HEAT VISION 2030

Accelerating Heat Network Deployment

Breaking down the barriers to city centre heat network deployment

What makes District Energy happen over & over?

HEAT VISION 2030

Accelerating Heat Network Deployment

Low Risk

Predictable

Repeatable

R.O.I.

What are the barriers to heat network deployment?

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Offtake surety

Electricity price

Heat price v Gas price

Public engagement

Stakeholder buy-in

Regulatory mix

Lack of data on demand and what is under the ground

What is the methodology?

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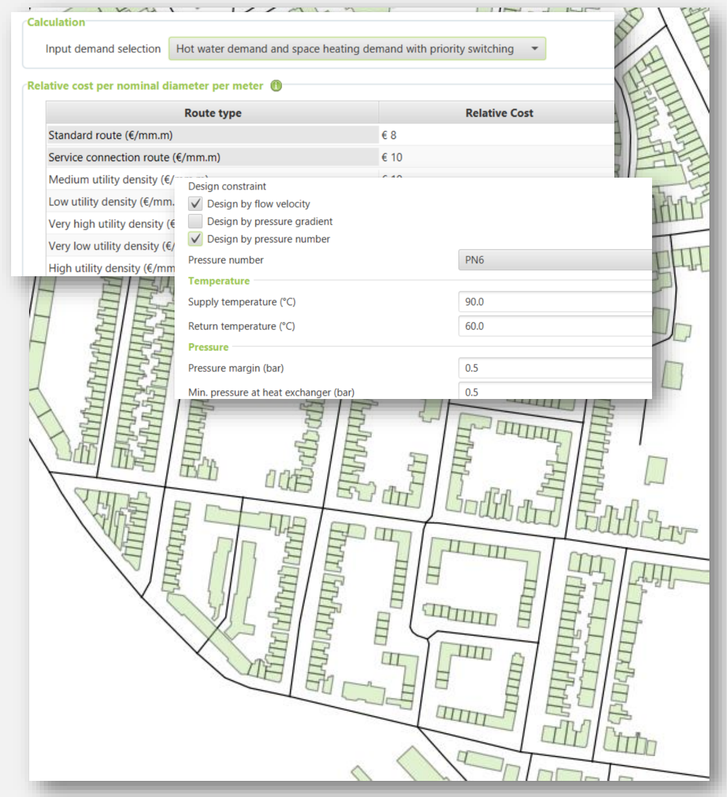
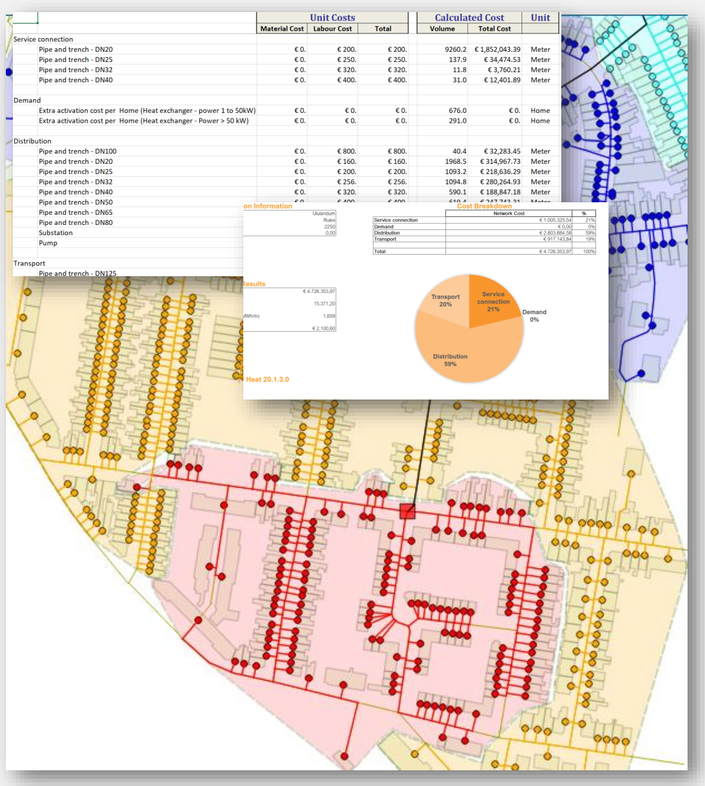
Accelerating Heat Network Deployment

PLANNING METHODOLOGY

COMSOF HEAT



INPUT: GIS, HEAT DEMAND, DESIGN & COST PARAMETERS



OUTPUT: NETWORK, BOM and COSTS

INSPECT RESULTS - GENERATE BILL OF MATERIAL

Results

Calculation Information

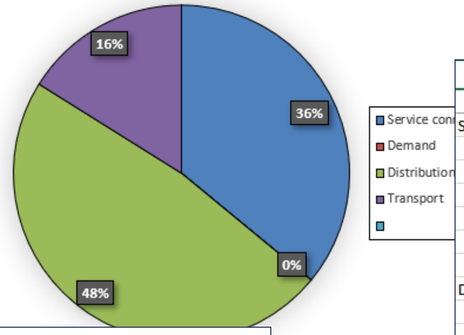
Area Name	demo 5
Design Rules	Rules
Number of Homes	967
Household Density (hh/sqkm)	0,00

