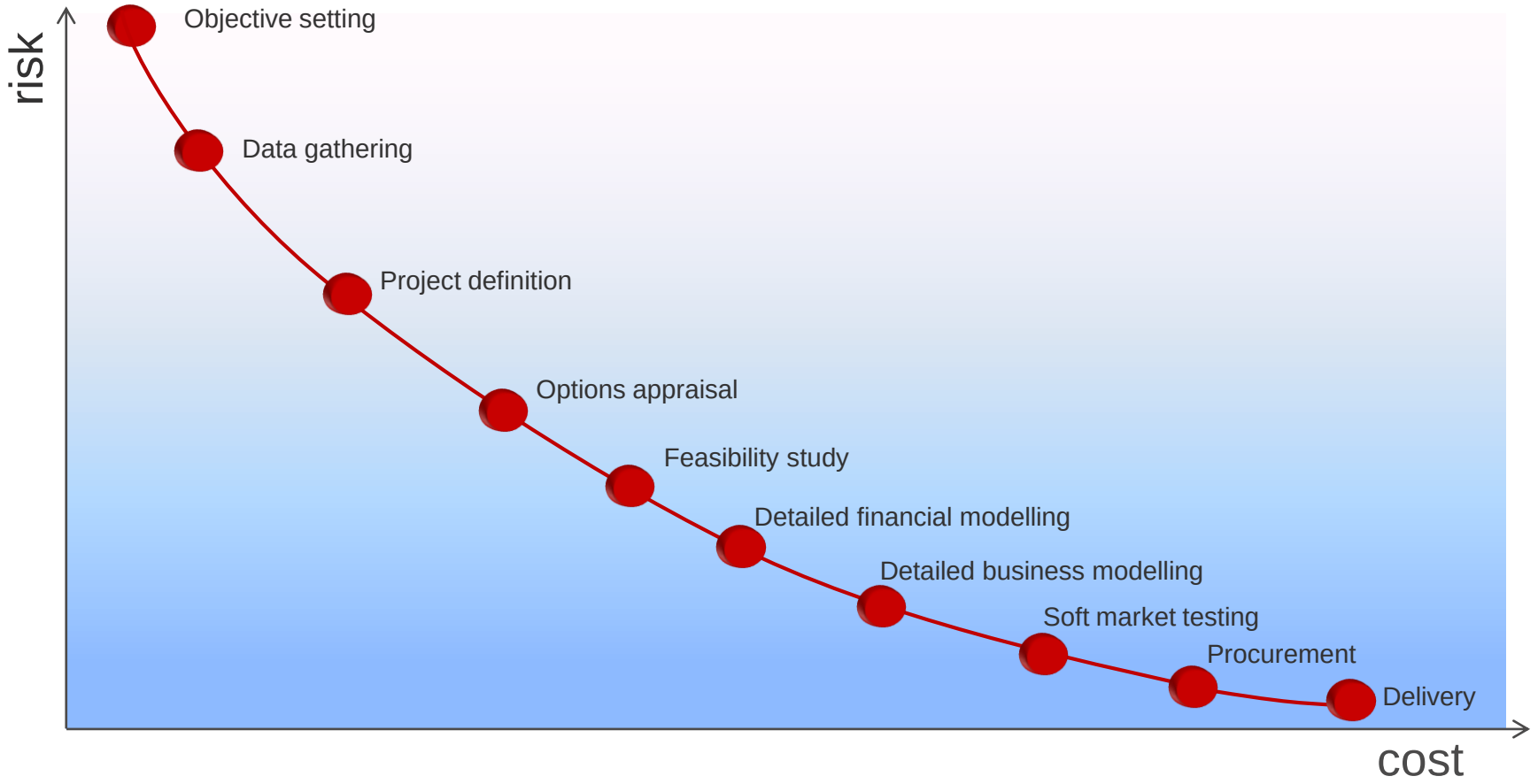
LONDON BOROUGH OF ISLINGTON

Bunhill Heat and Power

GATESHEAD COUNCIL

Town Centre District Energy Scheme

Project development process



Source: 'Community Energy: Planning, Development & Delivery', TCPA 2011

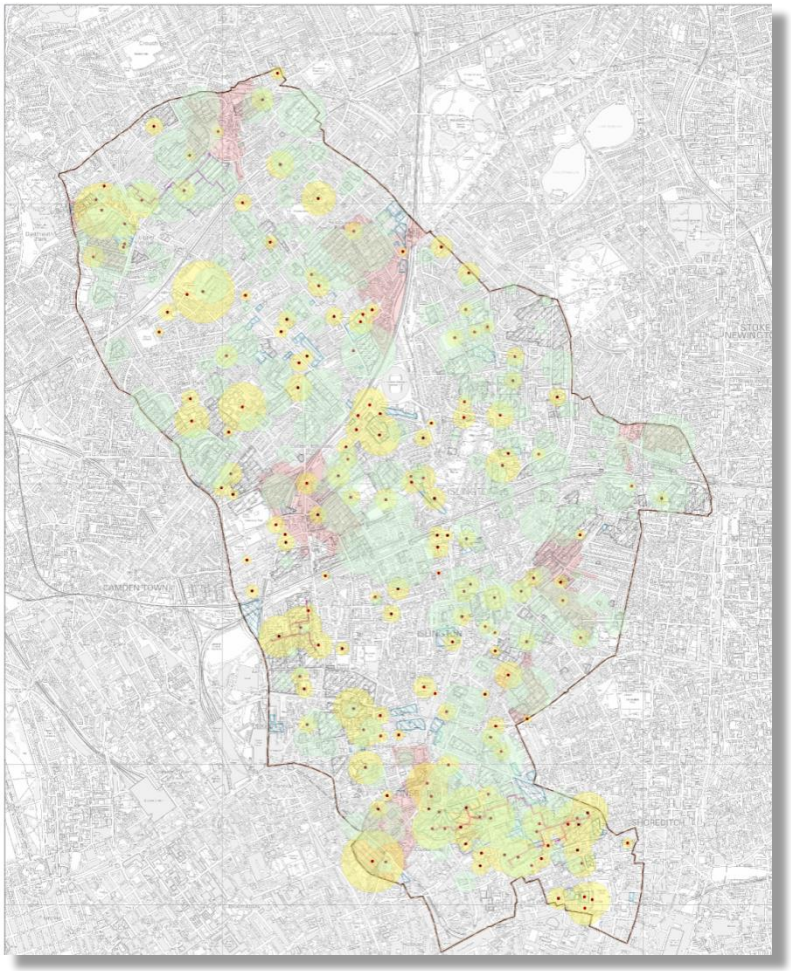
Islington Decentralised Energy Strategy

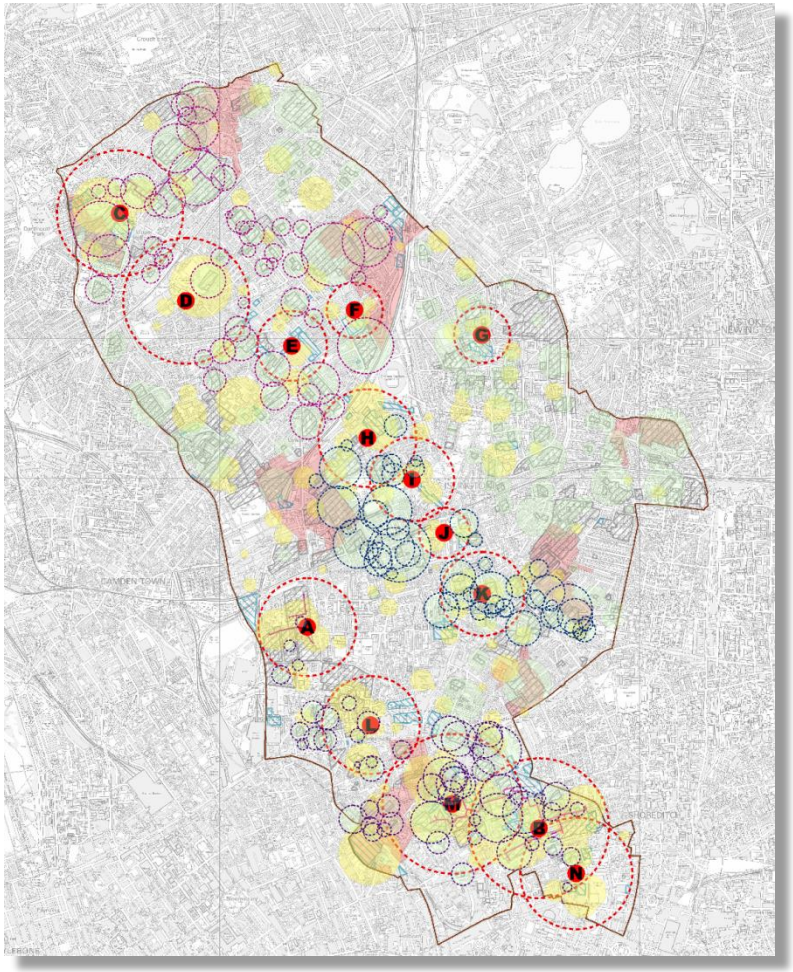
Aims of strategy:

- To inform the development of planning policy aimed at encouraging DE uptake
- To safeguard existing district and community heating systems for future connection
- To identify and preserve key energy infrastructure (i.e. potential energy centre sites)
- To ensure that the Borough is in the best position to make maximum use of available DE funding programmes when they arise
- To have a sound understanding of the commercial issues around DE deployment.

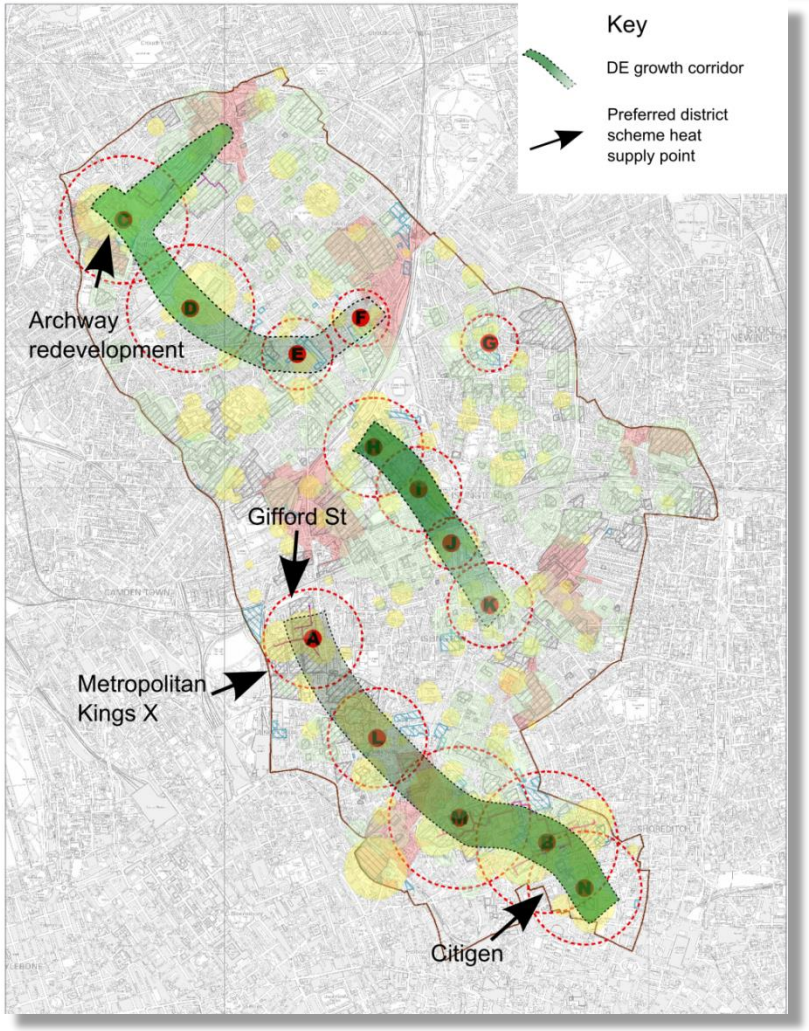
Energy centre looking north up Central Street (courtesy of Tim Ronalds Architects)

Islington Decentralised Energy Strategy

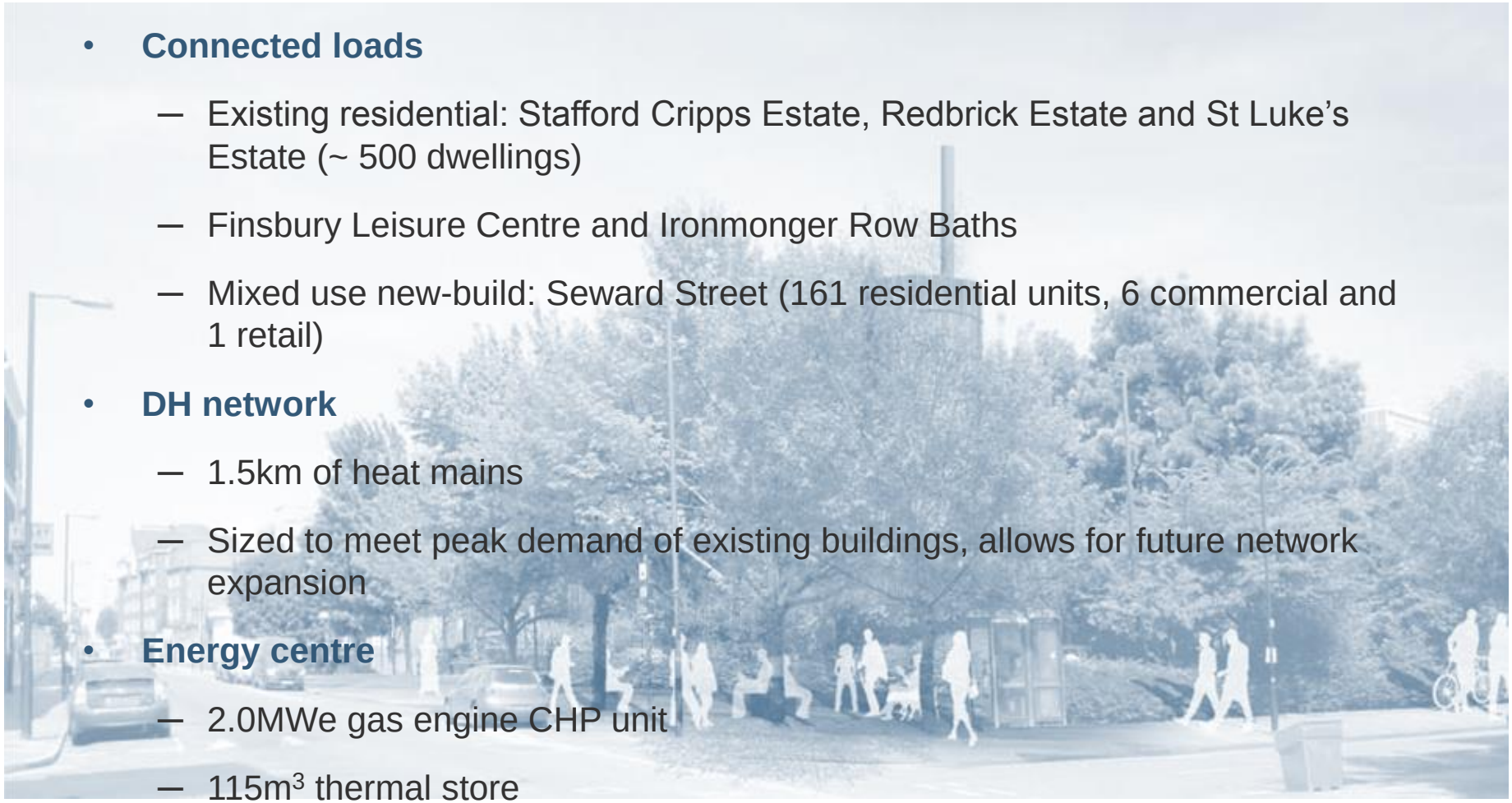




Islington Decentralised Energy Strategy

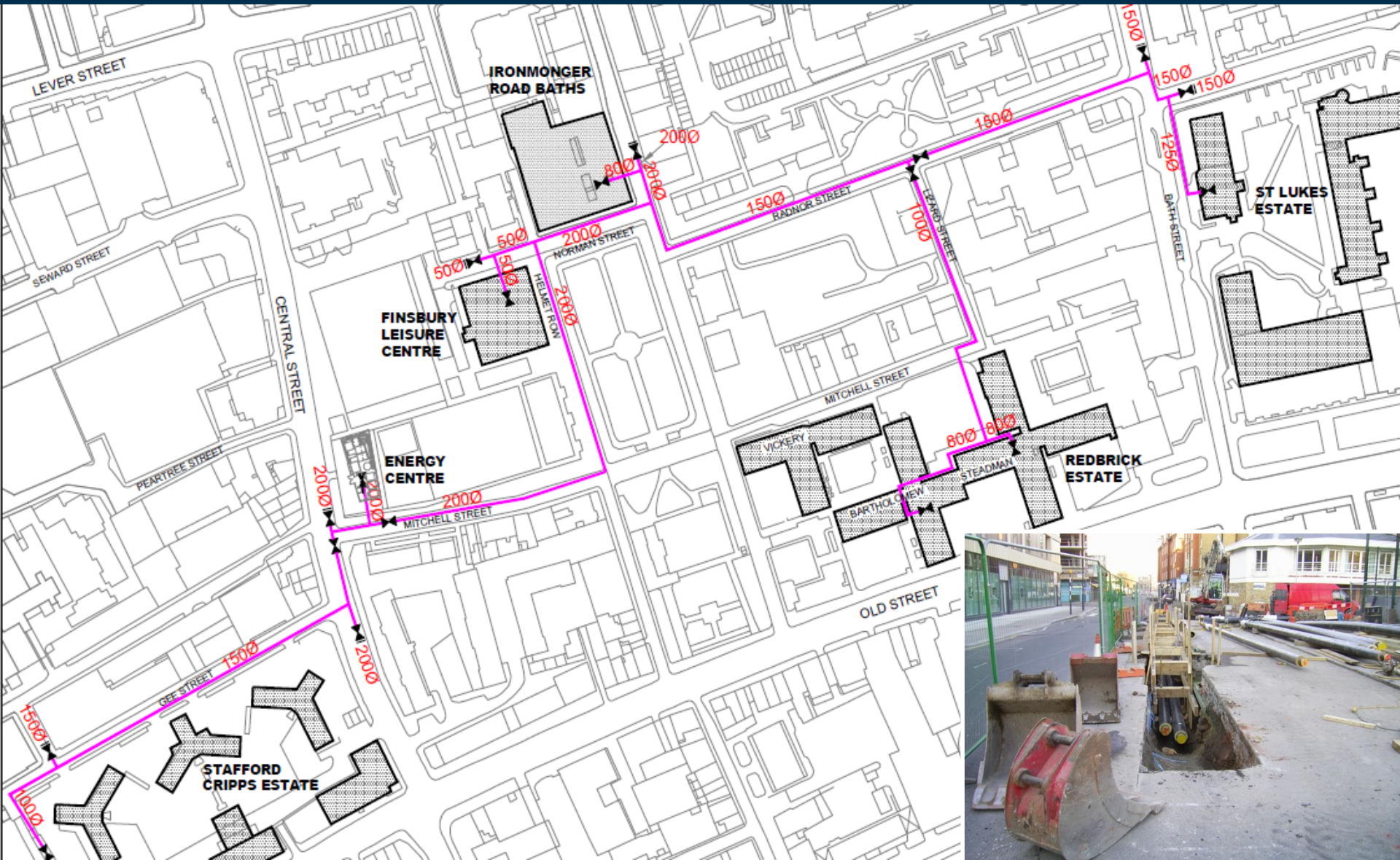


South cluster "B"



