A Guide to District Heating Schemes

Planner Capacity Building Project

4 July 2011

CLASP. Climate Change Local Area Support Programme

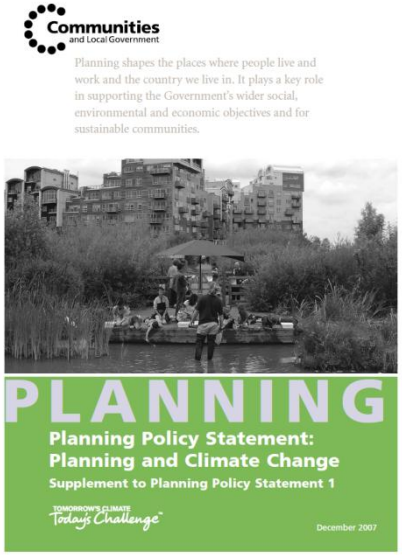
nwIEP north west improvement and efficiency partnership

Delivered by: ARUP

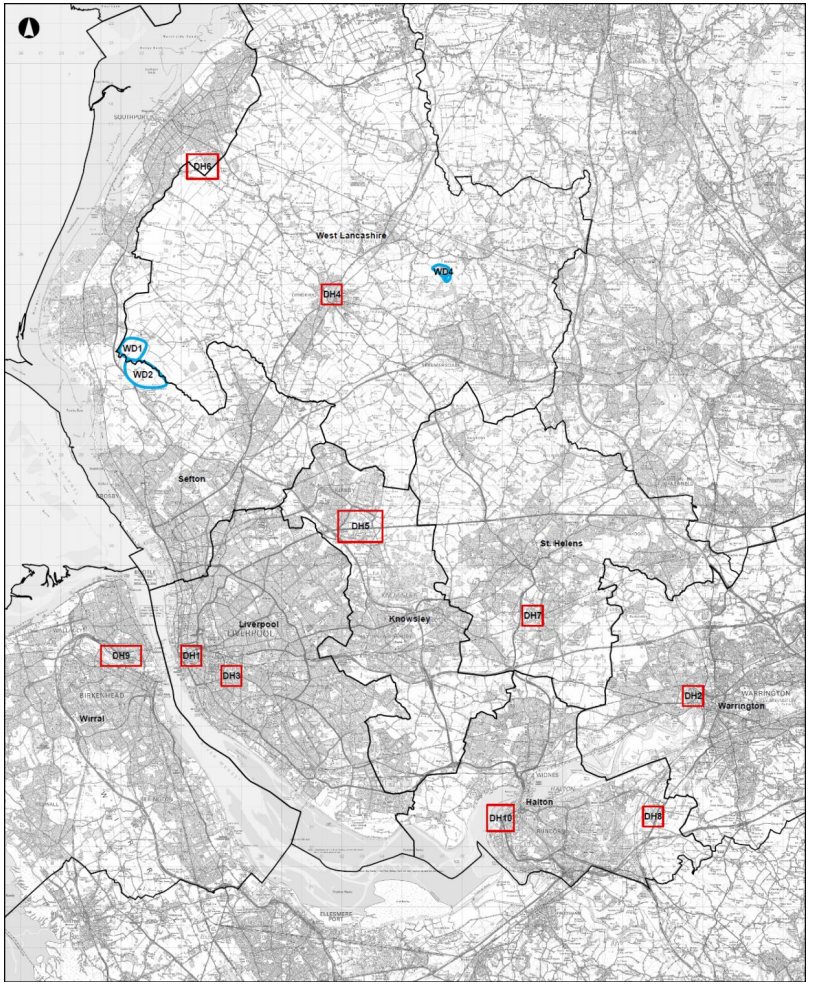
- Inform how DPD policies and allocations can be prepared
- Understand the district heating:
  - Technical feasibility
  - Financial viability
  - Barriers / constraints
  - Deliverability
- Ownership of certain aspects in relation to planning and development process

Context: Planning

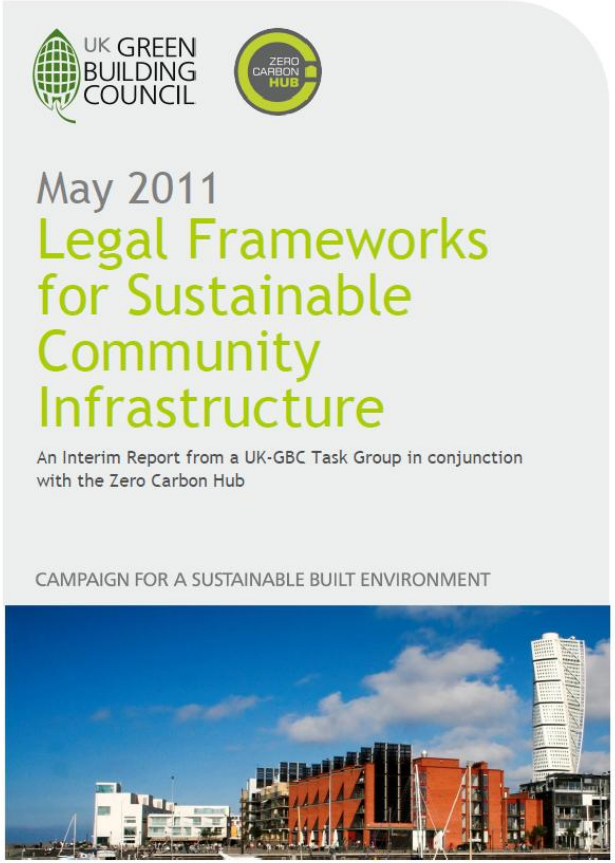
- National policy in a state of some transition
- New PPS1 Supplement, expected with. stronger and more direct guidance on how climate change should be addressed in planning policy document
- CHP / district heating is a key part of the carbon reduction agenda



- LDDs have significant role to play to deliver national commitments to carbon reduction
- Safeguarding areas for development of renewable energy and associated infrastructure
- Identifying opportunities for district heating is key



- ***Evidence bases:*** Local Development Documents must contain a 'reasoned justification' for policies and allocations
- ***Sustainability Appraisal:*** SAs often fail to address climate change related issues adequately
- ***Compliance with national policy:*** DPD are expected to consistent with national policy
- ***Deliverability and flexibility:*** Key to adoption of targets and identification of significant energy infrastructure projects



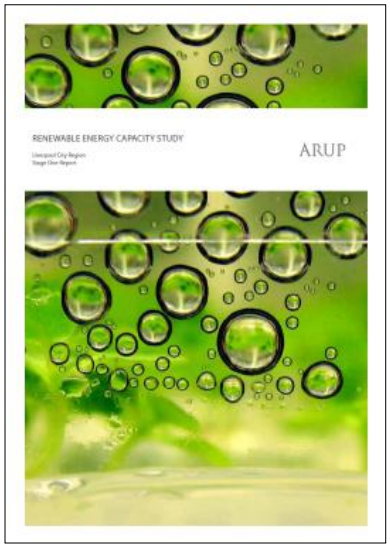
Context: Efficient energy generation

- CHP plant that does not ‘dump’ heat into the atmosphere
- Dumping heat reduces the operational efficiency of CHP plant
- “Good quality CHP” is defined in CHPA quality indexing system

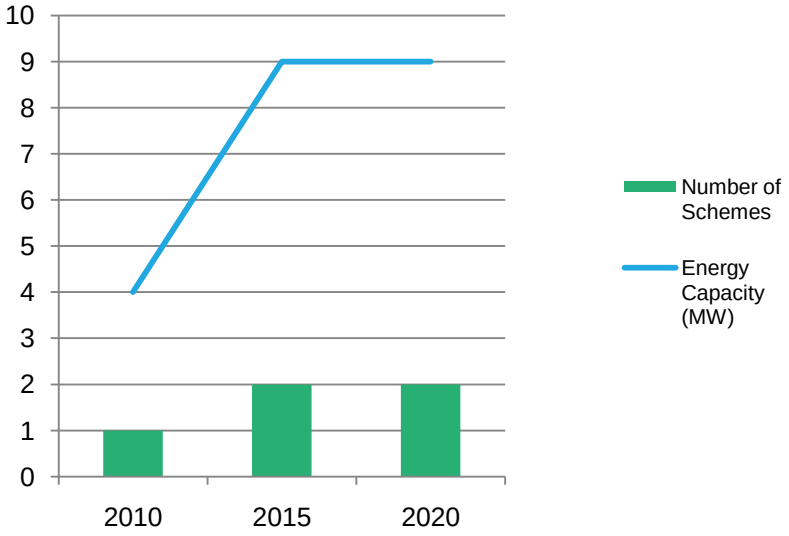
- Introduction of the Energy Efficiency Directive (EED)
- Replaces the Cogeneration Directive
- Promotes greater efficiency in energy generation
- Identifies district heating as a the default option
- Ideal fit for Liverpool City Region work undertaken to date

Context: The City Region

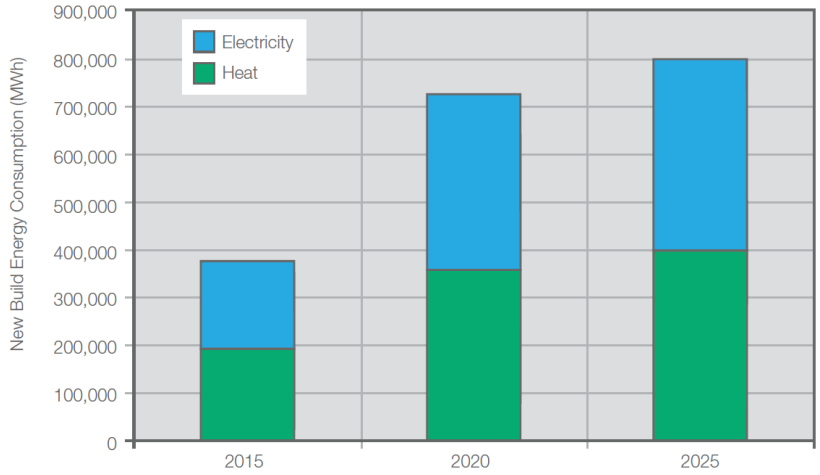
- **Stage 1:** Capacity
- **Stage 2:** Strategic opportunities
- **Stage 3:** Identification of mechanisms for delivering opportunities
- **Stage 4:** SEAP coordinate all energy issues and attract funding / investment