- **Connected loads**
  - Existing residential: Stafford Cripps Estate, Redbrick Estate and St Luke's Estate (~ 500 dwellings)
  - Finsbury Leisure Centre and Ironmonger Row Baths
  - Mixed use new-build: Seward Street (161 residential units, 6 commercial and 1 retail)
- **DH network**
  - 1.5km of heat mains
  - Sized to meet peak demand of existing buildings, allows for future network expansion
- **Energy centre**
  - 2.0MWe gas engine CHP unit
  - 115m^3 thermal store
  - Top-up and standby provided by local boilers

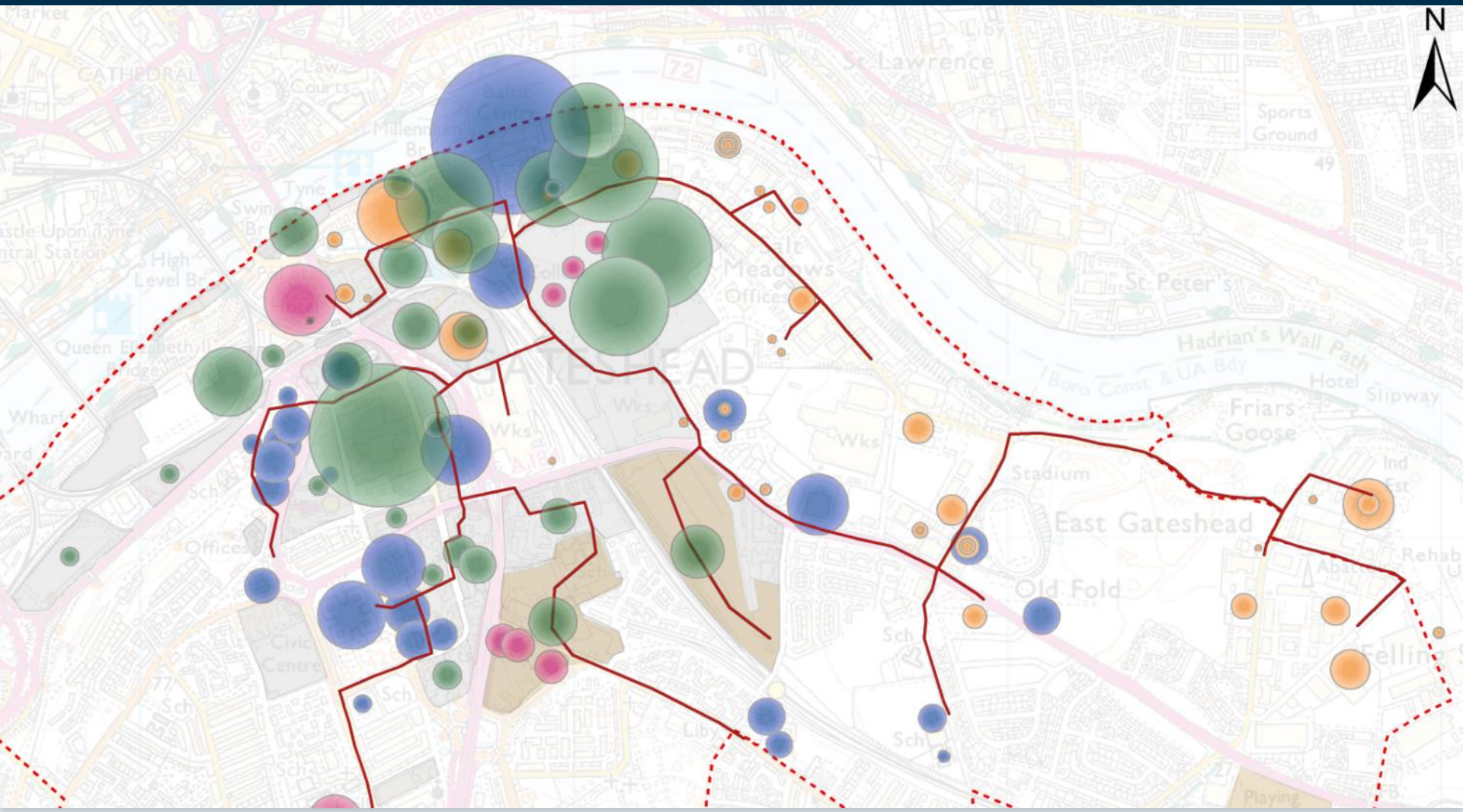
Bunhill Heat and Power



Bunhill Heat and Power

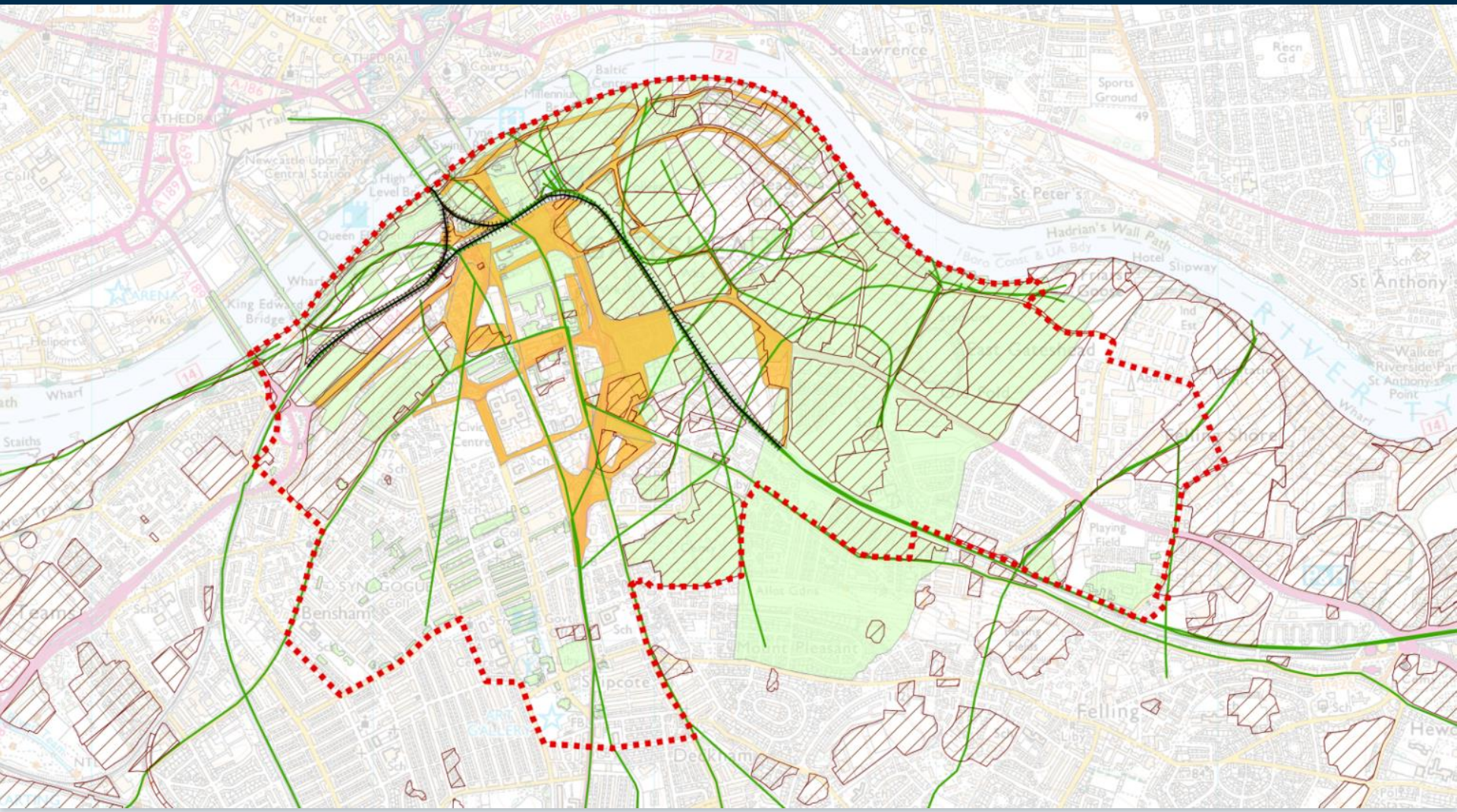
Gateshead Council

Map of heat demand in Gateshead



Gateshead Council

Constraints assessment



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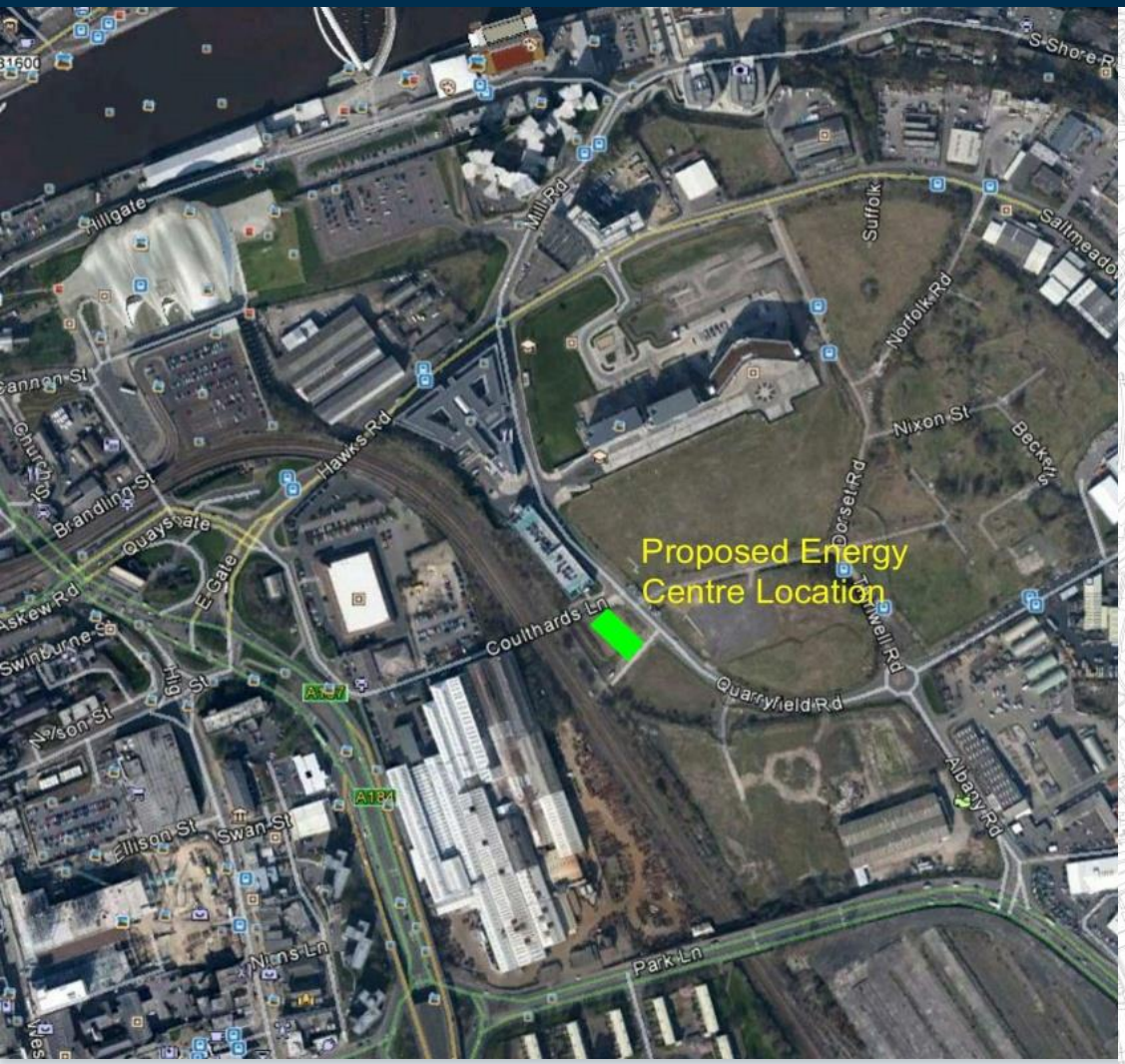
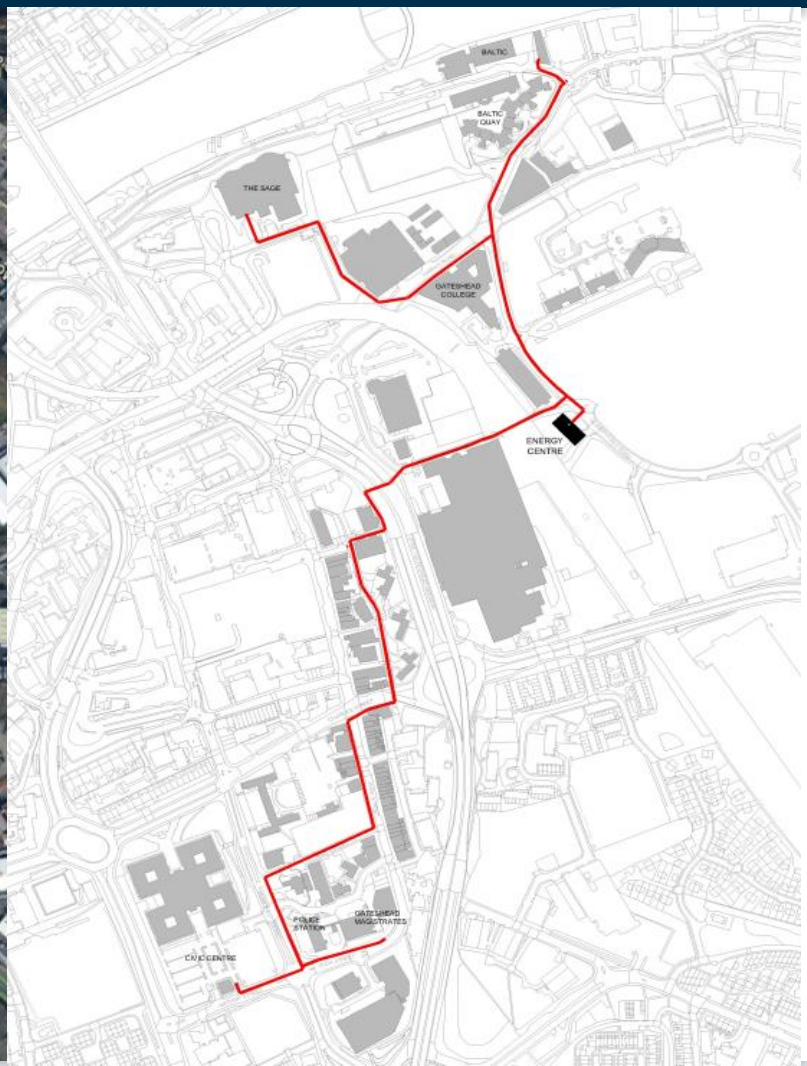
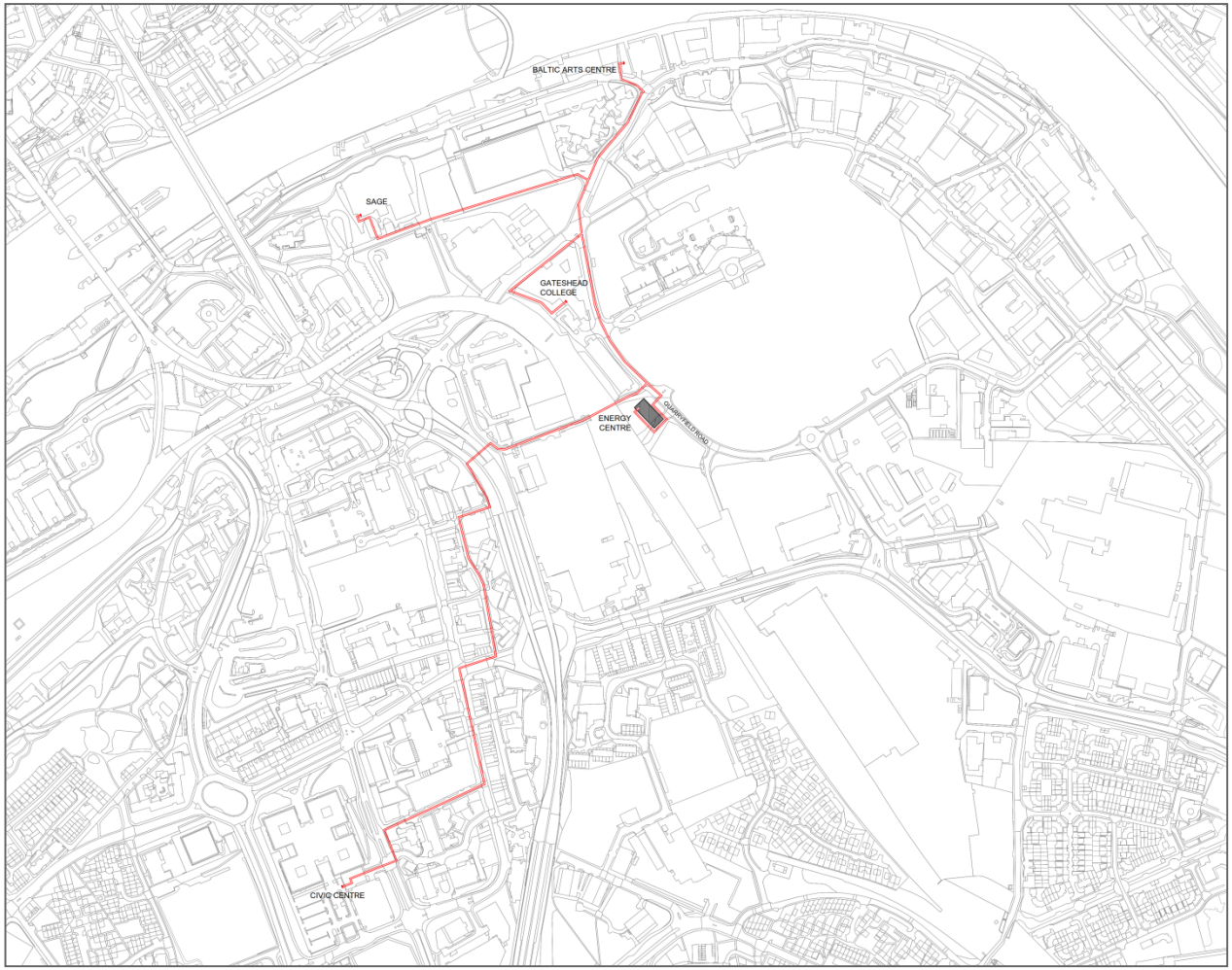
Strategic development – network flexibility