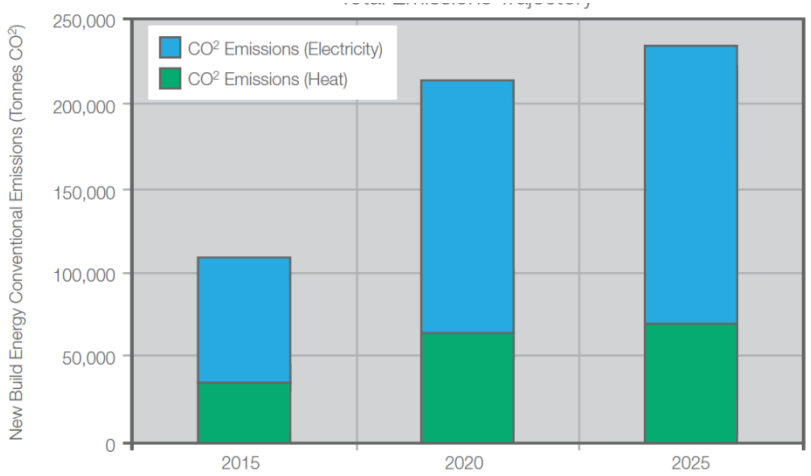
- As at 2009 targets identified:
  - A total of 3 schemes were required generating 9MW by 2020
  - One scheme had been delivered (Mossborough Hall Farm) with capacity of 0.3MW
  - 4 planning applications submitted that could generate up to 27MW.
  - EfW accounted for 5 applications generating over 400MW
- 2010 study identified 14MW of biomass heat capacity in Merseyside
- Stage 2 report identifies 23.2 MW of CHP capacity from 8 Priority Zones



- Understanding of net energy demand and carbon emissions from growth
- Growth projections used to inform analysis of heat loads

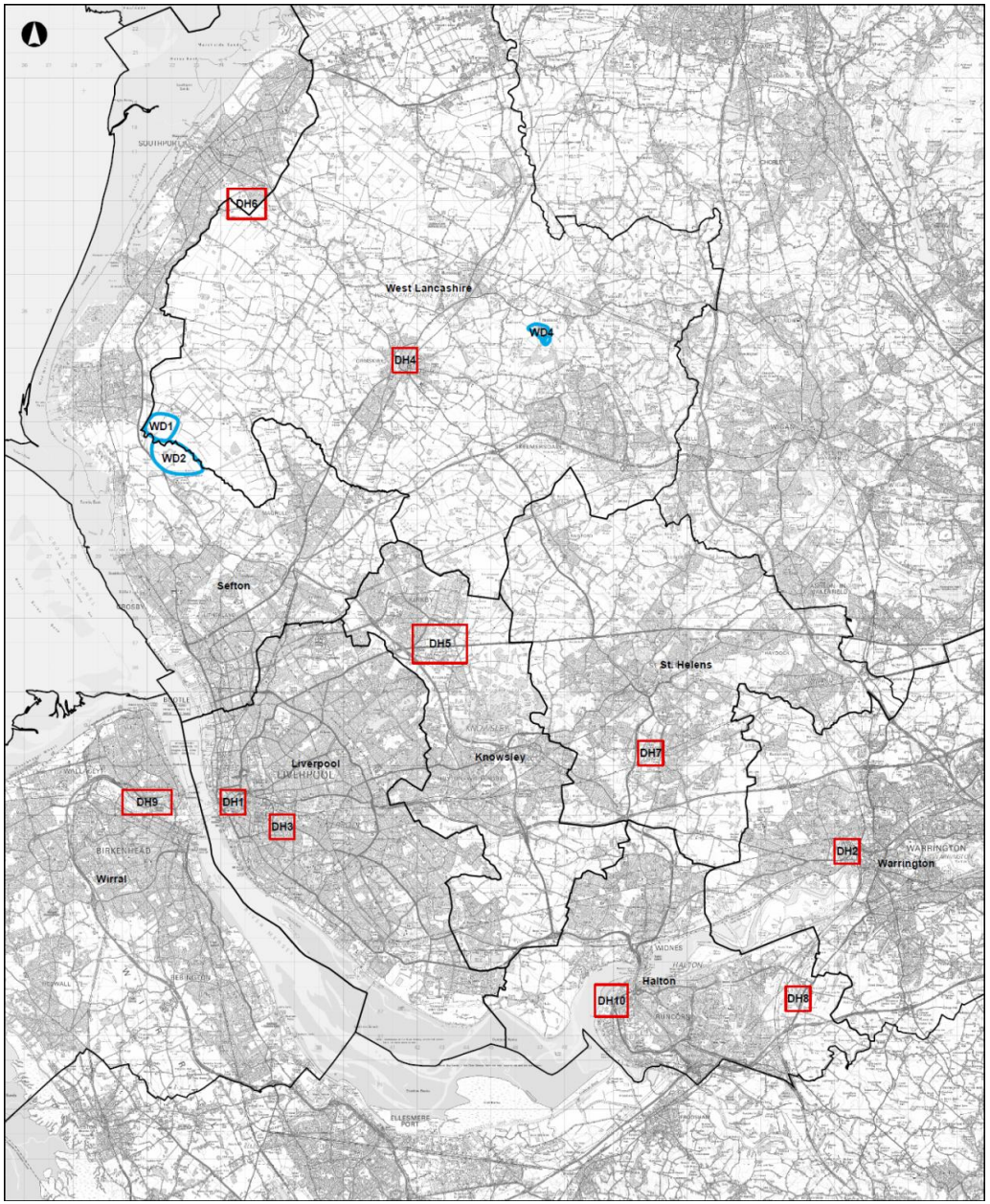


Total Energy Trajectory

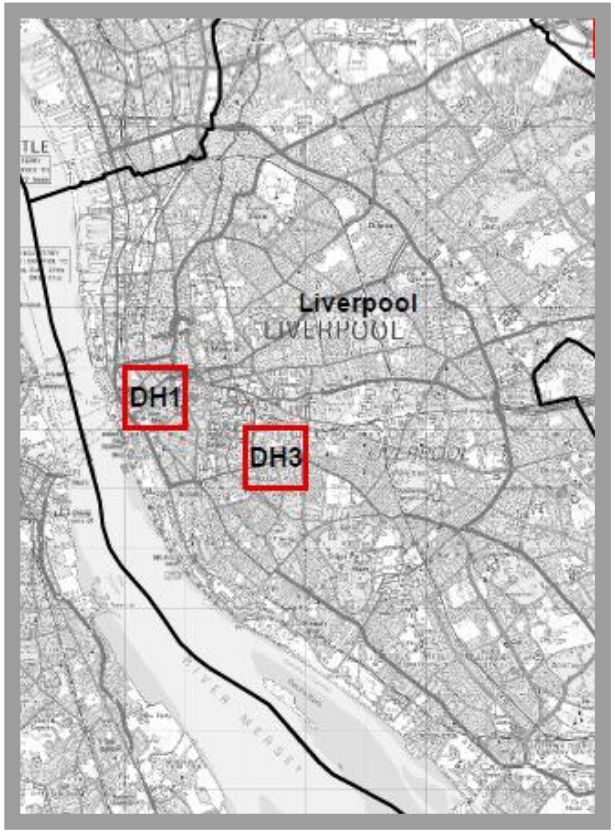


Total Emissions Trajectory

- 10 District Heating priority Zones identified (27.8MW)
- 8 Priority Zones in Merseyside (22.3 MW)



PRIORITY ZONE TYPE AND REF NO.		SUB-REGION	STATUS	LOCATION DESCRIPTION	MIX OR SPACE-TYPES - POTENTIAL CUSTOMERS/ PARTNERS	APPROX. VIABLE CHP CAPACITY	POTENTIAL CONSTRAINTS	COMMENTS
DH	5	Knowsley	Emerging	Knowsley Business Park & South of Industrial Park	**Existing** • Commercial buildings • Light Industry **Emerging** • New employment land build-out • Energos energy from waste-plant	**≈ 9 MWe** *(proposed by Energos)*	• Potential requirement to cross East Lancashire road to access emerging Industrial Park load centres	• Significant benefit offered by the commitment of Energos to install generation plant • Heat availability not necessarily limited by emergence of related demands



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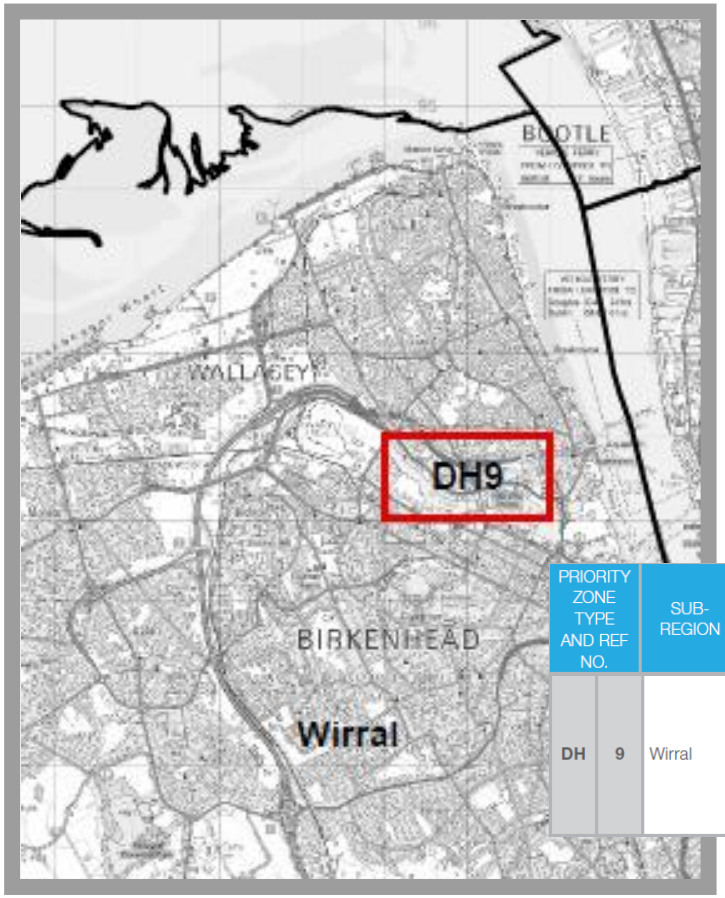
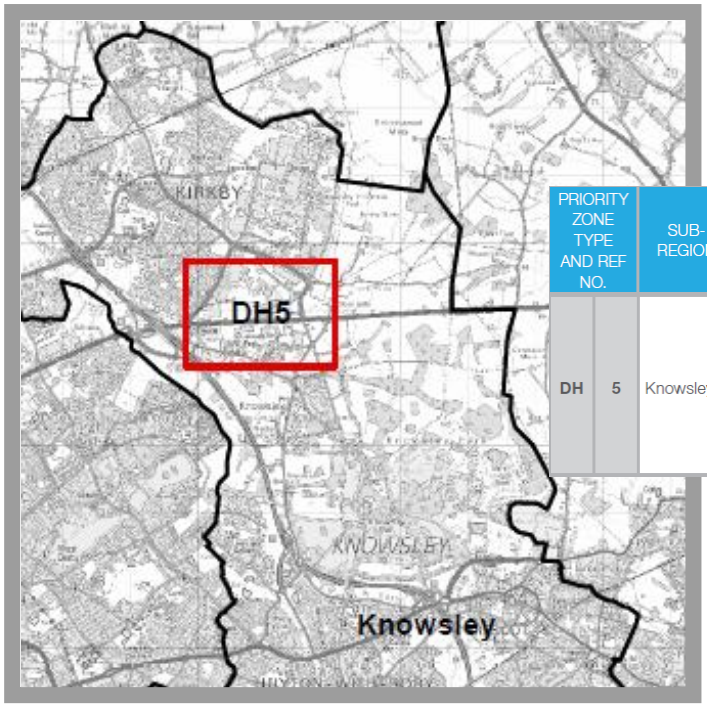
DH	1	Liverpool	Existing	City centre area to West of Lime Street station and East of Prince's Dock	• Commercial buildings • Retail (shopping centres) • Hotels • Town Hall • Law Courts and prisons • Leisure facilities • Residential buildings (flats)	≈ 3 MWe	• Likely costs of pipework installation in dense urban area • Mix of land ownership • Built heritage • Air quality	• Any CHP capacity will depend heavily on take-up within identified area • SHLAA plans feature new build-out areas in close proximity to priority zone • *Need to identify potential energy centre sites*
DH	3	Liverpool	Existing	Royal Liverpool Hospital & University of Liverpool	• Hospital • University Campus	≈ 3.5 MWe	• Requirement to cross Lime Street rail cutting to link to South of University Campus	• Royal Liverpool Hospital represents key anchor load

Strategic Opportunities: Liverpool



PRIORITY ZONE TYPE AND REF NO.		SUB-REGION	STATUS	LOCATION DESCRIPTION	MIX OR SPACE-TYPES - POTENTIAL CUSTOMERS/ PARTNERS	APPROX. VIABLE CHP CAPACITY	POTENTIAL CONSTRAINTS	COMMENTS
DH	9	Wirral	Potential	Wirral Waters	**Planned** • Commercial/Office space • Retail and Leisure • Residential • Hotels	**≈ 3.5 MWe**	• Extent to which heat network could serve entirety of site could depend on timing and phasing of scheme • Any anchor load(s) would ideally emerge early within scheme build-out	• Potential to size plant against sizeable and mixed heat loads • New-build scheme providing opportunity to introduce DH from the start

Strategic Opportunities: Wirral



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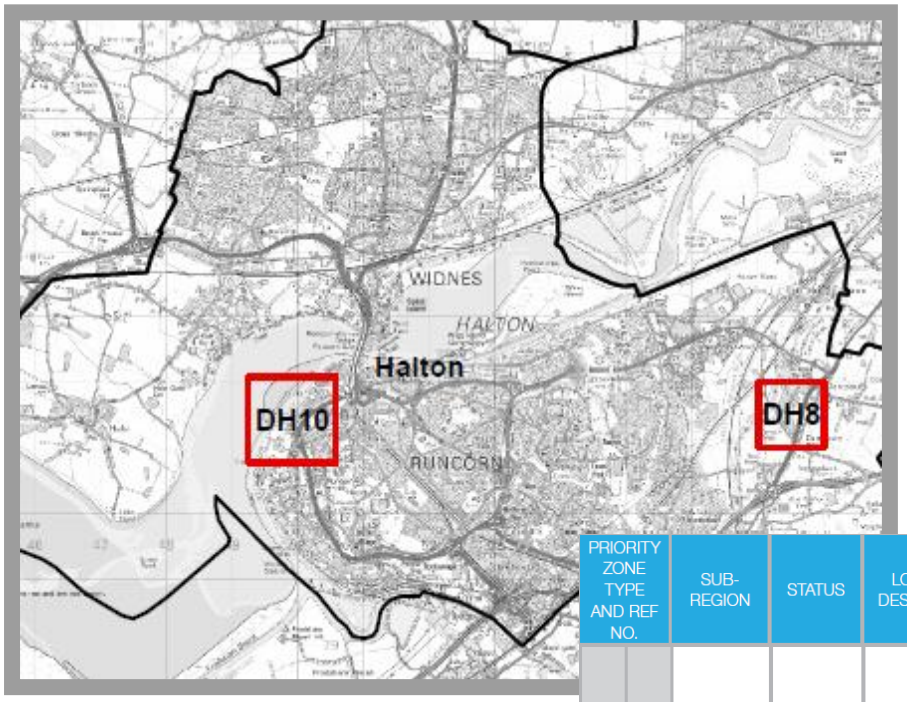
DH	5	Knowsley	Emerging	Knowsley Business Park & South of Industrial Park	**Existing** • Commercial buildings • Light Industry **Emerging** • New employment land build-out • Energos energy from waste-plant	**≈ 9 MWe** *(proposed by Energos)*	• Potential requirement to cross East Lancashire road to access emerging Industrial Park load centres	• Significant benefit offered by the commitment of Energos to install generation plant • Heat availability not necessarily limited by emergence of related demands

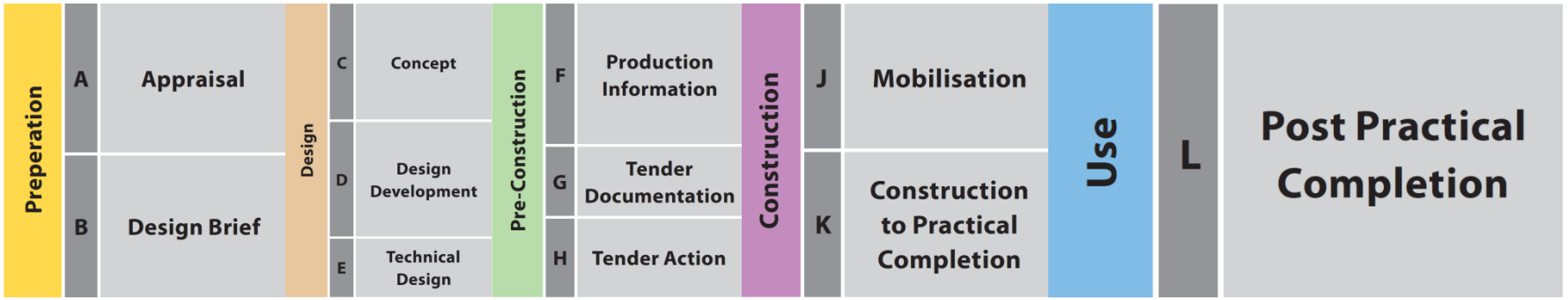


PRIORITY ZONE TYPE AND REF NO.		SUB-REGION	STATUS	LOCATION DESCRIPTION	MIX OR SPACE-TYPES - POTENTIAL CUSTOMERS/ PARTNERS	APPROX. VIABLE CHP CAPACITY	POTENTIAL CONSTRAINTS	COMMENTS
DH	8	Halton	Emerging	Green-field area in Daresbury to West of A56	**Existing** • Business Park • Science Park **Emerging** • New employment land built-out • New residential	**≈ 0.6 MWe**	• Planned build-out area is relatively large at approx 2km in length	• Existing load centres are at either end of planned development area, with feasibility of connection dependent upon new-build elements and precise types • New-build scheme providing opportunity to introduce DH from the start
DH	10	Halton	Potential	Runcorn Docks	**Planned** • Large residential area • Likely requirement for complimentary non-residential spaces	**≈ 0.2-0.7 MWe** *(based solely on residential build-out of between 1,200-4,000 homes)*	• Pure residential would not provide suitable mix to maximise plant size	• Scheme at this scale is likely to require provision of associated additional Community, Commercial and Retail spaces • New-build scheme providing opportunity to introduce DH from the start