Gateshead Town Centre DE Scheme





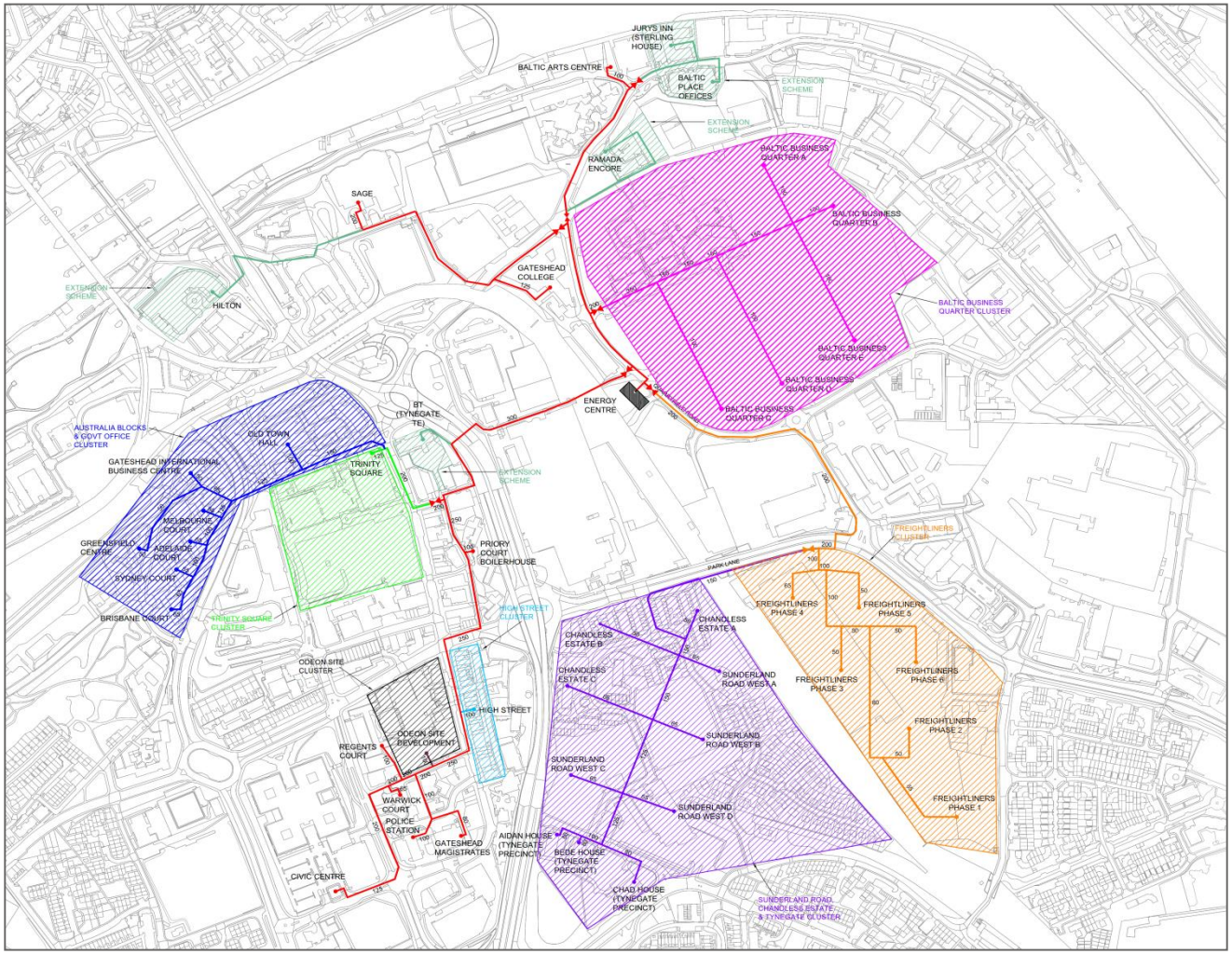
DE network – private wire network



Town Centre DE Scheme

- **Connected loads**
  - Existing residential blocks (replacing communal heating and individual gas fired systems in 400 dwellings)
  - Administration, legal and education buildings
  - Creative arts buildings
- **DH network**
  - 3km of heat mains initially, expanding to 8km
  - Sized to meet peak demand of connected buildings, allows for future network expansion
- **Energy centre**
  - 2.6MWe gas engine CHP unit
  - 2 x 135m^3 thermal stores
  - 2 x 7.0MW top-up and standby gas fired boilers

DE network – future expansion



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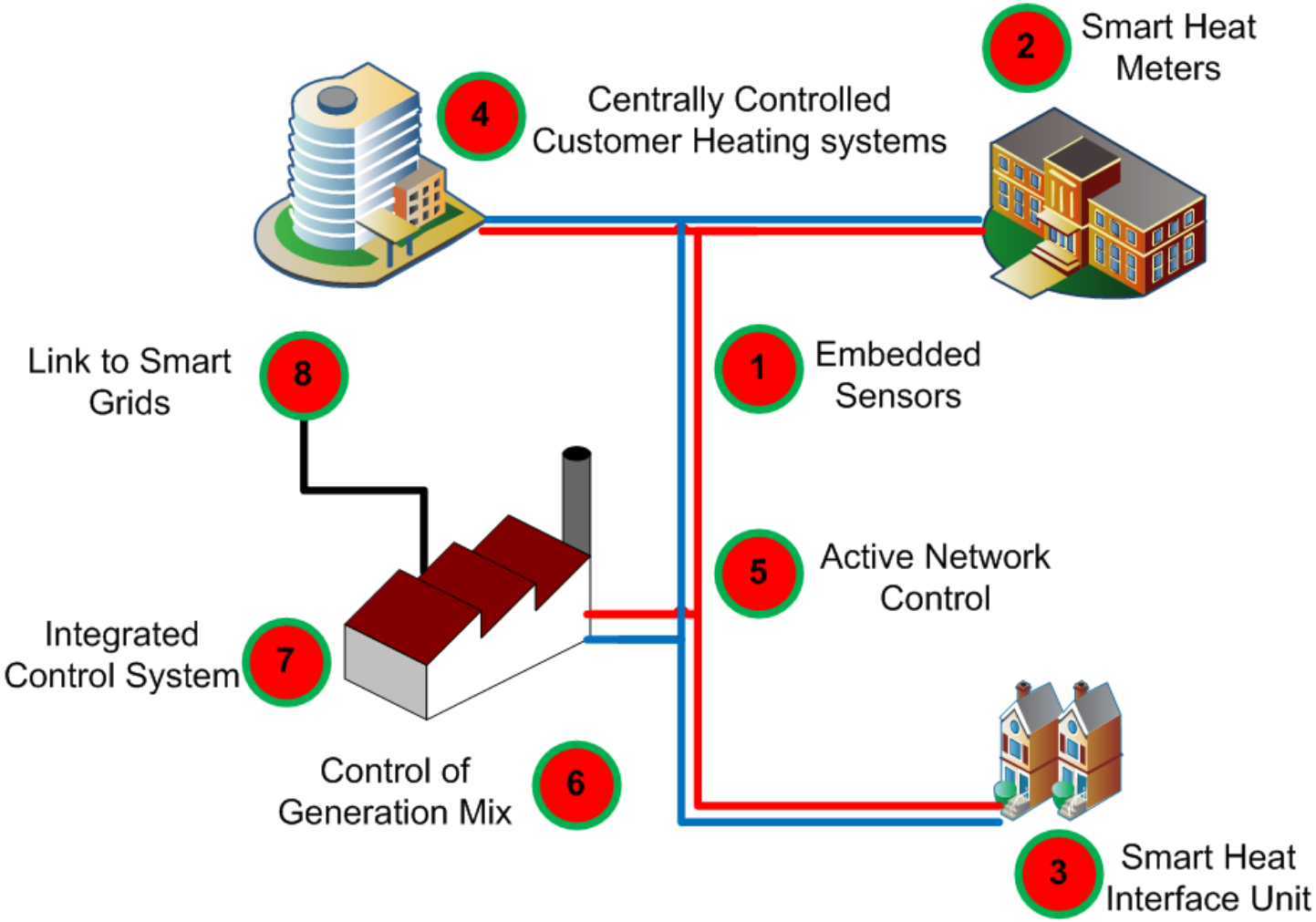
Gateshead Town Centre DE Scheme

What is a ‘smart’ heat network?

...a decentralised energy network with an ‘intelligent’ central control system that integrates data from the energy centre, district heating network, heat meters, heat interface units, customer heating systems and external sources to maximise the value of heat and power produced...

What makes a smart heat network



Embedded heat network sensors

Acquire operational and performance data to manage the system

- Flow and return temperature
- Differential pressure
- Flow rate
- External temperature
- Leak detection

Smart heat meters

- Interface between the central control system and the smart heat interface unit
- Manages data on heating demand patterns that can help to improve supply management
- Has local control logic to modify customer demand patterns
- Simplifies metering and billing for supplier and customer
- Variable tariffs to incentivise responsible use
- Real time and historic energy use

Smart heat interface units

- Integrated with the smart heat meter and customer heating systems
- Controls the supply to customer heat and hot water systems in response to variations in demand or price in order to derive the greatest value from the system
- Contains local control logic to assist with demand management

Centrally controlled customer systems

- Heating control linked to the central control system, via smart meter and heat interface unit
- Can allow sequencing of heat supply between individual buildings to reduce instantaneous peak – utilises thermal inertia of building to maintain internal temperature
- Altering of flow rate to maintain network temperature differential
- Can control hot water generation and storage to smooth peaks and improve efficiency of central plant operation

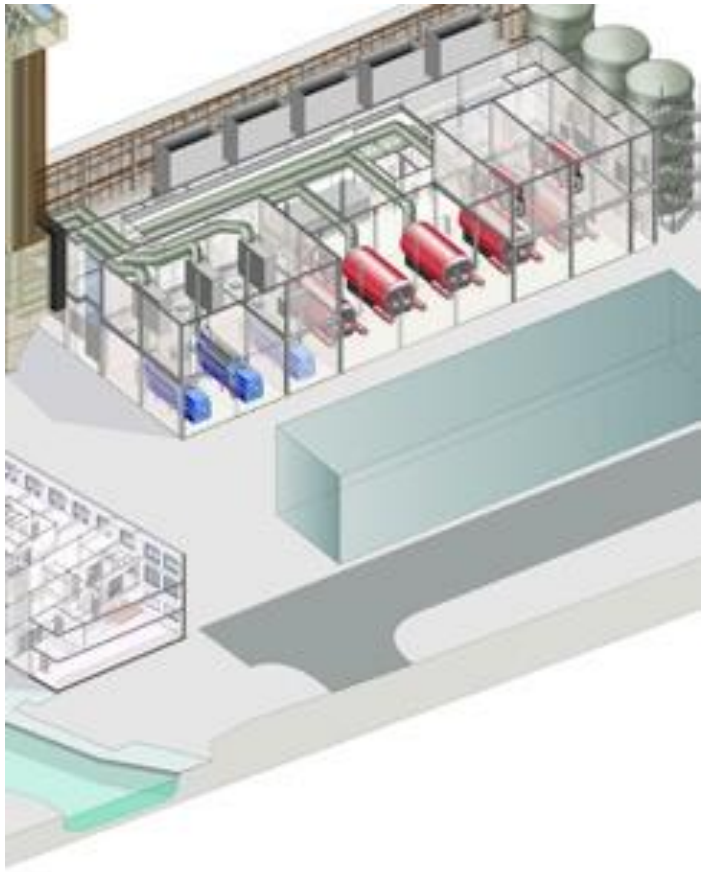
Active heat network management

- Distributed heating network control
- Uses data from network sensors to automatically modify the network control to improve operational efficiency and or capacity.
- When combined with information from the central control system and smart meters it is possible to further regulate supply to improve system operation

Control of generation

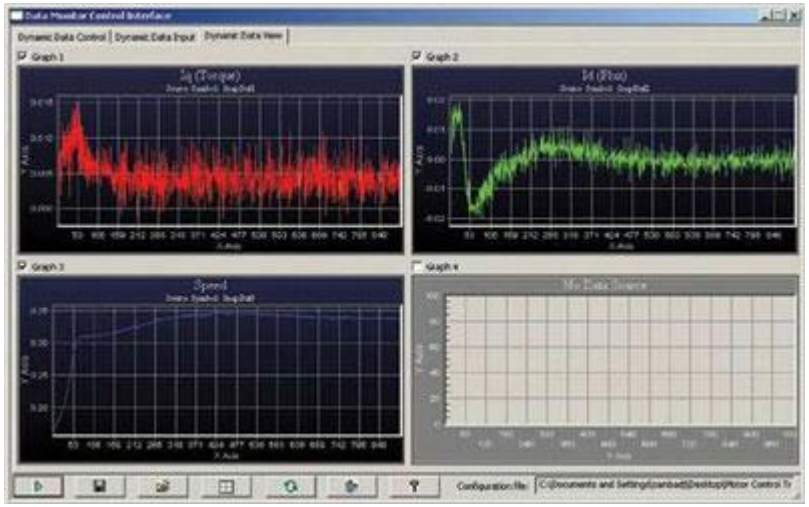
- Controls the operation of the energy centre generation and storage, based on data gathered from network sensors and customer smart meters.

- Use external and internal data to inform best value generation mix
  - CHP
  - Heat Pump
  - Electrode Boiler
  - Energy Storage
  - Boilers



Integrated heat network control

- Integrated network control platform that uses data from:
  - Customer heating systems
  - Smart heat interface units
  - Smart heat meters
  - Network sensors
  - Energy Centre
  - External sources
    - Temperature forecasts
    - Utility prices
    - Triads



Linking to smart electricity grids

- Energy Centre can supply local smart electricity grids
- Smart heat network can respond to signals from smart grid to maximise value of heat and power produced
- Use smart electrical storage to further improve value from smart DH network
  - EV charging
  - Batteries
  - Compressed air

How do Smart Heat Networks create value ?

- Control demand to allow CHP operation when value of electricity is greatest
- Reduce peak demands
- Increase efficiency of CHP plant
- Variable user tariffs to incentivise use patterns
- Better understanding of system operation
  - Prolong asset life
  - Real time performance assessment
  - Proactive maintenance
- Integration with smart electricity grids


Questions...

Heat Network Partnership – Technical Workshop

Heat network delivery in London

Case studies and key issues

Stephen Cook, Arup Energy and Climate Change Consulting

28 May 2014

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Contents

- London’s DE delivery programmes
- Heat sources for urban settings
- Planning practicalities
- Commercial issues

London’s DE delivery programmes

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London strategic and policy context

Target to meet 25% of London's energy needs from decentralised energy sources by 2025

New development subject to Mayor's energy hierarchy in London Plan:

1. Be lean: use less energy
2. Be clean: supply energy efficiently
3. Be green: use renewable energy

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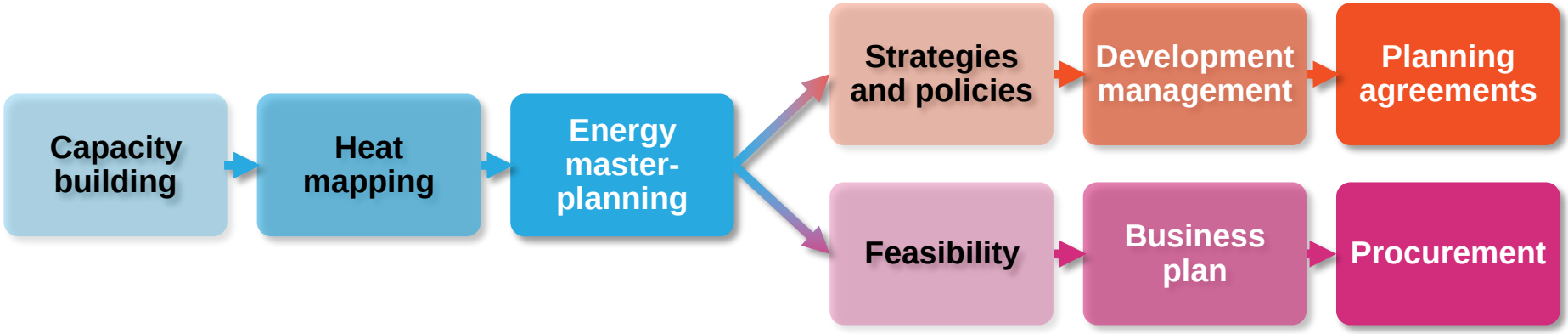
London DE Masterplanning (DEMaP) programme

Capacity building – training and ongoing support to local authority staff

Heat mapping – grants to boroughs with ongoing support

Energy masterplanning – techno-economic modelling of key opportunity areas

Planning advice – local DE policies and safeguarding future connections for DE opportunity areas



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Outcomes of DEMaP

Corps of knowledgeable local authority planners and energy officers

Guidance documents on energy masterplanning and project delivery

Growing integration between development planning and infrastructure investment

A pipeline of DE projects

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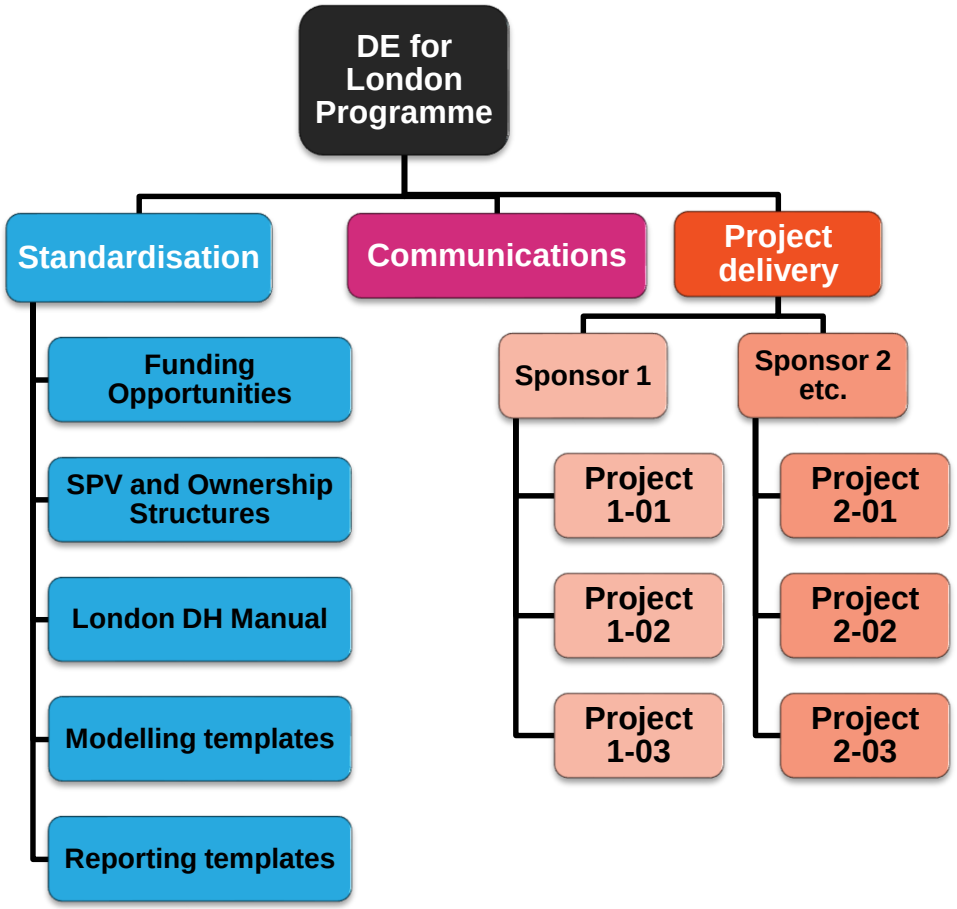
DE Project Delivery Unit (DEPDU)

GLA £3 million, 3-year programme for DE project development which is delivered as a free service to project sponsors. The programme operates through a single delivery team for the whole programme.

Key roles:

- Project initiator: GLA team
- Technical analysis and project advice: Arup DEPDU team
- Project sponsor: London boroughs



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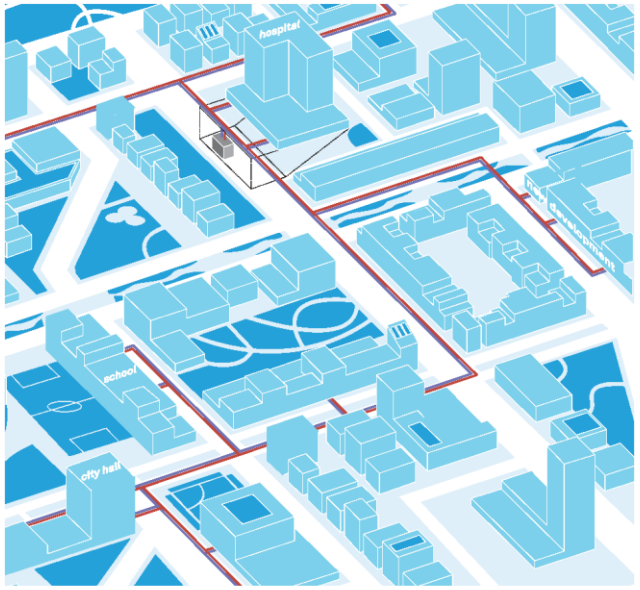
Support provided on DEPDU

The programme provides technical, financial and commercial assistance to Project Sponsors (borough councils or other organisations). Multiple projects for each sponsor may be supported.

In addition, the programme undertakes a number of standardisation workstreams which support its mission to provide common replicable documentation, processes and procedures.



LONDON HEAT NETWORK MANUAL

MAYOR OF LONDON

Co-funded by the Intelligent Energy Europe Programme of the European Union

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Achievements and key issues

1. Over £30 million in project delivery secured though DEPDU support, with significant progress on CHP from existing large scale DE sources
2. Programme structure has low transaction cost for each task order and allows for flexibility during task delivery
3. Standard methods and management processes and production of Heat Network Manual
4. Programme success depends on GLA leadership and a clear and consistent vision
5. Project success depends greatly on sponsor's capacity and commitment
6. Successful projects have not recapitalised programme funds

Heat sources for urban settings

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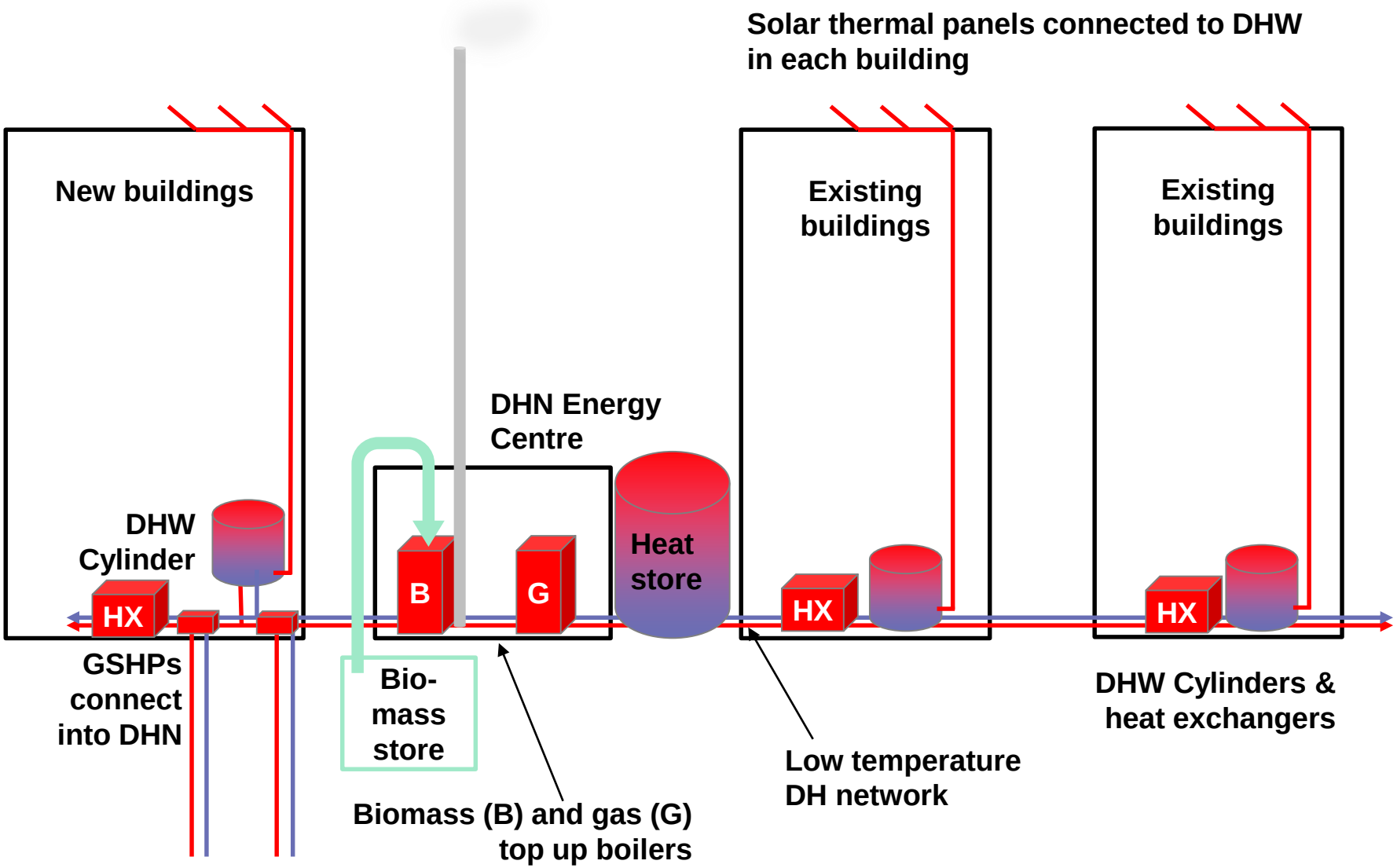
Gas vs. low carbon heat sources

- Gas – proven, space efficient, simple, with mature supply chain
- LC heat sources – emerging technologies / supply chains, more complex, not conventionally cost competitive
- Grid decarbonisation will eliminate any carbon savings from gas CHP.
- London study:
  - secondary heat about equivalent to total heating demand (70 TWh/yr);
  - nearly half can be used with DHNs (30 TWh/yr)

Low carbon alternatives to gas in urban areas

Option	Whole or part heat solution?	Energy costs	Capital costs	Space impact	Air Quality Impact
Solar Thermal	Part	✓	✓	≈	✓
Water source HP	Part	≈	≈	✗	✓
Other secondary heat	Part	≈	≈	✗	✓
Ground source HP	Part	≈	≈	✗	✓
Deep geothermal	Part	≈	✗	≈	✓
Energy from Waste	Whole	✓	✗	✗	✗
Biomass boilers	Whole	≈	✓	≈	✗/✓
Air source HP	Part	≈	✓	≈	✓

Integrated heat strategy - 1



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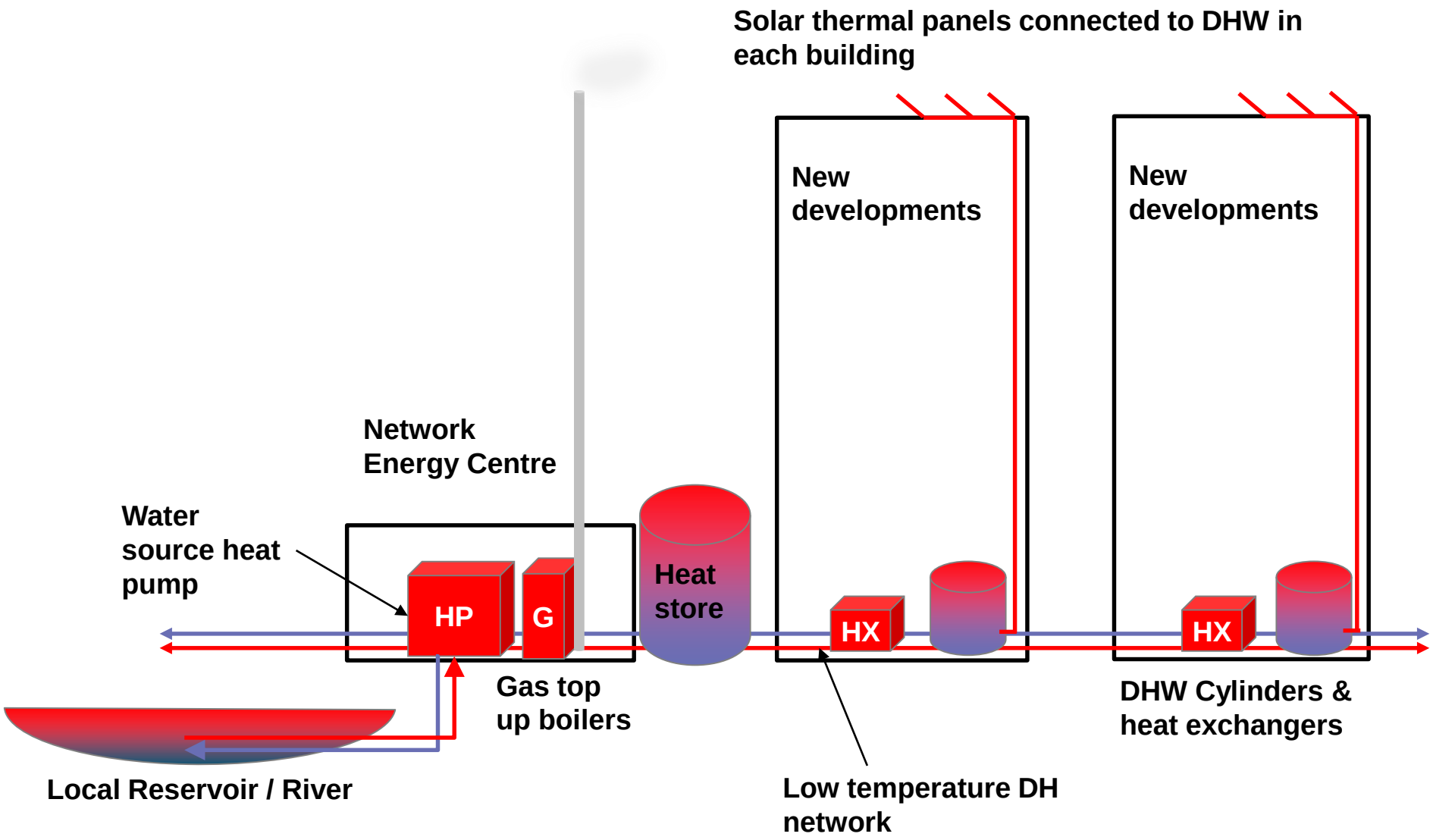
Integrated heat strategy - 2



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Planning practicalities

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Role of policy and planning decisions

- Evidence base needed to identify the potential for DHNs
- National and local planning policy preference for DHN connections (energy hierarchy)
- DM policy requires evidence of efforts to identify / connect to local DHNs
- Planning decisions incorporate energy strategy commitments
  - specifying wet / communal systems
  - safeguarding future DHN connection route
- Planning agreement includes:
  - right/obligation to connect (reasonable endeavours basis)
  - regular review of energy strategy
  - contingency position if no DHN in time

Commercial issues

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Concession arrangement

Brent are currently procuring a decentralised energy scheme for approximately 2500 homes.

DEPDU support:

- Pre-feasibility
- Feasibility modelling
- Detailed technical advice
- Contractual advice
- Procurement support
- Legal HoTs

"The Decentralised Energy for London programme has helped us realise our DE potential and has assisted us in bringing this project to market."

Joyce Ip, Regeneration Project Manager, London Borough of Brent

Local authority led scheme

The Euston Road scheme in Camden is anchored on a major new development and will be delivered by LB Camden.

Planning powers were key for catalyzing scheme.