Strategic Opportunities: Halton

Stage 1: Analysis of areas, sites and buildings

RIBA



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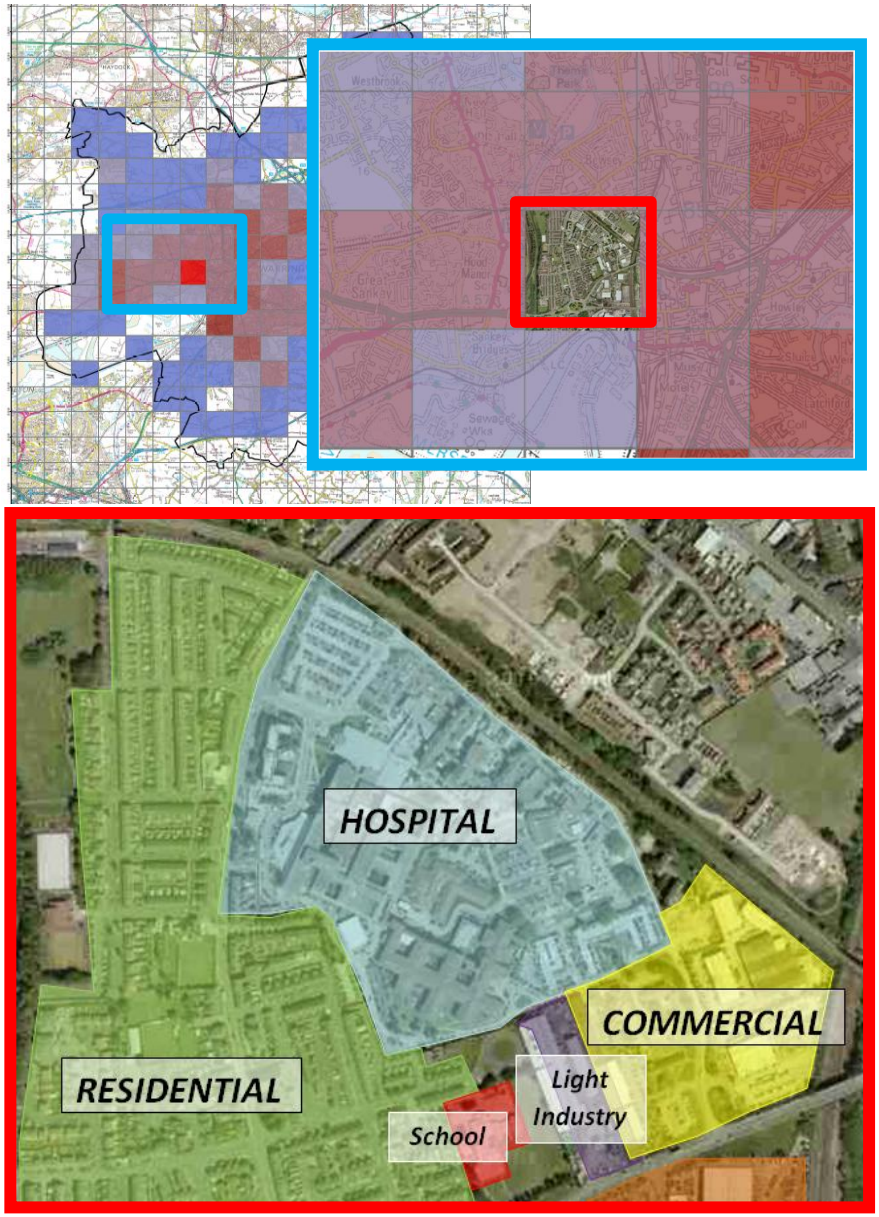
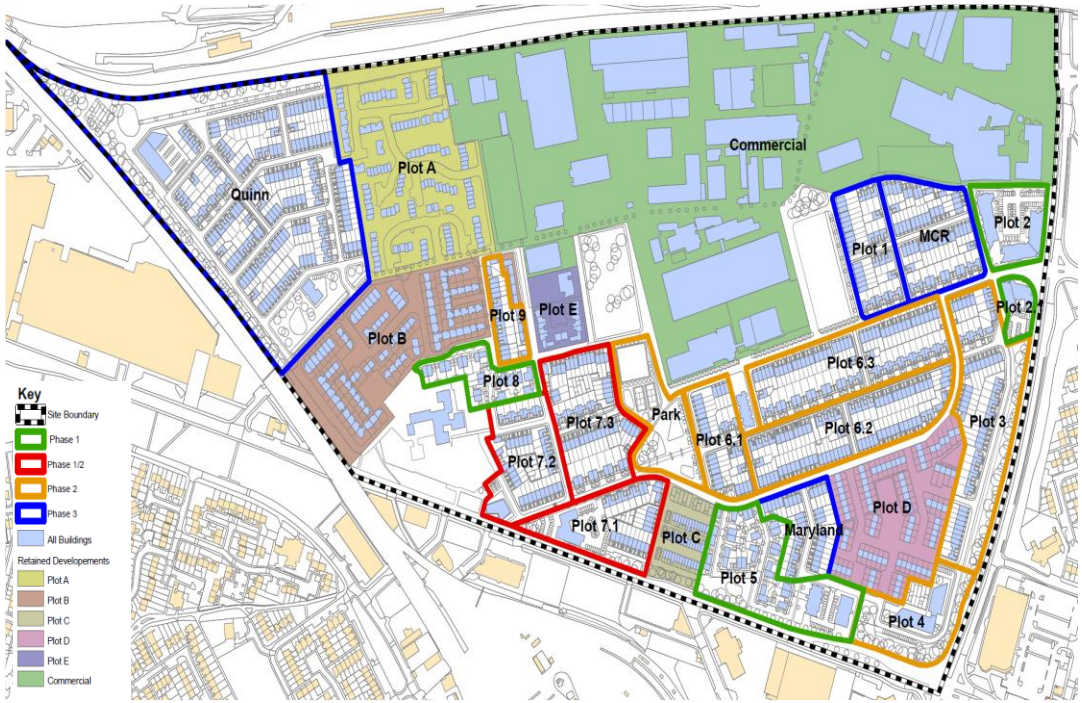
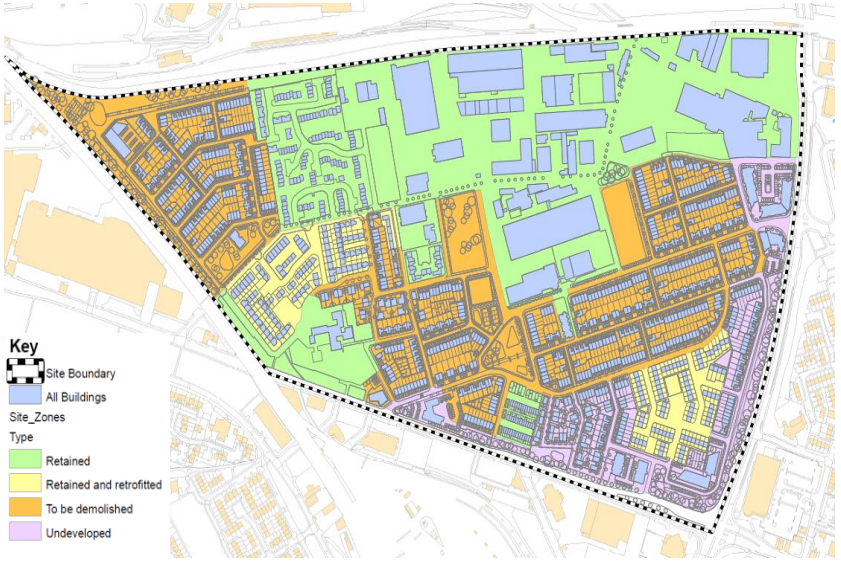
- Heat density mapping work provides areas of high heat demand at a 1km2 resolution
- Subsequent drill-down of identified sites allows specific load centres and space-types to be determined
- Key parameters for heat network suitability are tested:
  - *presence of anchor load(s)*
  - *mix of space-types*
  - *distance between loads*
  - *local geography/potential challenges to pipework routing*

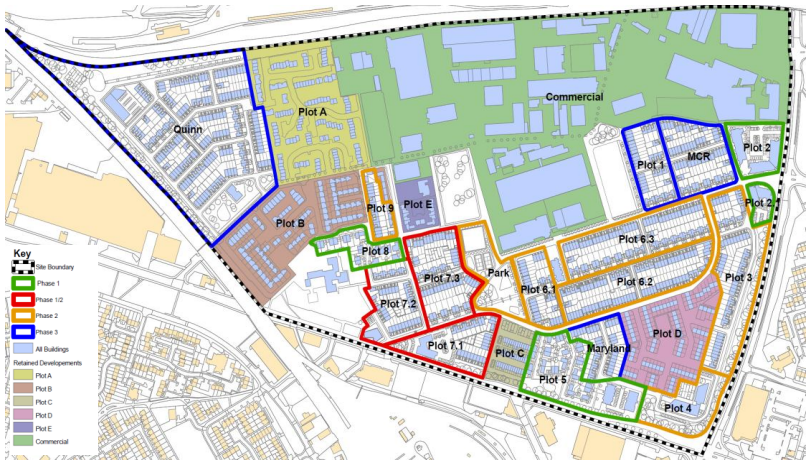


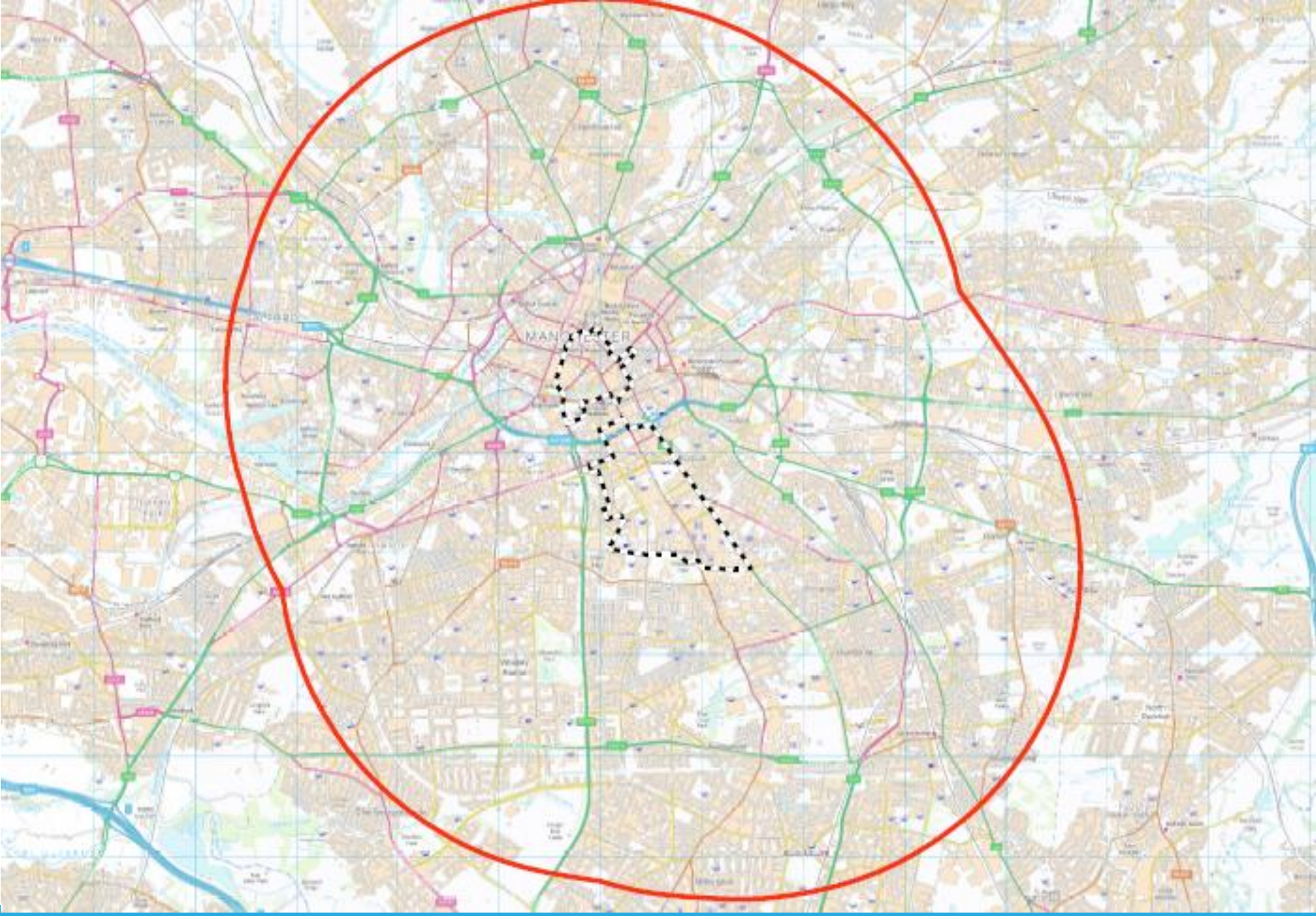
- Scale, mix, type , density and phasing of development
- Categorise building standards to be achieved (CfSH / BREEAM)
- Present proposed development details in tabular and spatial formats



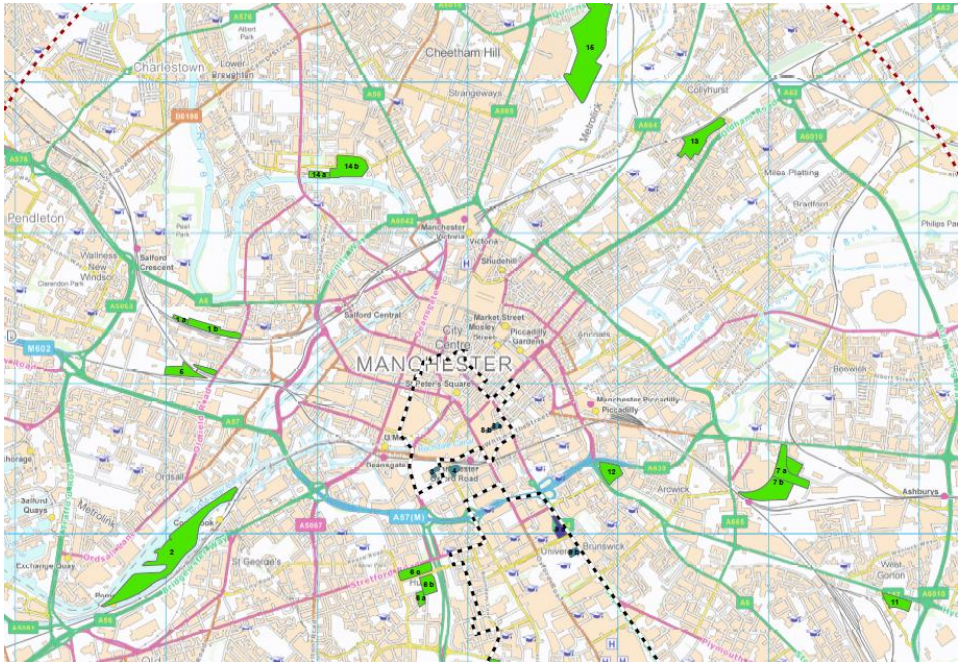
- Understanding areas of change
- Size, mix, type and end users of development
- Phasing
  - Dispersal / fragmentation
  - Certainty of land coming forward
- Obstacles and barriers between the building and the district heating network
- Building heat peak demand
- Compatibility of the building's heating system
- Capacity to locate plant and plant capacity