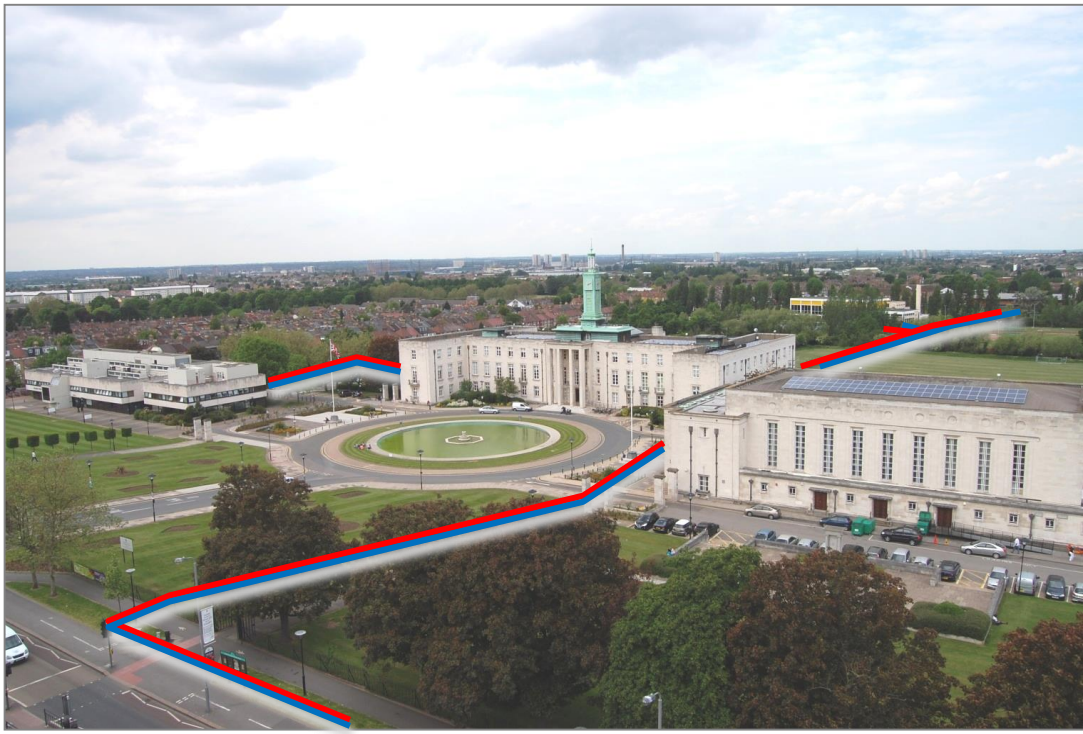
Following the DEPDU package of support, Camden elected to directly procure advice to complete the delivery of the project.

Challenges of suburban densities

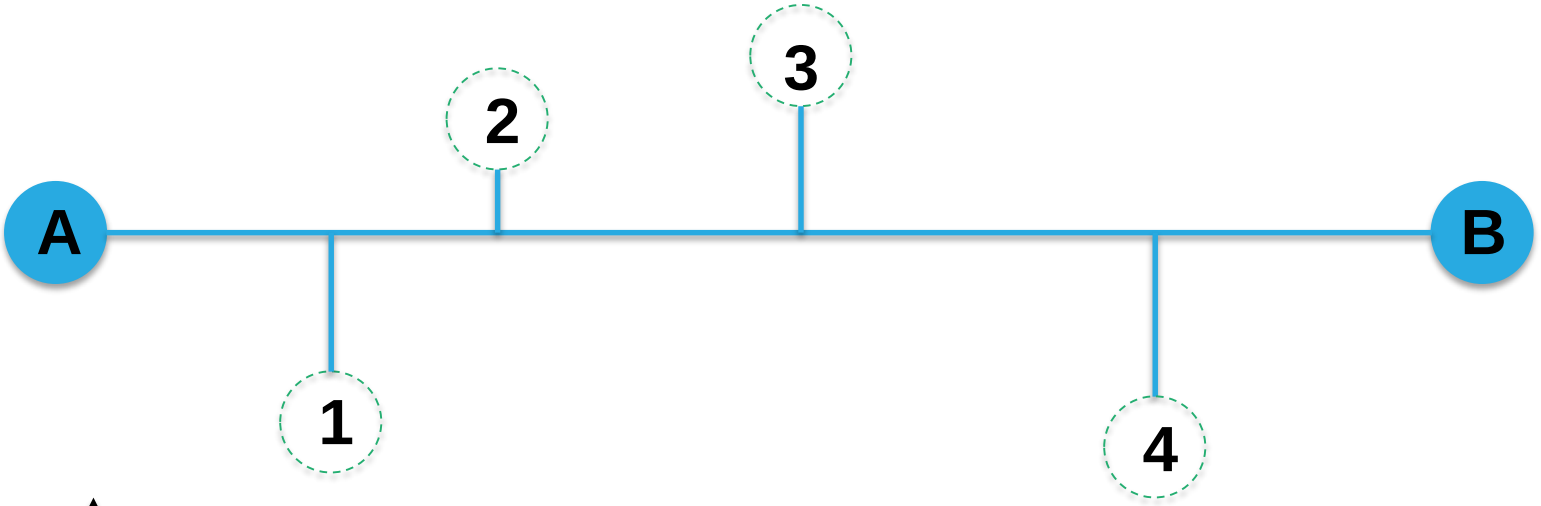
DEPDU analysed several opportunities in Waltham Forest in NE London.

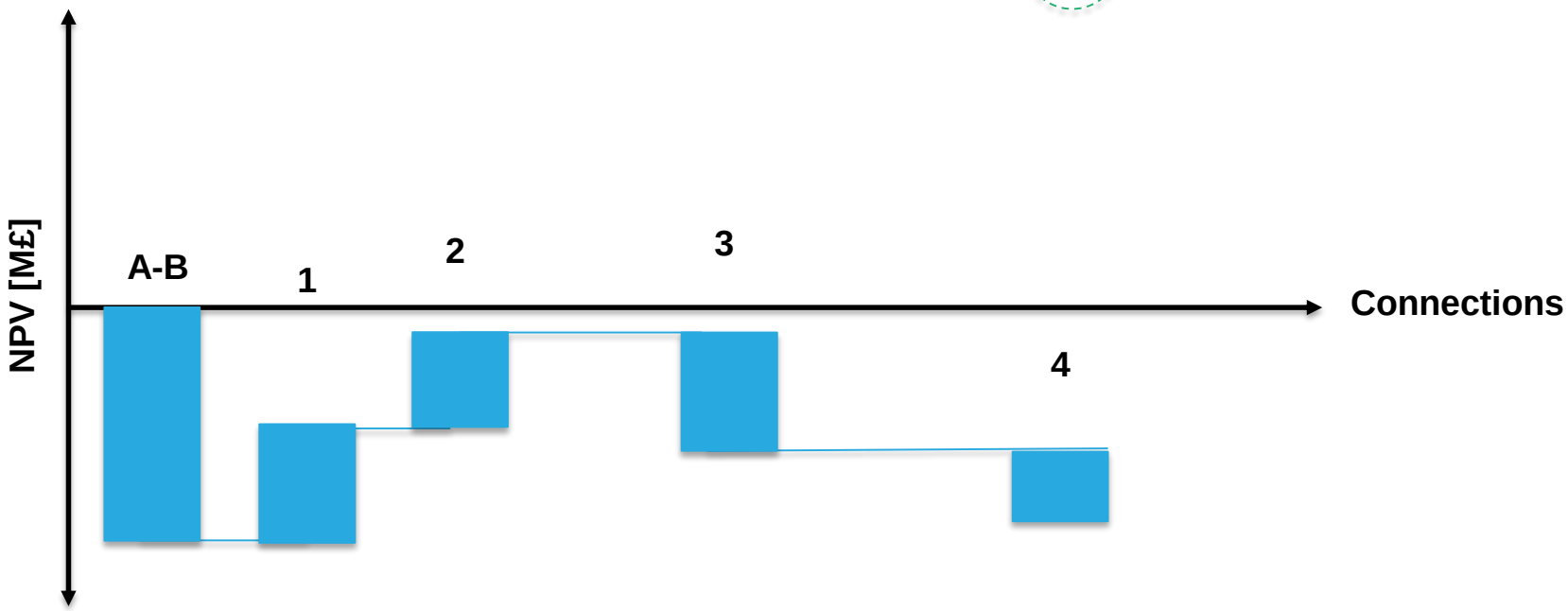
The area also provides limited potential for low carbon heat.

Returns on investment tended to erode as the scheme grew due to relatively low densities of demand.

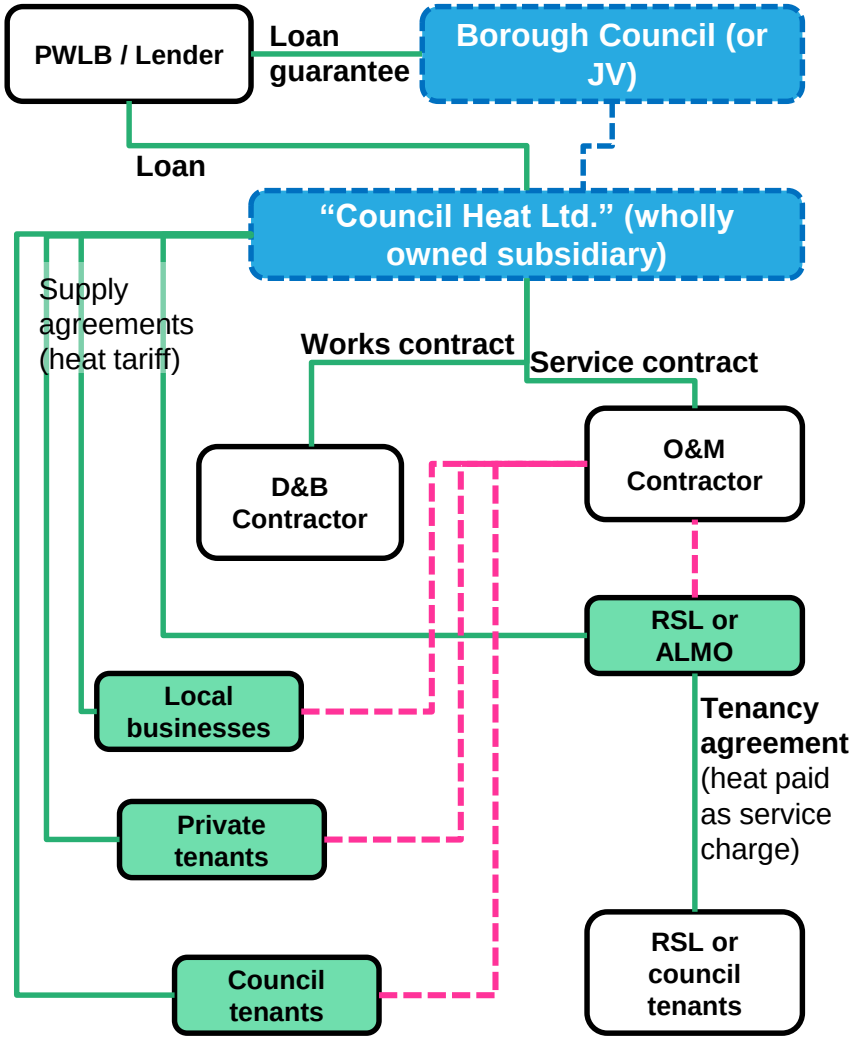


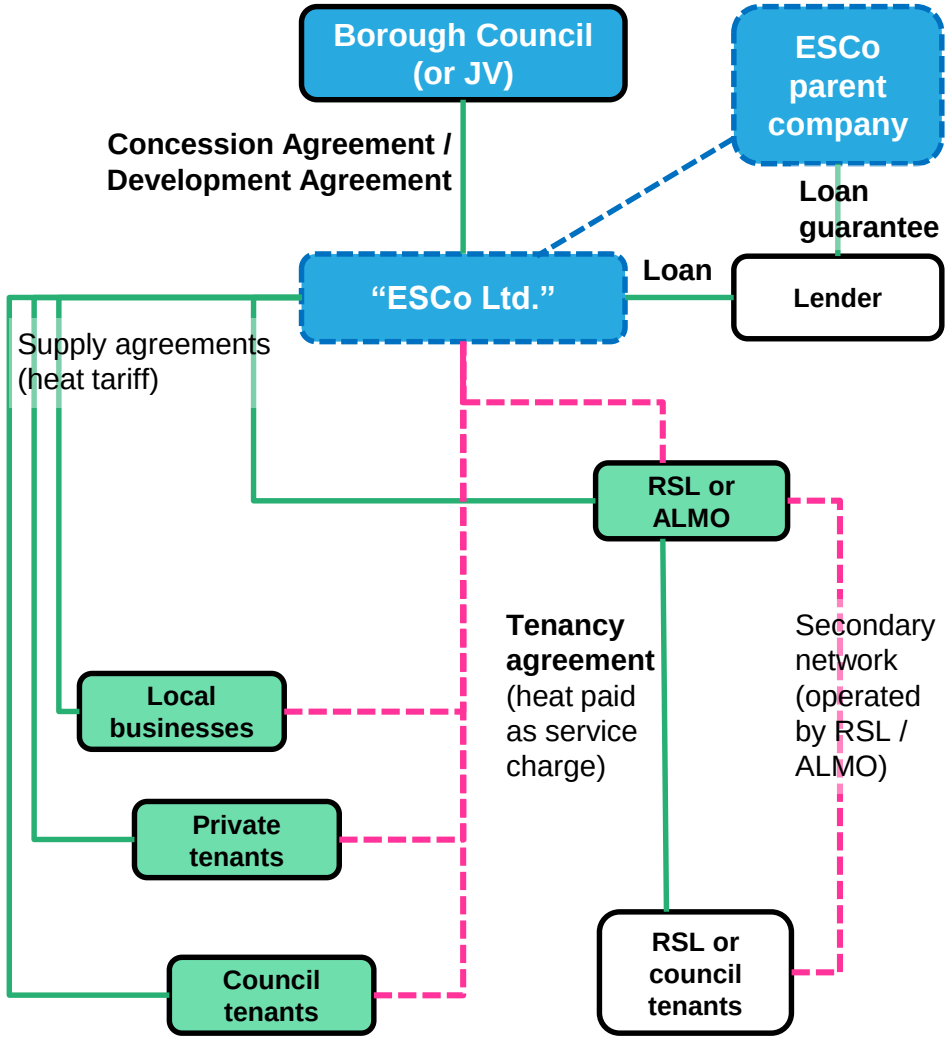
Project viability tipping point





Commercial models





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Conclusions

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Conclusions

- The market for DH is growing but is still very small
- Heat network delivery at scale needs large scale coordinated programmes
- Local authorities must be involved but many lack resources / capacity / commitment
- Complexity is high and rising

Thank you

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Heat Network Partnership – Technical Workshop

Heat Network Partnership – Technical Workshop

Michael O'Neill, Craighall Energy

Heat Network Partnership:

Technical Workshop

District Heating Feasibility Studies

28th May 2014

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Agenda

- **Background & Introduction**

- **Deliverables From a Typical DH Feasibility Study**
  - Project Plan
  - Individual & Complex Projects
  - Site Survey: Determination of Existing & Future Heat Requirements
  - Energy Model: Development of Heat & Power Profiles
  - Heat Network Options
  - Typical Energy Centre Layout, Plant Room Adaptation, Network Design and Specification
  - Typical DH Scheme Options for on-site and off-site Energy Generation
  - Outline & Full Business Case Deliverables
  - Typical Procurement Considerations (Time Permitting)

- **Summary & Conclusion**

Background & Introduction

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RES Framework: District Heating & Decentralised Energy Specialists

- Resource Efficient Scotland recently appointed a Framework of 8 Consultants to provide technical support on decentralised energy (DE) and district heating (DH)

- Specific pieces of work will be procured through this framework by mini-competition
  - strategic support to accelerate the development of DH and DE projects in Scotland
  - Focussed on enabling organisations to implement DE projects and assisting in the promotion of best practice

- **This presentation will focus on the inputs and outputs from a typical District Heating Feasibility Study…….**from high level feasibility to more detailed pre-design report covering detailed cost benefit and technical analysis

- Examples are provided to define a route map for Local Authorities, NHS, Universities or RSL's prior to construction of a district heating system

Decentralised Energy Master-planning – Akin to the RIBA Plan Of Work

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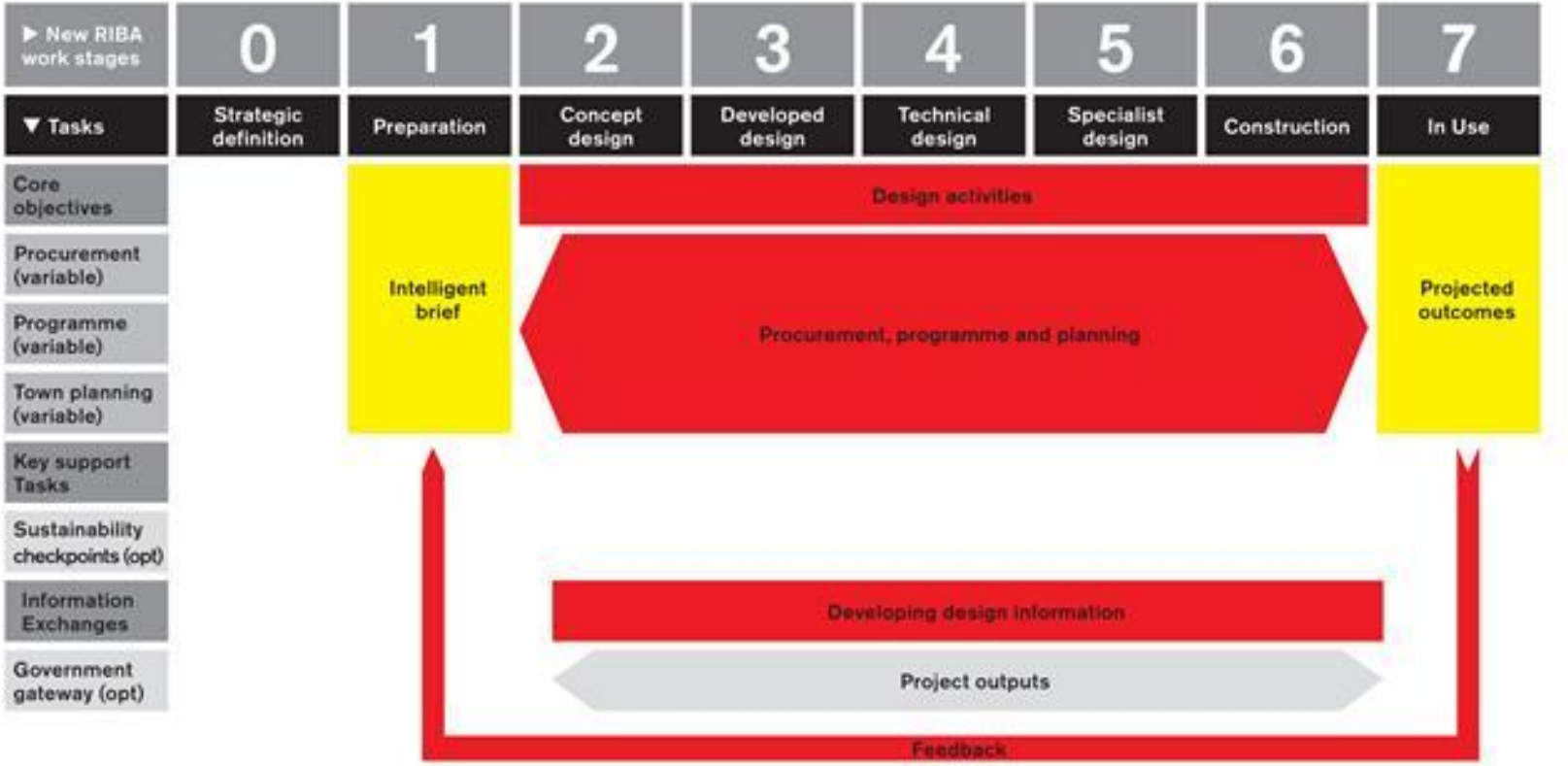

Components of A Simple District Heating Network

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Energy Centre

- Supply, installation and commissioning of the CHP Generator including LV/HV power systems
- Supply and commissioning of Boilers
- Builders Work/Structural upgrading
- Supply and installation of acoustic enclosures, ventilation/cooling equipment, access platforms
- Supply and installation of pipework, pumps, valves
- Supply and installation of control panels, control sensors, fire and gas alarm systems and associated electrical wiring works.
- Electricity, gas and water connections

DH Pipe

- Supply and installation of District Heating mains system including pre-insulated pipework materials pipework installation, and associated civil engineering work

Building

- Supply only of pipework, valves, heat exchanger etc
- Supply of heat interface units
- Supply of radiators
- Installation of pipework, pumps and valves heat exchanger heat interface units, radiators etc

Sources of Decentralised Energy

- Anaerobic Digestion (AD)
- Photovoltaic Panels (PV)
- Combined Heat & Power (CHP)
- Tri-generation: Combined Cooling, Heating, and Power (CCHP)
- Heat Pumps
- Wind Turbine
- Hydrogen Fuel Cells
- Hydrogen Mini Grid Supply for vehicle use
- Energy from Waste
- Solar Thermal Heating
- Gasification of bio-fuels

Thermal Generation, Transmission & Distribution

- Natural Gas Boilers
- Biomass Boilers
- Bioliquid Boilers
- Biogas Boilers

- Biomass CHP
- Bioliquid CHP
- Biogas CHP
- Natural CHP

- Ground, Water & Air Source Heat Pumps

- District Heating for heat distribution
- District Cooling networks
- Smart Electricity Grid Networks
- Smart Metering and Automated Billing

DH Feasibility Studies: Typical Project Plan

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Typical Client Project Plan

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Workstream 3: Development of District Heating Feasibility	
	Port Dundas/Craighall Only
3.1	Thermal Energy Demand Assessment
3.2	Preliminary DH Network Options Development
3.3	Identify preferred DH Network(s) option
3.4	Develop Financial Information for preferred Option
3.5	Project Financial Appraisal
	Queens Cross/Port Dundas/Craighall/Sighthill
3.6	Thermal Energy Demand Assessment
3.7	Preliminary DH Network Options Development
3.8	Identify preferred DH Network(s) option
3.9	Develop Financial Information for preferred Option
3.10	Project Financial Appraisal
	City Centre North
3.11	Thermal Energy Demand Assessment
3.12	Preliminary DH Network Options Development
3.13	Identify preferred DH Network(s) option
3.14	Develop Financial Information for preferred Option
3.15	Project Financial Appraisal
	Combined Scheme (North Glasgow & City Centre North)
3.16	Thermal Energy Demand Assessment
3.17	Preliminary DH Network Options Development
3.18	Identify preferred DH Network(s) option
3.19	Develop Financial Information for preferred Option
3.20	Project Financial Appraisal

STAGE 4: RECOMMENDATIONS AND FINAL REPORT

Workstream 4: Recommendations & Final Report	
4.1	Phasing and Delivery Plan
4.2	Funding Options
4.3	Possible Role and Remit of an Energy Partner
4.4	Possible Role and Function of an ESCo
4.5	Next Steps
4.6	Final Recommendations

Typical Deliverables: DH Feasibility Study

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1) Review and Verification of **Existing Client Energy Data** (Heat & Electricity)

2) **Site Survey** & preparation of a Bespoke Baseline **Energy Model**

3) **Technical Review** of Suitable Thermal Generation & Power Options

4) Review of **Constraints or Barriers** to Decentralised Energy Options - steam/hot water, Flow/Return temps, plant rooms adaptations, DNO Capacity, availability of infrastructure e.g. gas grid etc.

5) **Connectivity** with other local DH Networks (to feed or receive heat)

6) **Socio-Economic & Environmental Benefits Appraisal** – CAPEX/OPEX, NPV, IRR, CO2 Benefits etc.

7) **Recommendations**, Risk Register, Stakeholder Engagement Plan

8) **Route Map** with Procurement/Delivery/Funding Strategy

Deliverables:
Individual & Complex Projects

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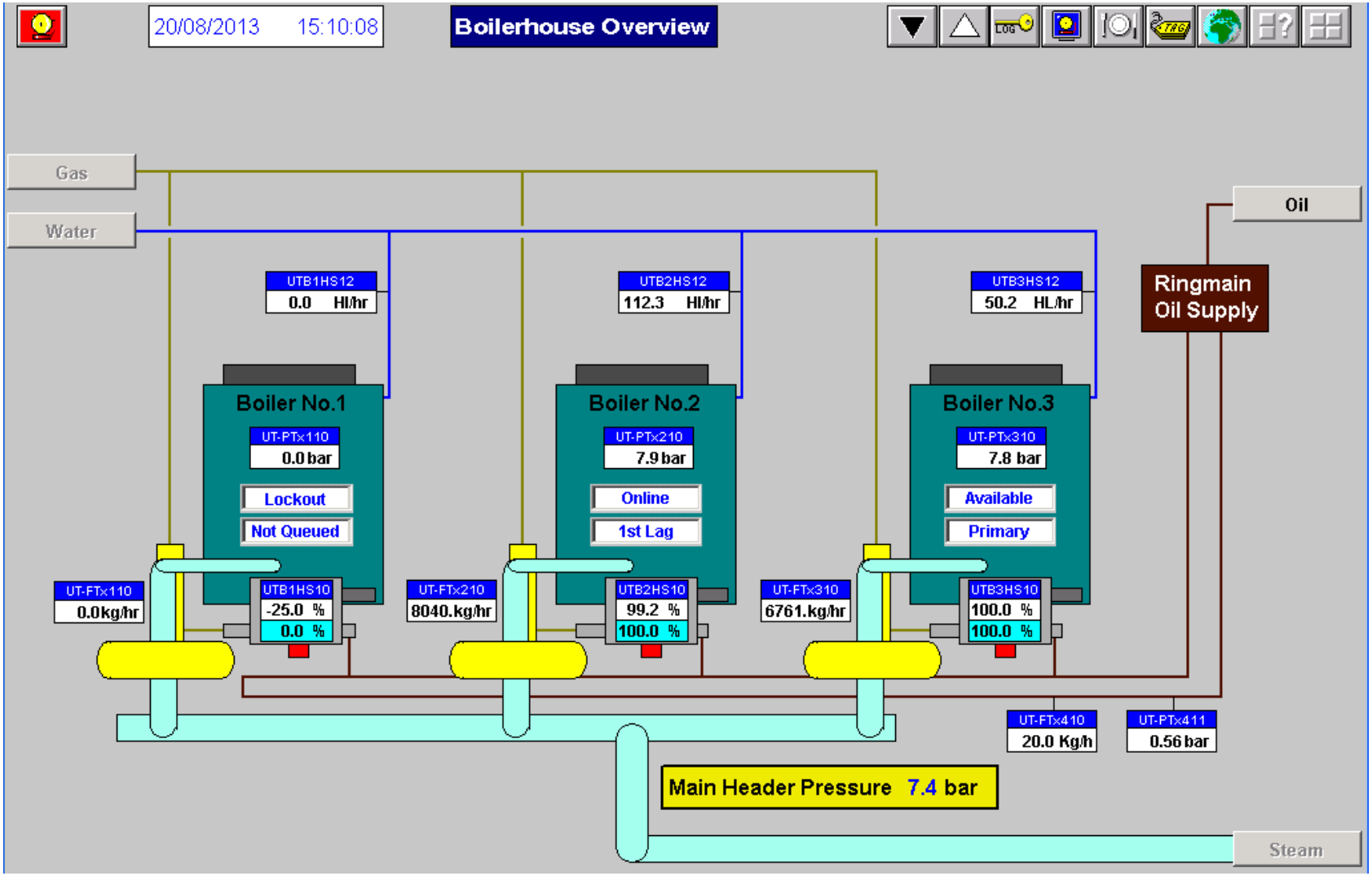
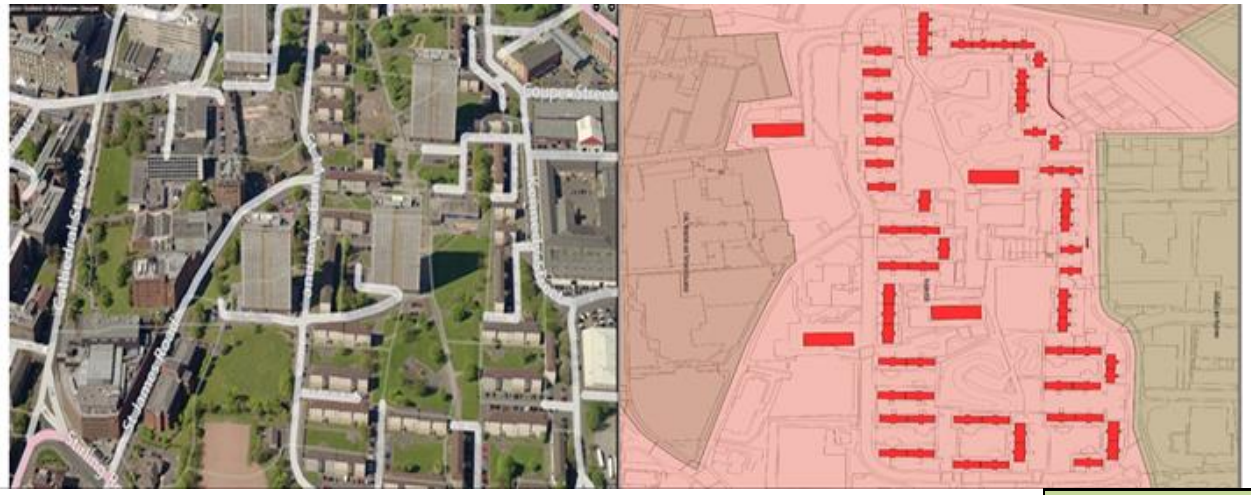
Review of Existing Site Conditions: Site Survey Establishes Existing & Future Layout and Energy Flows

Client Data is Often the Key to success……..The Methodology & Approach to DH Feasibility is Broadly Similar With Varying Degrees of Complexity Relative to the size and scale of the project…….

Review of Existing Conditions: Identification of Boiler House and Plant Room Arrangements



Heat Consumption Data Developed – Example of Typical Domestic DH Network



House Type	Gas	Electric	Total No. of Dwellings	Total Consumption [MWh/annum)
FOS/16	0	16	**16**	108
M/SWIMPA/1	0	351	**351**	2,145
M/SWIMPA/1	0		**0**	0
M/SWIMPEY6	0	228	**228**	1,541
SPE12/ABC	24		**24**	215
SPE12/D	4		**4**	36
SPE12/EF	16		**16**	144
SPE12/G	48		**48**	431
SPE15/WIMP	0	1	**1**	7
T-20-3NF	0	6	**6**	61
T-20-3VNF	0	4	**4**	41
T-20-4NF	24	48	**72**	730
Totals	**116**	**654**	**770**	**5,458**

Review of Existing Conditions: Develop Bespoke Heat & Electricity Demand Profiles

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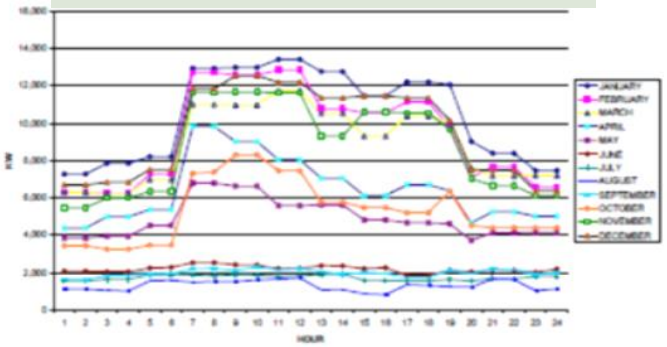
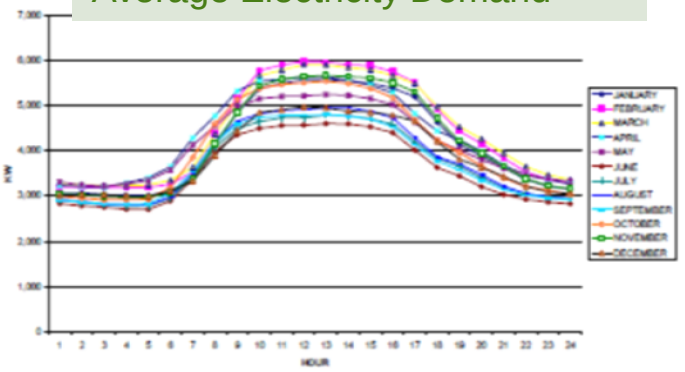
Average Heat Demand



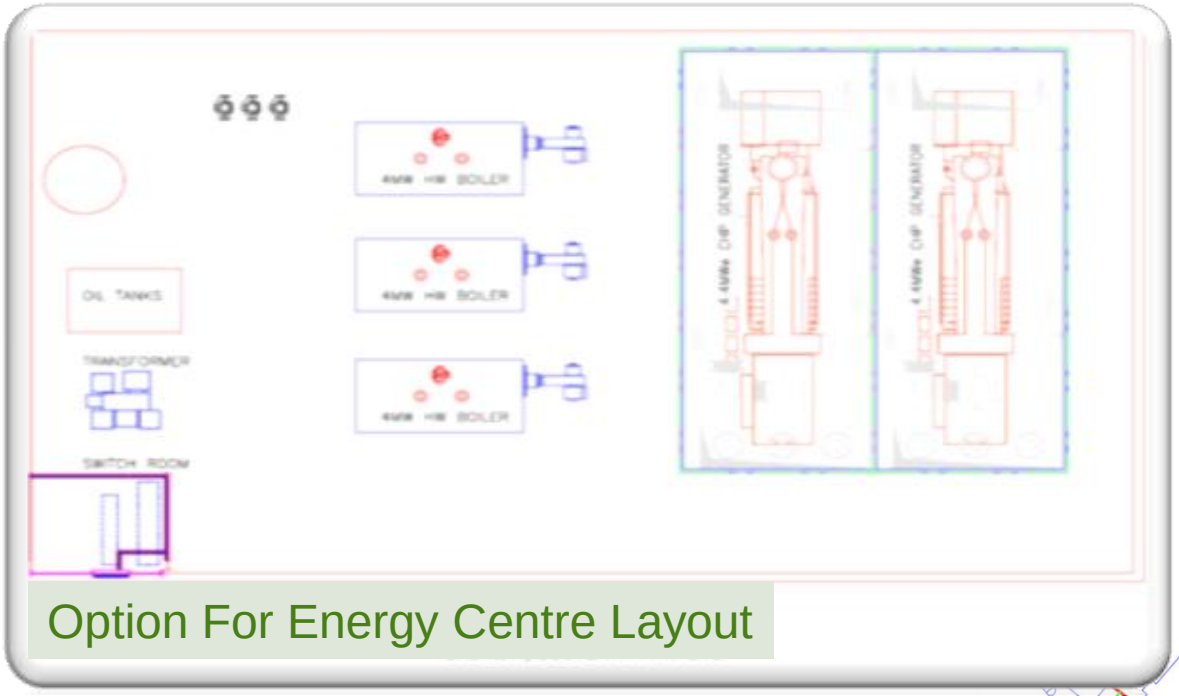
Average Electricity Demand



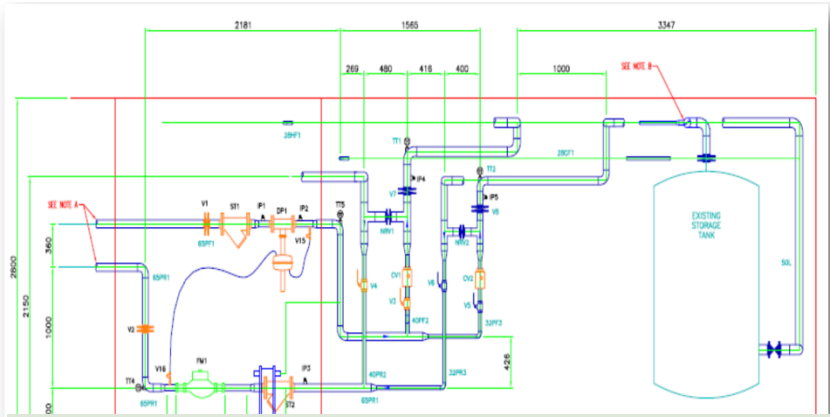
Development of Heat Network Options

Network Options For NHS De-Steaming Project

Typical Energy Centre Layout, Plant Room Adaptation, Network Design and Specification