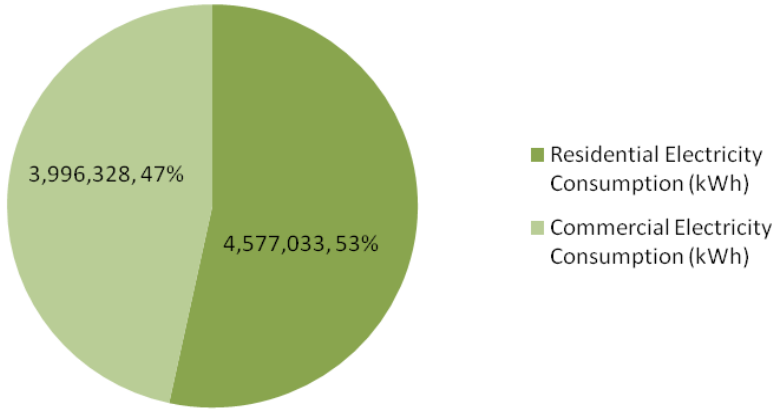
- Overall land area
- Proximity of the site to demand locations
- Vehicular access to the site
- Availability of utilities on/in proximity to the site
- Ability to erect buildings to house plant, with necessary permits and consents
- Ground conditions including contamination and presence of water



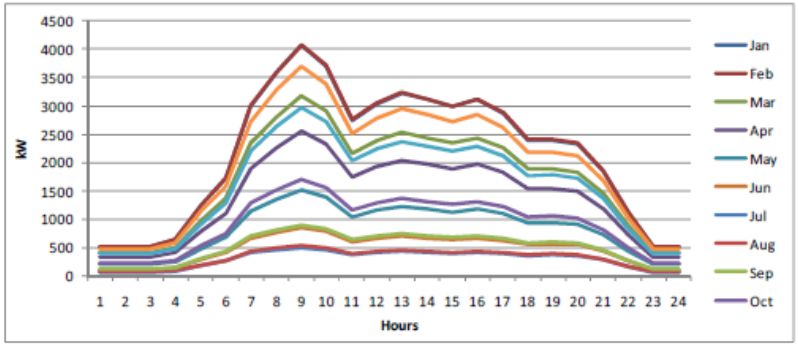
Stage 2: Energy Consumption & Profiling

- Types of energy:
  - Grid Electricity
  - Natural Gas
  - Renewables
- Assess plots by development type, size and building standard
- Regulated / unregulated energy

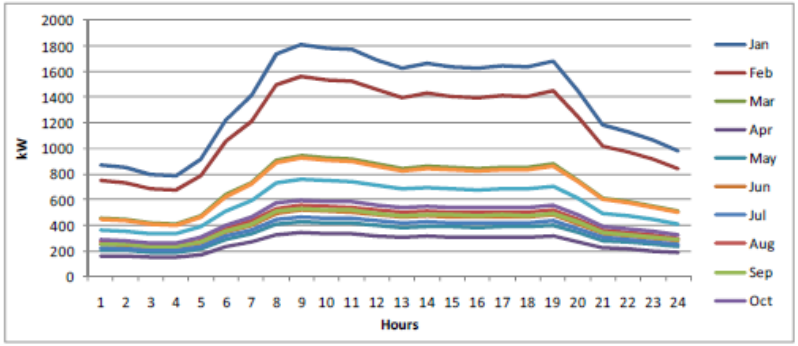
Utility	Energy Consumption		Cost	
	kWh/year	%	£/year	%
Electricity	8,600,000	44%	£930,200	73%
Gas	11,100,000	56%	£338,100	27%
Total Energy	**19,700,0000**		**£1,268,300**	



- Understanding the nature of energy demand ie, electricity and heat demand
- Development of profiles:
  - Total energy consumption
  - Total demand profile
  - Plot / individual building profiling
  - Assessment across the year
- Profiles used to identify energy peak requirements.
- Provide indication of size of plant needed to meet estimated demand



Heat Demand Profile of a Town Hall Complex

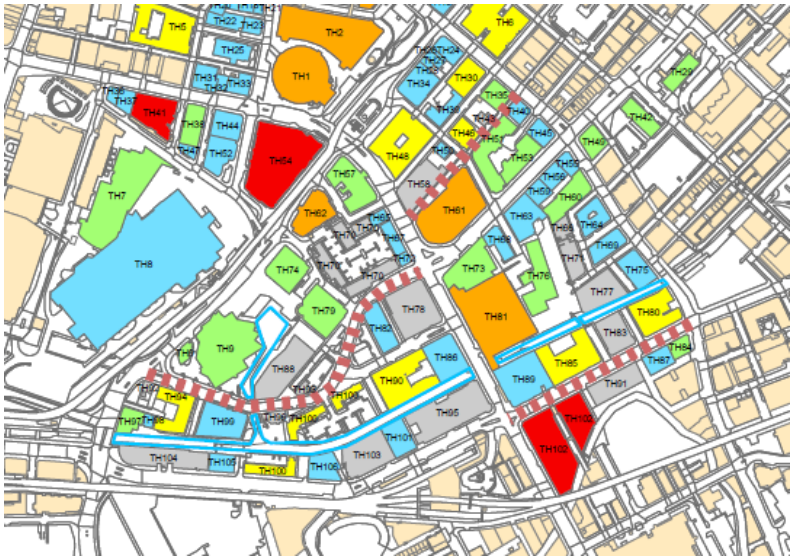


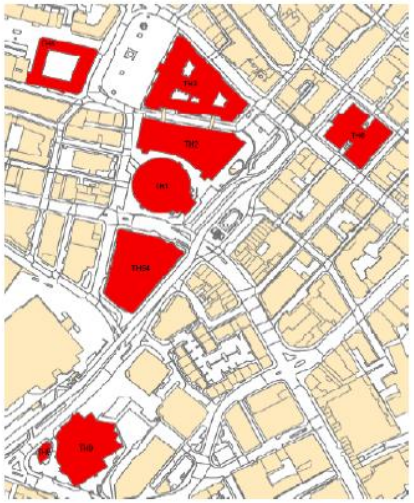
Heat Demand Profile of a Hotel

Assessing District Heat Options

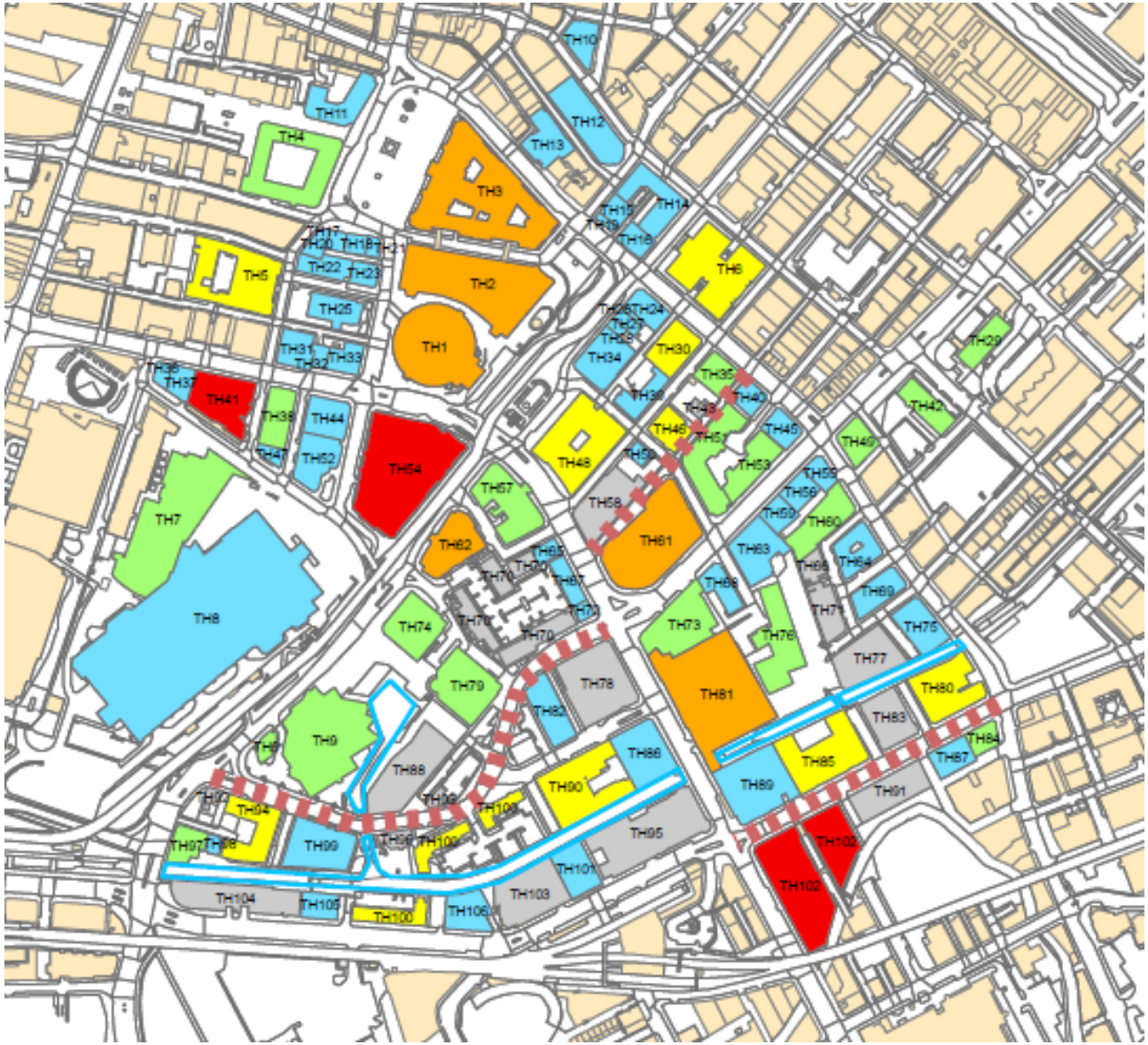
ARUP

- First step towards to detailed design of CHP / District Heating
- Identifying sites and buildings and building users
- Significant stakeholders engagement required
- Collection of detailed metered energy information
- Accuracy of data is very important to understand business case