Option For Energy Centre Layout



Plant room Adaptation Working Drawing

Network Options For NHS De-Steaming Project

Heat Consumption – City Scale Connectivity

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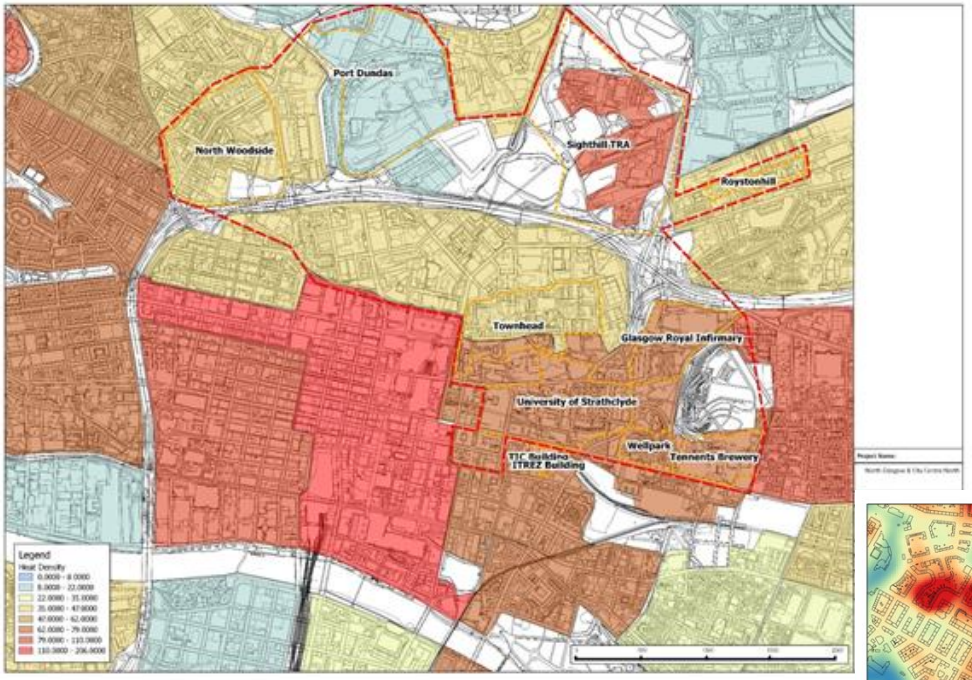

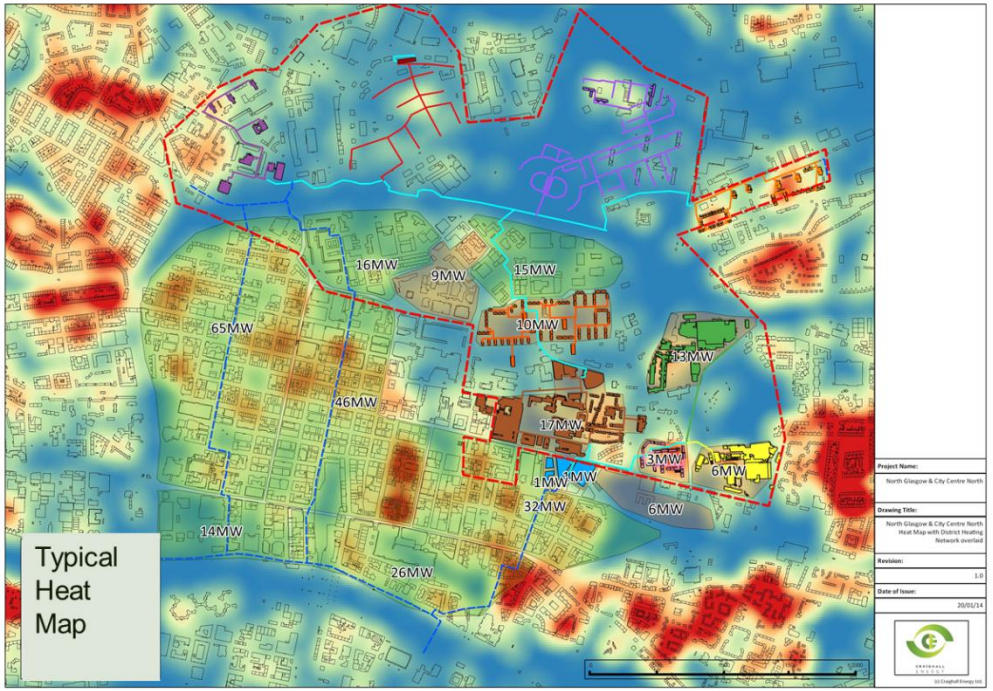

Deliverables: Typical DH Scheme Options For on-site and off-site Energy Generation

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Typical DH Scheme Options

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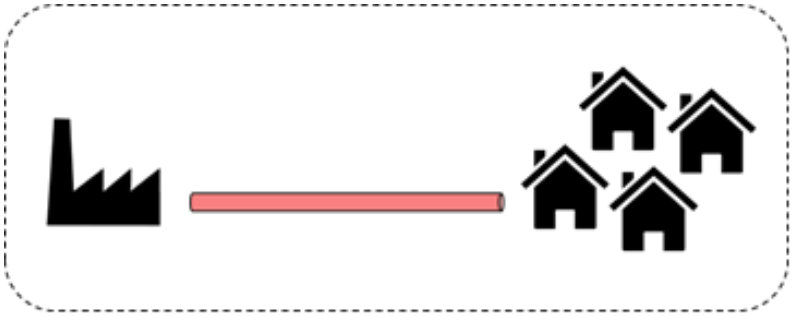
1. **On-site generation, no interconnection** - Generate heat on-site for exclusive use of Client / private tenants within the development boundary

Advantages:	Simple DH network arrangement under single ownership/management
	Local supply of heat, under control of Client / ESCo
	Scheme not reliant on external sources of heat
Disadvantages:	Single heat source (albeit with backup boilers in energy centre building)
	Client / ESCo responsible for all aspects of development - generation, energy supply contracts, O&M, billing, etc. – and attendant risks [risk could be mitigated through third-party contract of role]
	No interconnection to external heat sources means cheaper or lower-carbon sources of heat that may connect to a wider network are not available to development

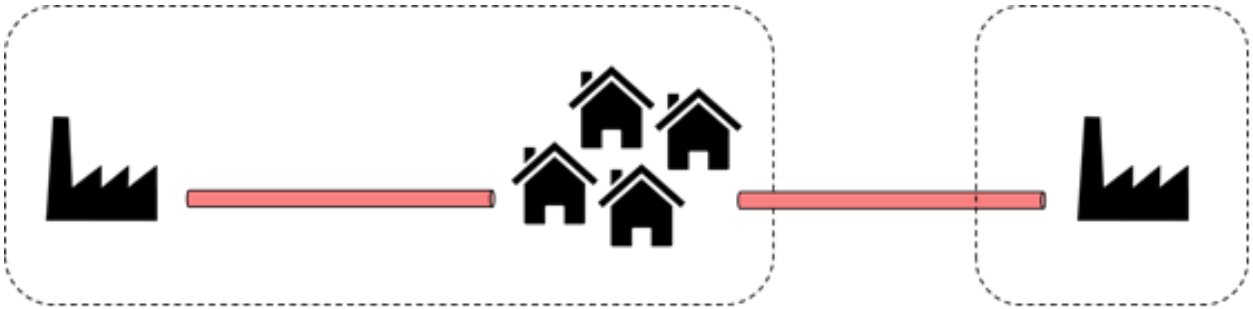


Typical DH Scheme Options

2. On-site generation, interconnection to external source of heat -

Generate heat on-site for use of Client / private tenants within the development boundary, but interconnect with nearby district heating developments / large consumers to either: (1) export heat; (2) improve resilience; or (3) allow for import of cheaper/lower-carbon heat

Advantages:	Local supply of heat, under control of Client / ESCo
	Scheme not reliant on external sources of heat, however backup available
	External source of heat may provide cheaper/lower carbon heat that on-site generation
Disadvantages:	Connection to external heat source will require contract to be setup that adds complication to scheme arrangement
	Extra infrastructure required to connect external load, depending on proximity to scheme



Typical DH Scheme Options

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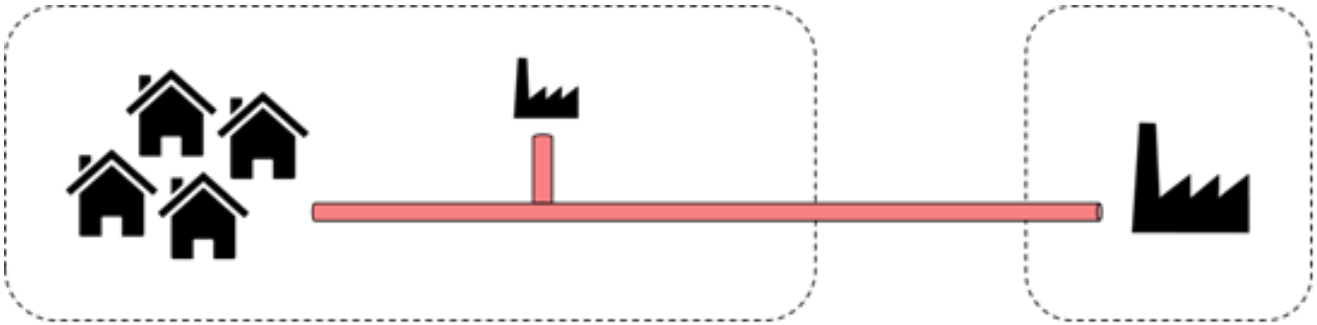
3. External heat supply with local backup generation - Accept heat from external district heating development / large consumer via an inter-connecting pipe, with on-site backup generation

Advantages:	Primary responsibility of heat passed over to third party
	Access to potentially cheaper or lower-carbon supply of heat through interconnected network
	Backup provides resilience to scheme and fall-back supply of heat should external source have any issues
Disadvantages:	Rely on third party to supply heat – lost control of heat source and ability to set price of heat
	Backup generation costs money, but may not be required



Typical DH Scheme Options

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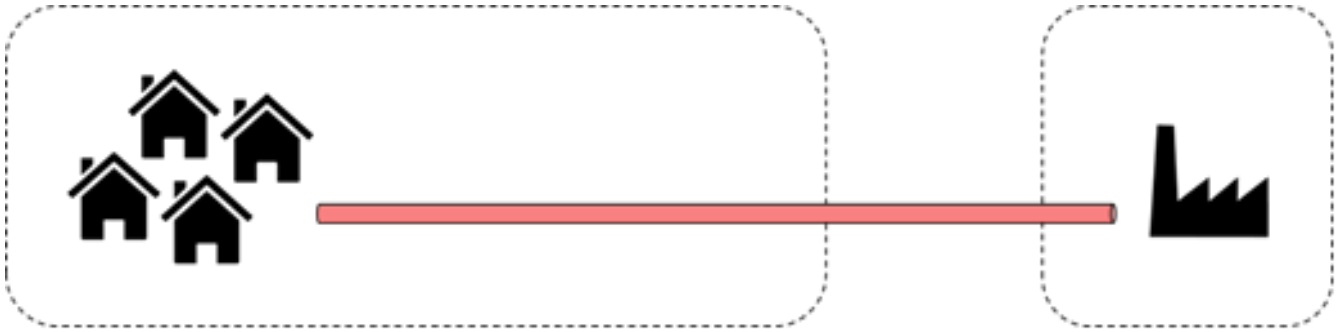
4. External heat supply with no local backup generation - Accept heat from external district heating development / large consumer via an interconnecting pipe, with no on-site backup generation

Advantages:	Primary responsibility of heat passed over to third party
	Access to potentially cheaper or lower-carbon supply of heat through interconnected network
	No CAPEX/OPEX costs for backup generation
Disadvantages:	Rely on third party to supply heat – lost control of heat source and ability to set price of heat
	No backup generation – lost resilience



Deliverables: Outline & Full Business Case

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Outline & Full Business Case Preparation

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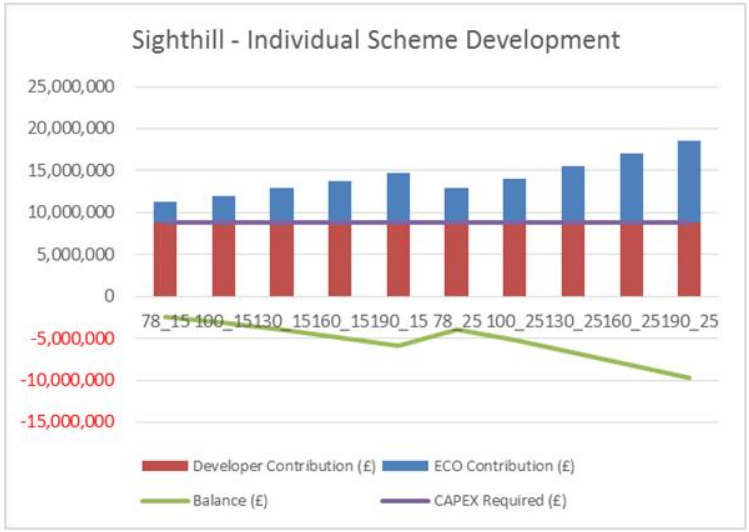
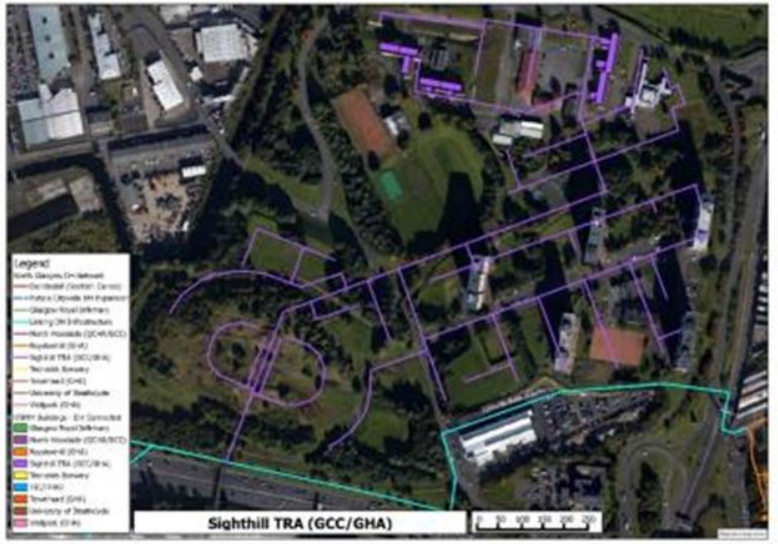
	Estimated Capital Cost Summary CHP DH to 2 New Development Schemes			
New Development Scheme	**CHP Station [£]**	**District Heating Mains [£]**	**Housing Internals [£]**	**Total [£]**
Port Dundas	2,577,000	2,500,000	5,171,000	**10,248,000**
Sighthill	1,977,000	3,038,000	3,402,518	**£8,872,566**
TOTAL	**£4,554,000**	**£5,538,000**	**£8,573,518**	**£19,120,566**

	Estimated CHP DH Operating Cost benefit for Two New Development Schemes			
New Development Scheme	**Annual CO2 saving (Tonnes)**	**Heat and Electricity Income [£]**	**Operating cost [£]**	**Annual operating profit [£]**
Port Dundas	1195	1,374,509	1,266,555	107,954
Sighthill	2,048	686,960	631,503	55,457
TOTAL	**3,243**	**£2,061,469**	**£1,898,058**	**£163,411**