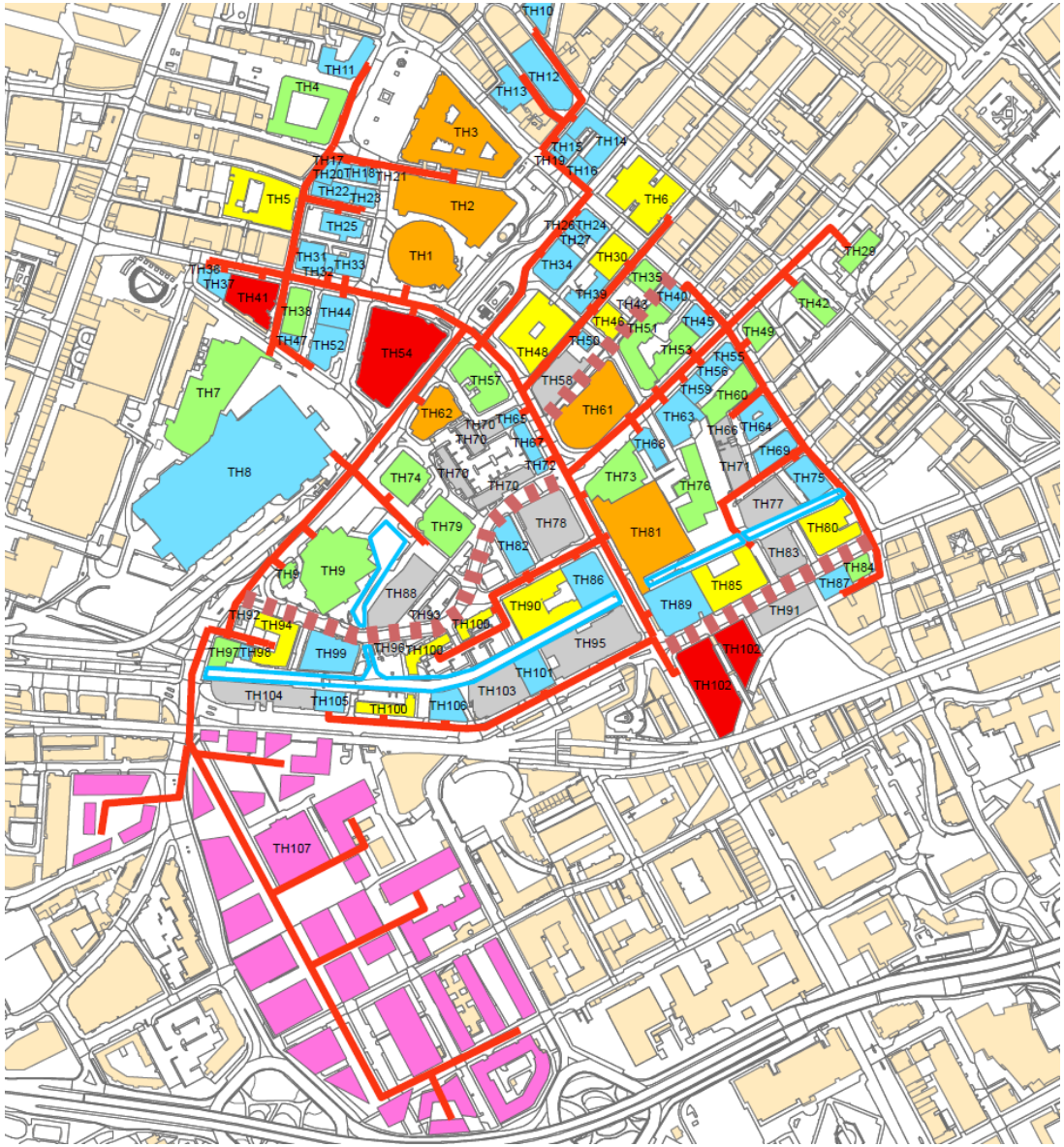




Ref	Heat Consumption (kWh/year)	Electricity Consumption (kWh/year)
TH1	5,280,061	4,284,089
TH2		3,072,061
TH3	4,611,399	1,711,968
TH4	1,450,372	1,154,767
TH6	1,776,281	2,479,697
TH9	1,202,888	2,271,131
TH54	4,947,097	4,278,734



Data sources



Legend

- Buildings Comprising 0% - 20% Heat Consumption
- Buildings Comprising 20% - 40% Heat Consumption
- Buildings Comprising 40% - 60% Heat Consumption
- Buildings Comprising 60% - 80% Heat Consumption
- Buildings Comprising 80% - 100% Heat Consumption
- Not included because no heat load, or electrically heated
- Concept Network Route
- Canal
- Utility Congested Streets

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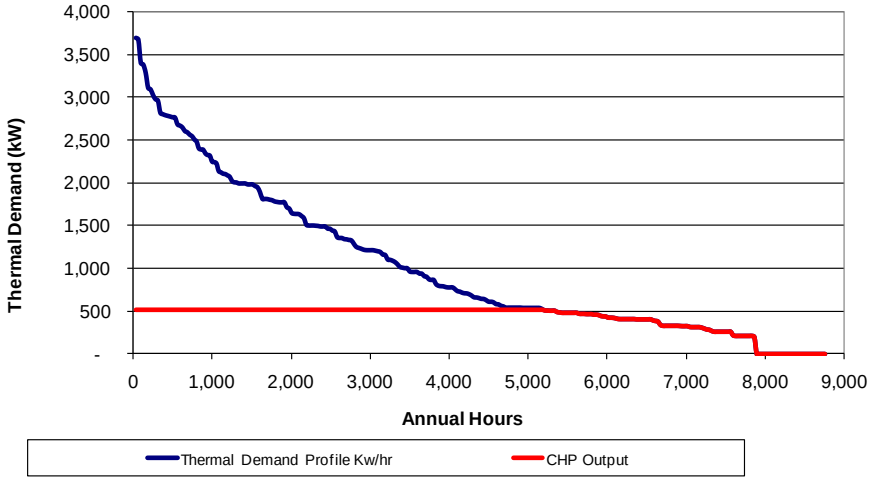
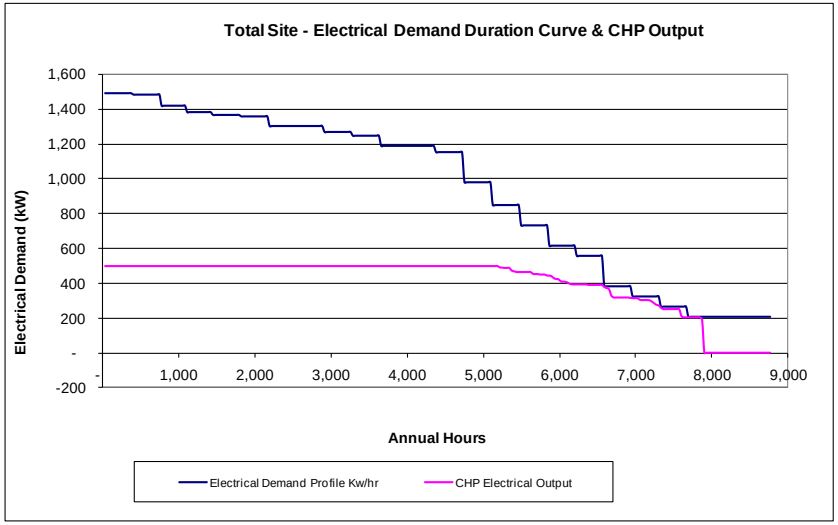
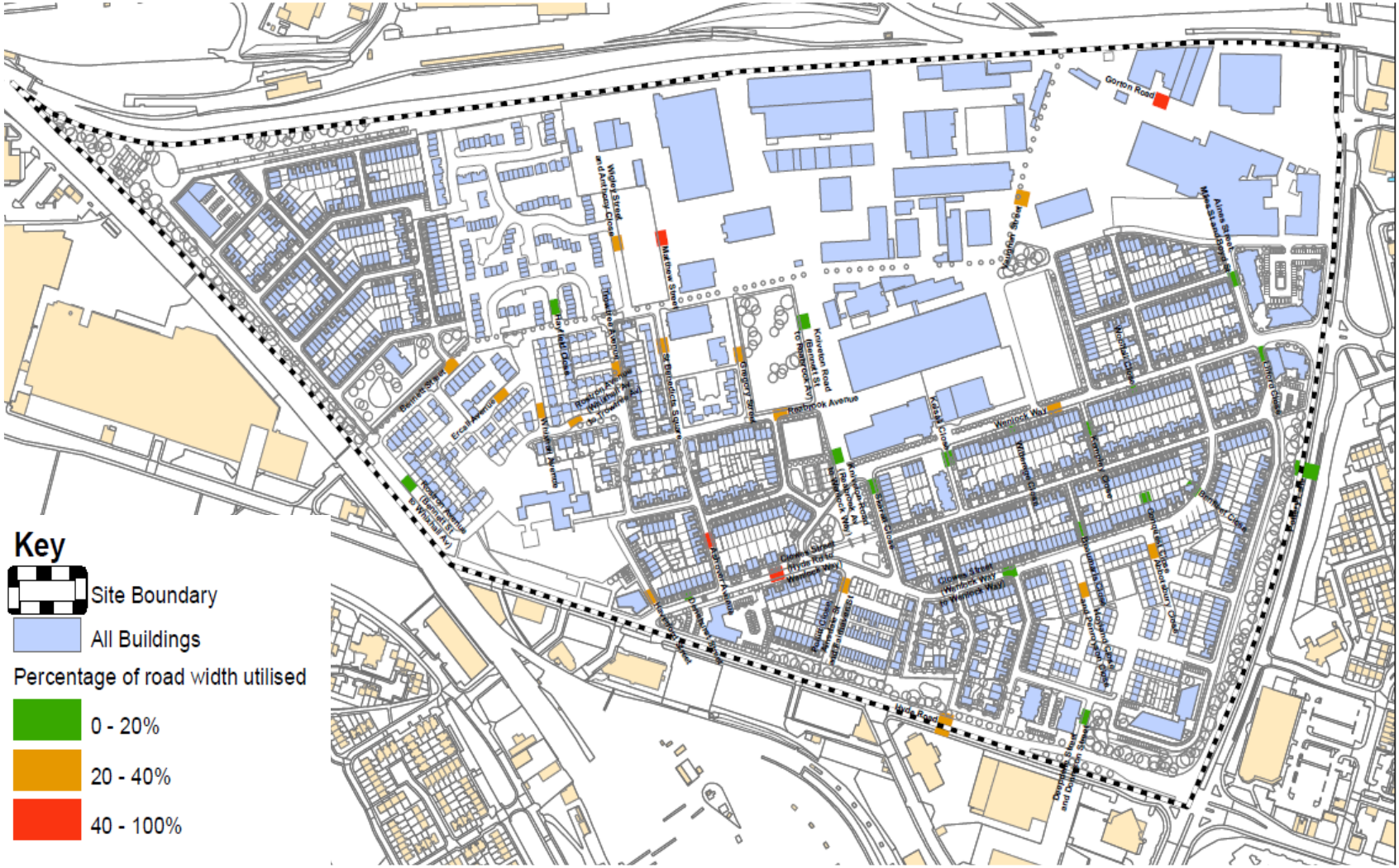
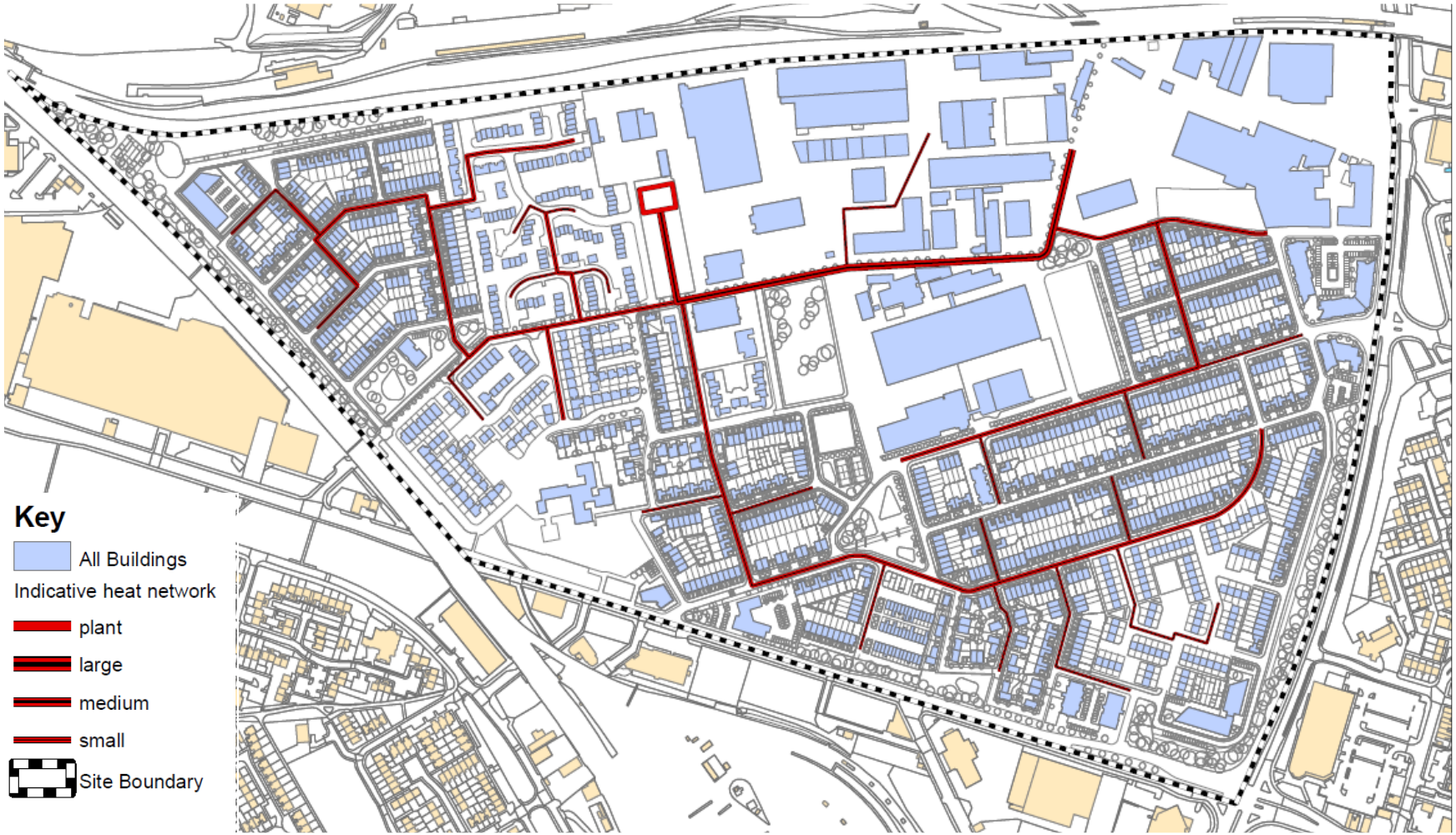
- Heat and electricity duration curves key to plant sizing.
- Implications on land requirement and location of plant.

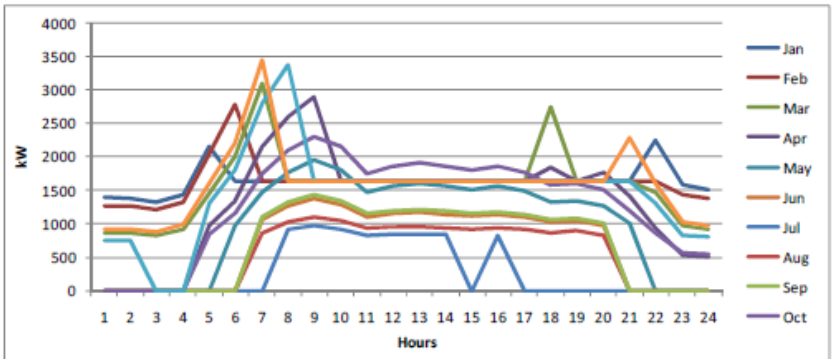




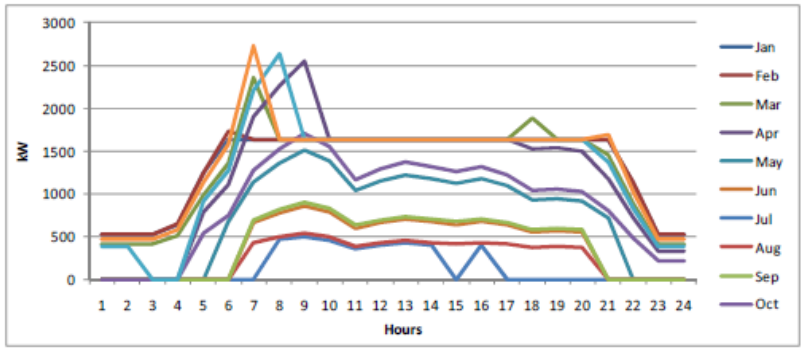
- **Option 1:** A combined heat and power (CHP) plant to produce both heat and electricity (to national grid)
- **Option 2:** A CHP plant that produces electricity directly to the end users through a dedicated, and privately owned, wire.
- **Option 3:** A biomass boiler plant. This option produces heat only.


Key
Site Boundary
All Buildings
Percentage of road width utilised
0 - 20%
20 - 40%
40 - 100%

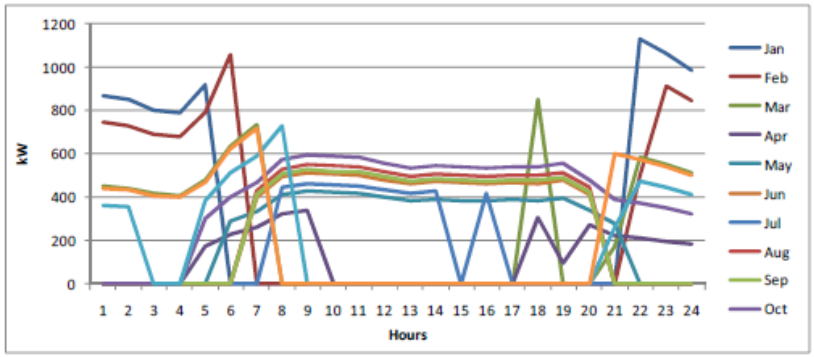

Key
All Buildings
Indicative heat network
plant
large
medium
small
Site Boundary



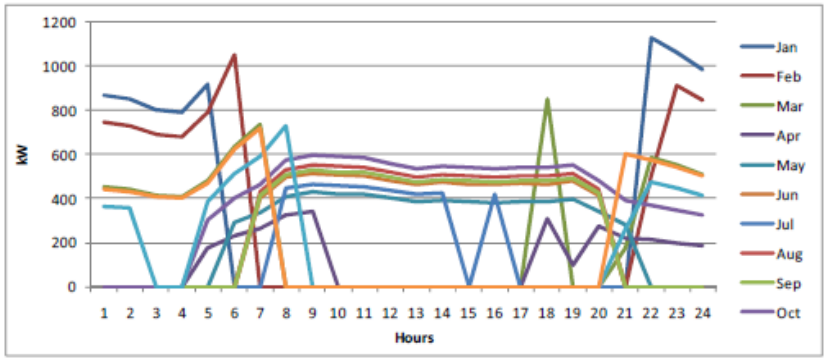
Profile of how the CHP and thermal store deliver heat to the buildings opposite:



This graph shows much of the heat generated by the CHP is used by the Town Hall complex.



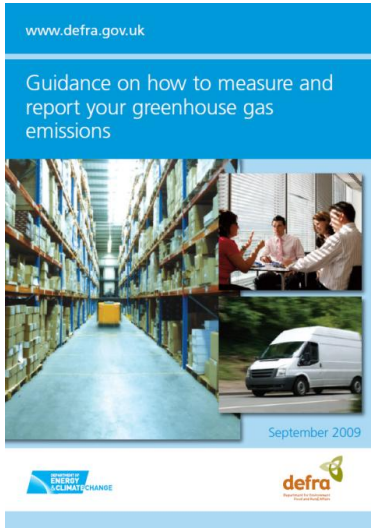
Graph shows the remaining available heat after the Council use what they can.

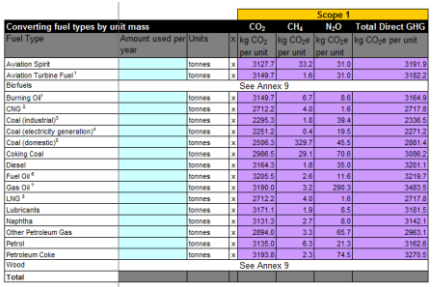


Graph shows that all the remaining available heat can be used by the hotel according to their demand profile. This is due to how the CHP is operating in accordance to the combined heat demand of all the buildings connected. In the model, no surplus heat is generated by the CHP.