Annual Operating Performance & NPV Forecast

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			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Income															
Domestic Heat Income inc maint	9.75	£/dwel./wk													£ -
Commercial Heat Income	3.65	p/kWh													£ -
Brown Elec Export Income Night	5.80	p/kWh	£ 59,999	£ 42,930	£ 45,384	£ 26,488	£ 16,431	£ 705	£ 20	£ -	£ 253	£ 13,232	£ 40,041	£ 53,255	£ 298,738
Brown Elec Export Income Day	5.80	p/kWh	£ 128,060	£ 98,522	£ 105,436	£ 61,342	£ 33,742	£ 207	£ 10	£ -	£ 475	£ 46,131	£ 97,900	£ 132,380	£ 704,205
LEC's income CCL exemption	0.00	£/MW	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	
RHI Income	2.93	p/kWh													£ -
Total Income			**£ 188,060**	**£ 141,452**	**£ 150,820**	**£ 87,830**	**£ 50,173**	**£ 912**	**£ 29**	**£ -**	**£ 728**	**£ 59,363**	**£ 137,941**	**£ 185,634**	**£ 1,002,943**
Expenditure															
															£ -
CHP Natural Gas	2.65	p/kWh	£ 382,937	£ 318,728	£ 340,334	£ 258,551	£ 217,337	£ 143,852	£ 154,509	£ 158,660	£ 150,184	£ 223,702	£ 317,003	£ 357,289	£ 3,023,086
Top Up Elecricity for Plant night	6.05	p/kWh	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ -	£ 0	£ -	£ -	£ -	£ 0
Top Up Elecricity for Plant day	12.00	p/kWh	£ -	£ -	£ -	£ -	£ -	£ 0	£ 0	£ 0	£ 0	£ 0	£ -	£ -	£ 0
CHP Maintenance Cost	8	£/MWh	£ 47,833	£ 40,947	£ 44,785	£ 35,384	£ 30,412	£ 20,192	£ 21,688	£ 22,271	£ 21,081	£ 31,171	£ 40,929	£ 45,989	£ 402,681
Other Plant Maintenance Costs	7500	£/month	7500	7500	7500	7500	7500	7500	7500	7500	7500	7500	7500	7500	£ 90,000
Rates	3000		3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	36000
Insurance	3600		3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	3600	43200
Legal & Professional	3000		3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	36000
Staff cost	4500		4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	54000
Office Costs	1000		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	12000
Total Expenditure			**£ 453,370**	**£ 382,275**	**£ 407,719**	**£ 316,535**	**£ 270,349**	**£ 186,644**	**£ 198,797**	**£ 203,531**	**£ 193,865**	**£ 277,472**	**£ 380,532**	**£ 425,878**	**£ 3,696,968**
Net operating cost			**-£ 265,311**	**-£ 240,823**	**-£ 256,899**	**-£ 228,706**	**-£ 220,175**	**-£ 185,731**	**-£ 198,768**	**-£ 203,531**	**-£ 193,138**	**-£ 218,109**	**-£ 242,591**	**-£ 240,244**	**-£ 2,694,025**

Energy Summary			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Electricity															
Brown Electricity Generated	kWh		5,979,152	5,118,334	5,598,153	4,423,053	3,801,438	2,524,017	2,711,012	2,783,856	2,635,131	3,896,344	5,116,075	5,748,621	
Brown Electricity Exported Night	kWh		1,034,474	740,174	782,481	456,689	283,300	12,158	339	-	4,358	228,131	690,363	918,183	
Brown Electricity Exported Day	kWh		2,207,933	1,698,655	1,817,868	1,057,616	581,759	3,573	169	-	8,188	795,368	1,687,926	2,282,411	12,141,466
Electricity Imported Night	kWh		-	-	-	-	-	-	-	-	0	-	-	-	0
Electricity Imported Day	kWh		-	-	-	-	-	0	0	0	0	0	-	-	0
Electricity Demand Night	kWh		582,301	567,043	645,137	671,809	700,127	579,721	619,979	629,524	607,916	633,907	576,430	586,607	7,400,501
Electricity Demand Day	kWh		2,154,445	2,112,461	2,352,667	2,236,939	2,236,251	1,928,565	2,090,526	2,154,332	2,014,668	2,238,938	2,161,356	1,961,420	25,642,569
Heat Demand	kWh		6,814,640	5,545,302	5,790,265	4,061,008	3,198,191	1,382,282	1,124,268	849,864	1,253,371	3,473,492	5,480,534	6,217,132	45,190,349
Heat Generated															
Natural Gas CHP Hot Water	kWh		5,591,866	4,786,805	5,235,546	4,136,560	3,555,208	2,360,530	2,535,413	2,603,538	2,464,446	3,643,967	4,784,693	5,376,267	47,074,839
Natural Gas Boiler Hot Water	kWh		1,272,965	815,652	642,343	195,246	20,581	-	-	-	-	49,419	767,473	895,326	4,659,005
Total Heat Generated	**kWh**		**6,864,831**	**5,602,458**	**5,877,889**	**4,331,806**	**3,575,789**	**2,360,530**	**2,535,413**	**2,603,538**	**2,464,446**	**3,693,386**	**5,552,166**	**6,271,593**	**51,733,844**
Fuel															
Natural Gas	kWh		14,450,460	12,027,473	12,842,775	9,756,637	8,201,409	5,428,359	5,830,525	5,987,188	5,667,328	8,441,570	11,962,392	13,482,612	**114,078,726**

Project A: Operating Performance

NET PRESENT VALUE	NET PRESENT VALUES - CASH INFLOW / (OUTFLOW)				
	OPTION 1 £000s	OPTION 2 £000s	OPTION 3 £000s	OPTION 4 £000s	OPTION 5 £000s
Capital Investment	(2,463,000)	(3,577,000)	(4,559,000)	(4,725,472)	(6,265,000)
Capital Contribution from BCC/ECO	-	3,557,000	-	950,000	950,000
Net Benefit	3,971,720	2,851,936	15,220,688	16,977,709	22,935,319
TOTAL INFLOWS / (OUTFLOWS)	1,508,720	2,831,936	10,661,688	13,202,237	17,620,319

Project B: NPV Calculation

An Integrated & Structured Delivery Plan

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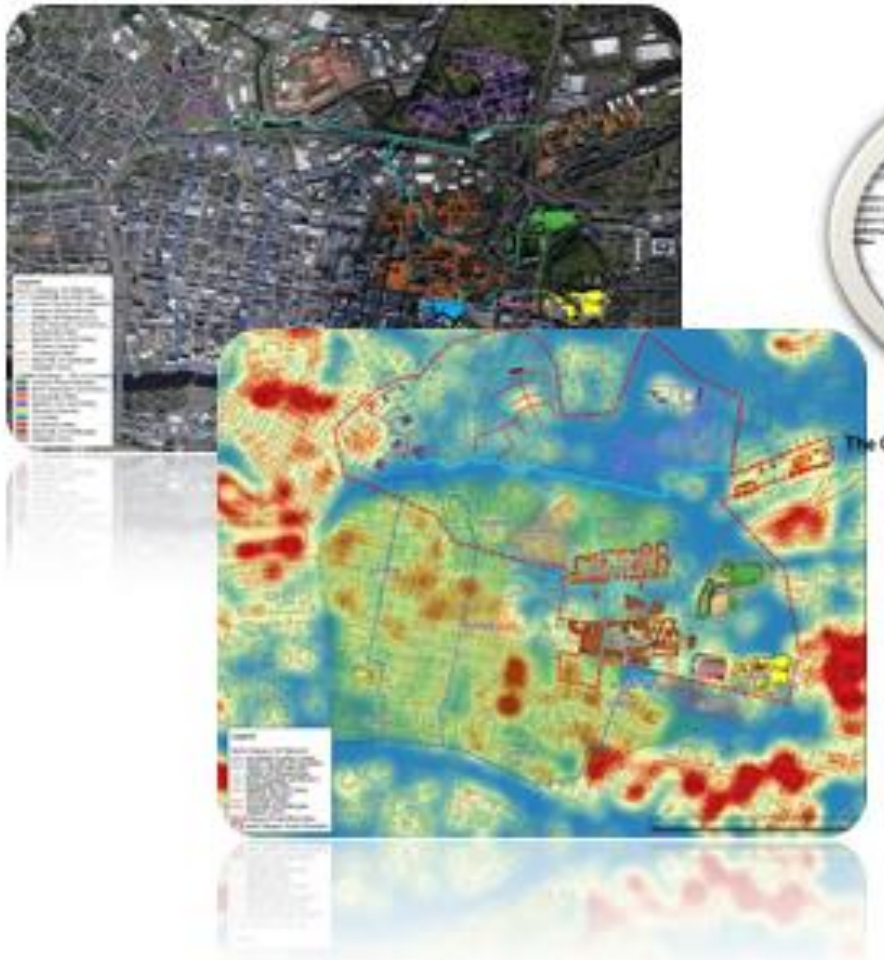
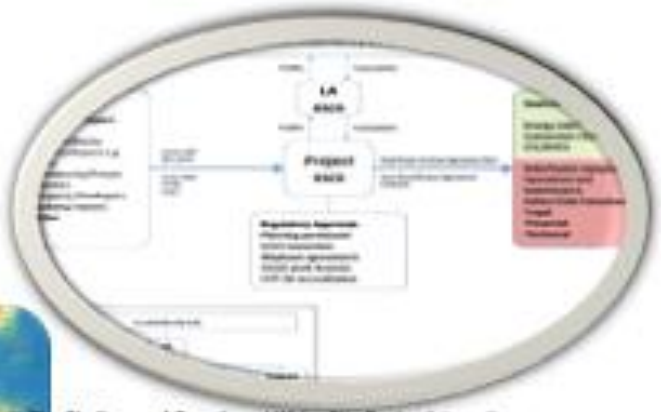




The Challenge of Growth and Wider City Region Integration

I. Existing 300MW Heat Load Estimated within City Centre Boundary

II. 500MW+ Heat Load across City Region

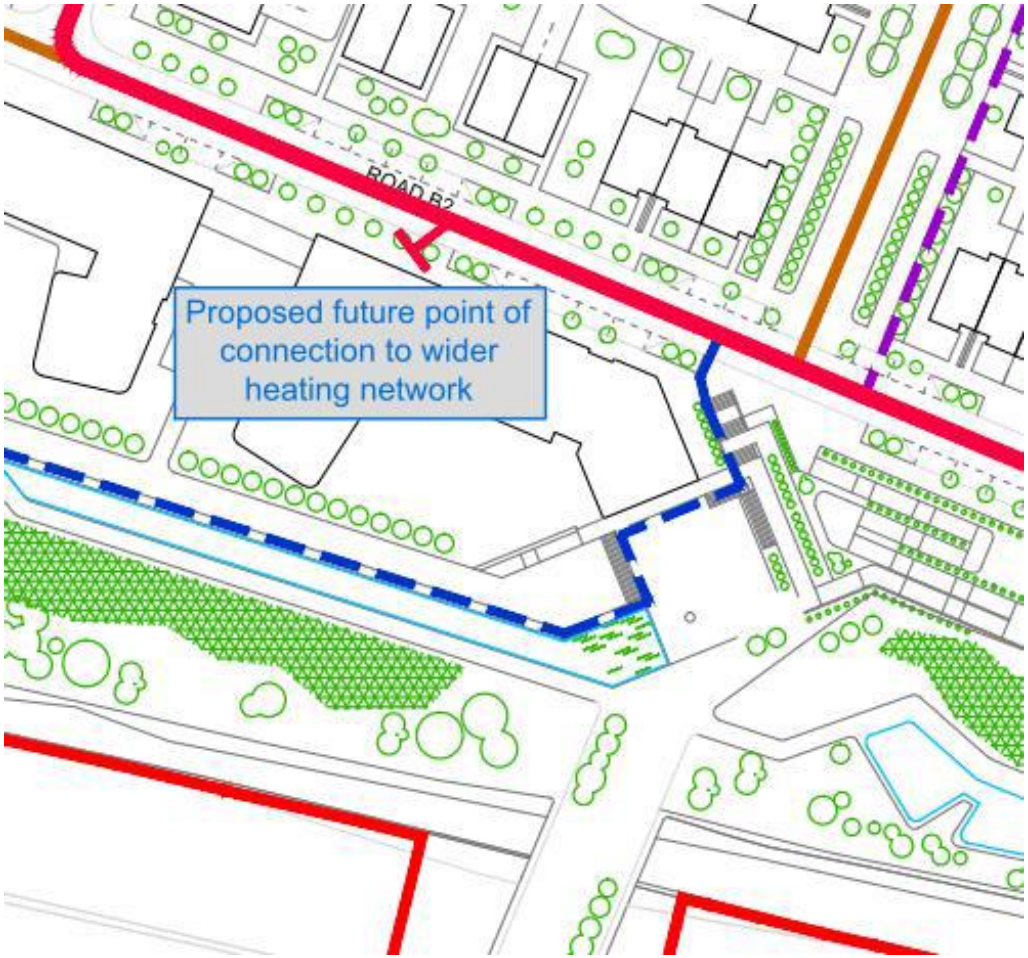
III. New City Infrastructure

- a) Polmadie Energy From Waste Plant
- b) Scottish Water Effluent Pipeline(s)
- c) SUDS Programmes
- d) Geothermal Heat Recovery From Shallow Mine Workings (PRENES)
- e) On-Going Development of CHP DH Schemes (Athletes Village, Wyndford, Broxholm etc.)

IV. Sustainable Glasgow Targets and Tightening Legislative Requirements (30% Carbon Emissions targeted in Glasgow by 2020)

V. Funding Availability – SFC Grants to UoS or ECO Funding only available until 2015 but new horizons exist with ever changing UK Government Policies e.g. RHI, FiT, CfD etc.

An Integrated & Structured Delivery Plan



Proposed Future Connection to Wider Area District Heating Network

Risk Management Strategy & Delivery Plan

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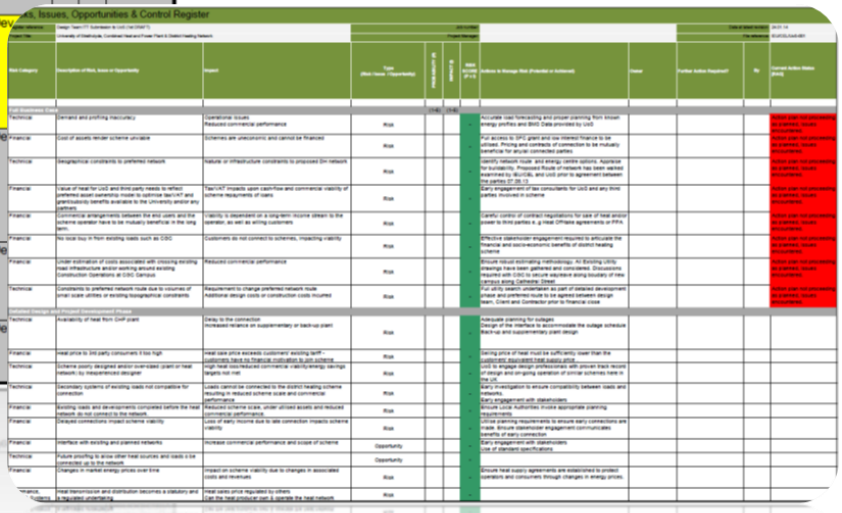
sk	Risk Cat	I	P	Mitigation	Owner	RI	RP	Review
Loss of funding or capital for the business	Fin	4	2	To date we have a good track record of delivering projects that save cash and reduce carbon, which is a key objective for Council. It shows that these projects are a sound investment	Dev	3	2	Review periodically
Inadequate scrutiny of finance	Fin	5	2	Audit controls already in place need to be more robust particularly in light of a move to a subsidiary company structure	Dev / P&O	3	2	Review periodically
Catastrophic technical failure	Rep	5	4	Generators and back up boilers are serviced regularly. Distribution pumps are duty standby, and it is intended to carry spares for these items. Underground piping is alarm monitored. There is therefore a degree or redundancy built into existing systems. Need to carry adequate spare parts	De			
Failure to deliver on capital projects	Rep	3	2	Careful management of projects is key to achieving project deliverables against cost and time. We have a good spread of experienced personnel to deliver projects	De			
Poor quality of installations leading to complaints	Rep	4	1	To date, the satisfaction surveys that have been carried out and word of mouth have yielded that overall satisfaction on installations is high. We need to maintain these standards going forward	De			
Alternative technologies for fuel put do not perform as as gas firing	Pol / Env	4	3	Careful and extended studies of various fuel technologies needs to be carried out to minimise the risk impact on the business	De			



Typical Procurement: DH Works Packages

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Energy Centre

- Supply, installation and commissioning of the CHP Generator including LV/HV power systems
- Supply and commissioning of Boilers
- Builders Work/Structural upgrading
- Supply and installation of acoustic enclosures, ventilation/cooling equipment, access platforms
- Supply and installation of pipework, pumps, valves
- Supply and installation of control panels, control sensors, fire and gas alarm systems and associated electrical wiring works.
- Electricity, gas and water connections

DH Pipe

- Supply and installation of District Heating mains system including pre-insulated pipework materials pipework installation, and associated civil engineering work

Building

- Supply only of pipework, valves, heat exchanger etc
- Supply of heat interface units
- Supply of radiators
- Installation of pipework, pumps and valves heat exchanger heat interface units, radiators etc

Typical Procurement of DH Works Packages

CRAIGHALL ENERGY

Energy Centre

- Supply, installation and commissioning of the Thermal Generator including LV/HV power systems (+ O&M Contract)
- Supply and commissioning of Boilers
- Builders Work/Structural upgrading
- Supply and installation of acoustic enclosures, ventilation/cooling equipment, access platforms
- Supply / Installation of pipework, pumps, valves
- Supply and installation of control panels, control sensors, fire and gas alarm systems and associated electrical wiring works.
- Electricity, gas and water connections

Typical Procurement of DH Works Packages

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District Heating Mains

- Supply and installation of District Heating mains system including pre-insulated pipework materials pipework installation, and associated civil engineering work

Plant Room Adaptation, Domestic/Commercial Heating Systems

- Supply / Installation of pipework, valves, heat exchanger, Heat Interface Units, heat emitters/radiators etc.

Summary

1. District Heating is not new and should be welcomed for a range of social, economic and environmental reasons
2. District Heating is technology neutral. Choose the generation technology that suits your needs best
3. Clients should clearly define and prioritise key drivers for change at the outset (CAPEX/OPEX cost, socio-economic, environmental objectives etc.)
4. Willingness to look beyond your own horizons offers significant potential for decentralised energy projects
5. District Heat Networks are here for the long-term
6. Modular and phased scheme development is always an option
7. Where necessary, start small but always think big and consider the potential for future technology solutions.
8. RES and the Framework Providers are always here to help

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