Stage 4: Calculating Carbon

- National Calculation Methodology - Standard Assessment Procedure (SAP)
- Other sources DEFRA / Carbon Trust



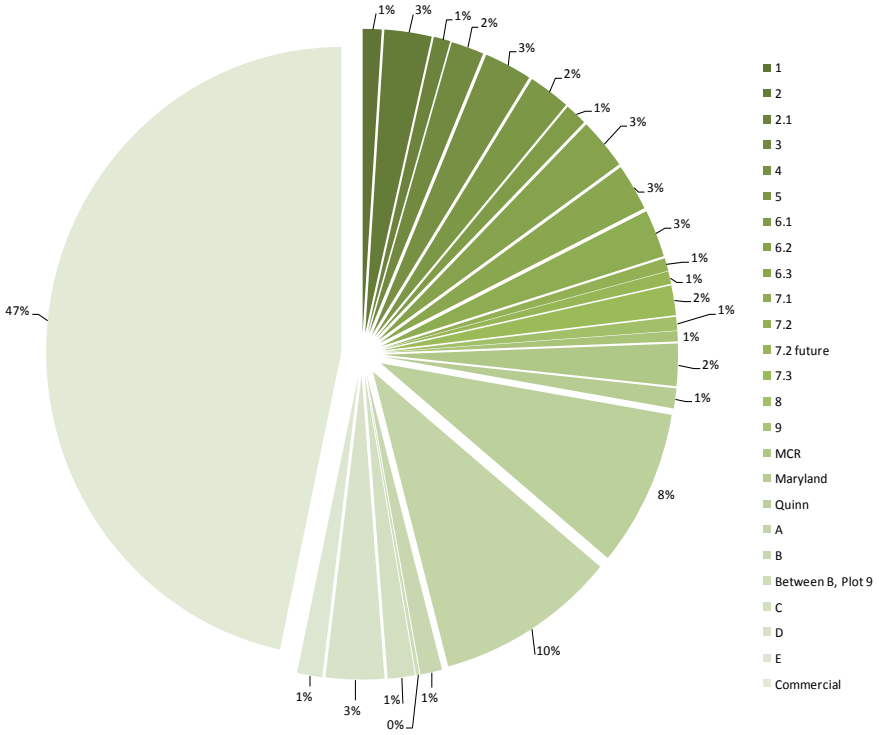


Converting fuel types by unit mass				Scope 1			
				CO_2	CH_4	N_2O	Total Direct GHG
Fuel Type	Amount used per year	Units	x	kg CO_2 per unit	kg CO_2e per unit	kg CO_2e per unit	kg CO_2e per unit
Aviation Spirit		tonnes	x	3127.7	33.2	31.0	3191.9
Aviation Turbine Fuel[1]		tonnes	x	3149.7	1.6	31.0	3182.2
Biofuels				See Annex 9			
Burning Oil[1]		tonnes	x	3149.7	6.7	8.6	3164.9
CNG[1]		tonnes	x	2712.2	4.0	1.6	2717.8
Coal (industrial)[2]		tonnes	x	2295.3	1.8	39.4	2336.5
Coal (electricity generation)[2]		tonnes	x	2251.2	0.4	19.5	2271.2
Coal (domestic)[2]		tonnes	x	2506.3	329.7	45.5	2881.4
Coking Coal		tonnes	x	2966.5	29.1	70.6	3066.2
Diesel		tonnes	x	3164.3	1.8	35.0	3201.1
Fuel Oil[4]		tonnes	x	3205.5	2.6	11.6	3219.7
Gas Oil[1]		tonnes	x	3190.0	3.2	290.3	3483.5
LNG[1]		tonnes	x	2712.2	4.0	1.6	2717.8
Lubricants		tonnes	x	3171.1	1.9	8.5	3181.5
Naphtha		tonnes	x	3131.3	2.7	8.0	3142.1
Other Petroleum Gas		tonnes	x	2894.0	3.3	65.7	2963.1
Petrol		tonnes	x	3135.0	6.3	21.3	3162.6
Petroleum Coke		tonnes	x	3193.8	2.3	74.5	3270.5
Wood				See Annex 9			
Total							

- Uses calculations for electricity and thermal demand.

- Two ways of calculating for developments:
  1. Based on energy efficiency standard of building only. CO_2 produced through the conversion of fuel to electricity and heat
  2. Taking full account of building standards and the 'offsetting' through energy infrastructure that will be required to meet standards

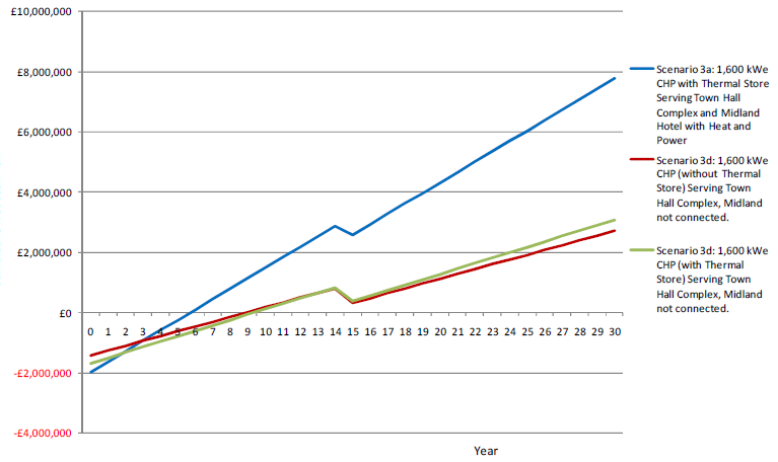
- Assess at individual plots levels in addition to overall development



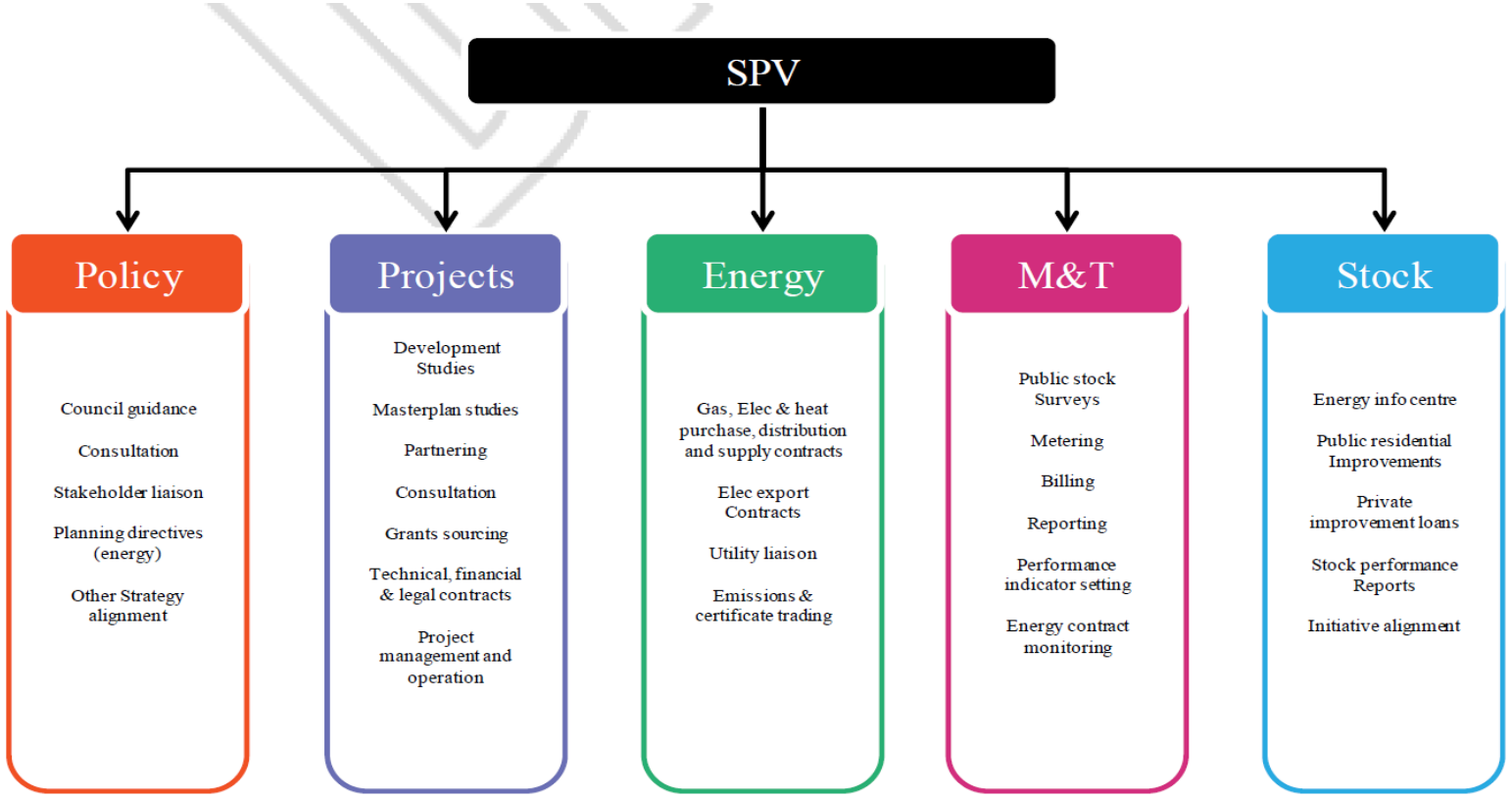
Stage 5: Deliverability and Viability

- Simple Payback
- Net Present Value
- Internal Rate of Return
- Other measures:
  - Discount factor
  - Cost of connecting buildings to the heat network
  - Cost of the heat network
  - Biomass and Gas Fuel Price
  - Electricity price

Economic Viability Ranking	Scenario	CHP Capacity (kWe)	Capital Cost (£)	Simple Annual Cash Flow (£/year)	Simple Payback (years)
1	Scenario 3a **with** thermal storage	1,600	£1,954,000	£293,000	6.7
2	Scenario 3b **with** thermal storage	1,600	£1,954,000	£183,000	10.7
3	Scenario 3a **without** thermal storage	1,600	£1,823,000	£146,000	12.5
4	Scenario 2 **with** thermal storage	2,000	£3,632,000	£290,000	12.5
5	Scenario 3b **without** thermal storage	1,600	£1,823,000	£138,000	13.2
6	Scenario 1a **with** thermal storage	460	£1,142,000	£80,000	14.3
7	Scenario 1b **with** thermal storage	460	£1,142,000	£77,000	14.7



Connection costs	Cost of heat network	Fuel Costs
Obstacles and barriers between the building and the district heating network	Extension of the district heating network	Market value Length of contract
Compatibility of the building's heating system with the district heating heat supply (temperatures, pressure)	Obstacles and barriers between the buildings and the district heating network	Quantity
Space available in the plant room	Heat peak demand	Operator credit risk
Accessibility to the plant room in the building	Construction risk	Recourse limitations


SPV
Policy
Council guidance
Consultation
Stakeholder liaison
Planning directives (energy)
Other Strategy alignment
Projects
Development Studies
Masterplan studies
Partnering
Consultation
Grants sourcing
Technical, financial & legal contracts
Project management and operation
Energy
Gas, Elec & heat purchase, distribution and supply contracts
Elec export Contracts
Utility liaison
Emissions & certificate trading
M&T
Public stock Surveys
Metering
Billing
Reporting
Performance indicator setting
Energy contract monitoring
Stock
Energy info centre
Public residential Improvements
Private improvement loans
Stock performance Reports
Initiative alignment

ARUP