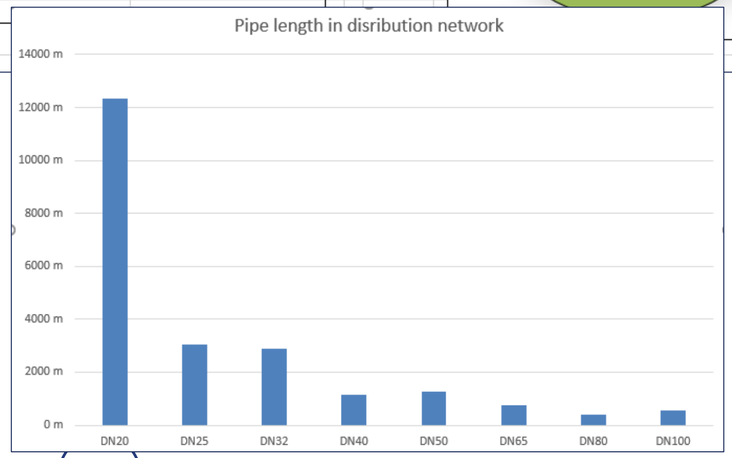
Cost Breakdown

	Network Cost	%
Service connection	€ 2.594.840,18	36%
Demand	€ 0,	0%
Distribution	€ 3.457.628,83	48%
Transport	€ 1.161.781,64	16%
Total Cost	€ 7.214.250,66	100%

Results

Total Cost of Project	€ 7.214.250,66
Total Public trench length (m)	23.729,57
Deployment Cost per Home	€ 7.460,45



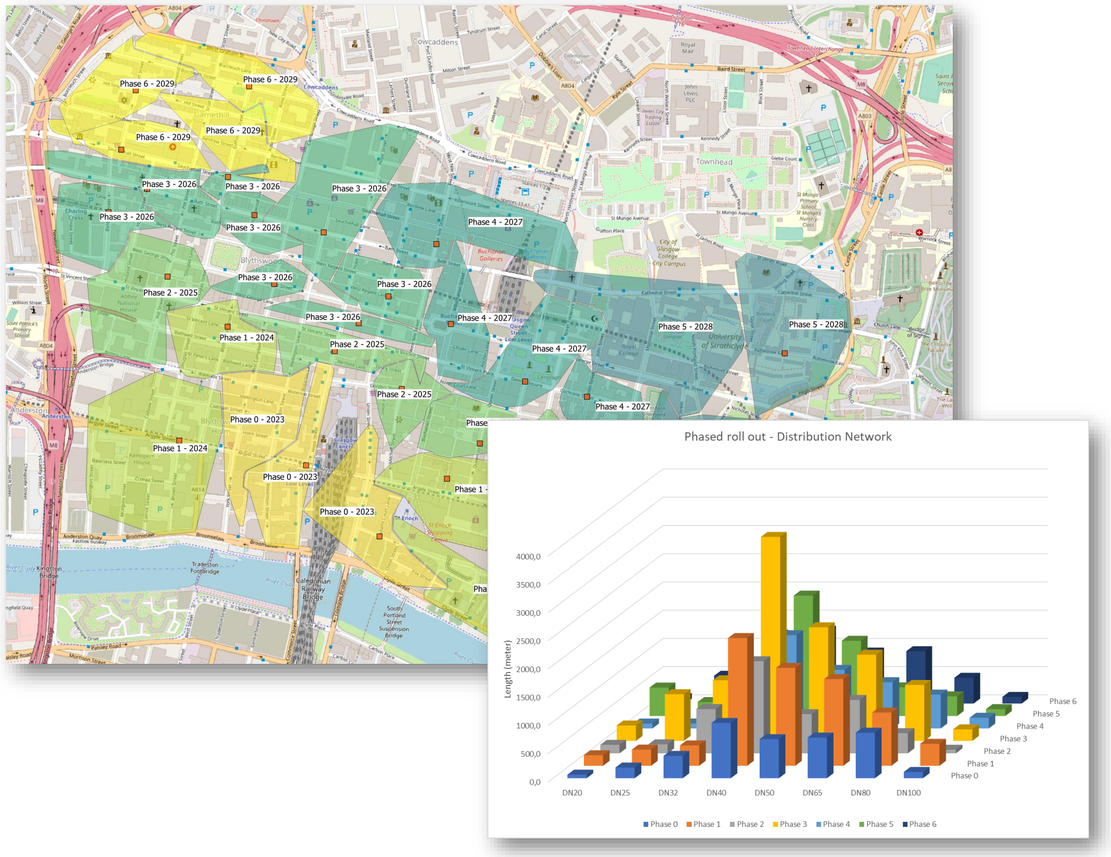


	Unit Costs			Calculated Cost		Unit
	Material Cost	Labour Cost	Total	Volume	Total Cost	
Service connection						
Trench and pipe - DN20	€ 0,	€ 200,	€ 200,	10451,2	€ 2.090.230,8	Meter
Trench and pipe - DN25	€ 0,	€ 250,	€ 250,	939,2	€ 234.808,71	Meter
Trench and pipe - DN32	€ 0,	€ 320,	€ 320,	485,4	€ 155.315,02	Meter
Trench and pipe - DN40	€ 0,	€ 400,	€ 400,	123,9	€ 49.554,22	Meter
Trench and pipe - DN50	€ 0,	€ 500,	€ 500,	129,9	€ 64.931,44	Meter
Demand						
Extra activation cost per Home (Heat exchanger - Power > 50 kW)	€ 0,	€ 0,	€ 0,	168,0	€ 0,	Home
Extra activation cost per Home (Heat exchanger - power 1 to 50kV	€ 0,	€ 0,	€ 0,	799,0	€ 0,	Home
Distribution						
Trench and pipe - DN100	€ 0,	€ 800,	€ 800,	574,3	€ 459.435,91	Meter
Trench and pipe - DN20	€ 0,	€ 160,	€ 160,	1883,9	€ 301.430,28	Meter
Trench and pipe - DN25	€ 0,	€ 200,	€ 200,	2114,0	€ 422.796,63	Meter
Trench and pipe - DN32	€ 0,	€ 256,	€ 256,	2416,5	€ 618.614,6	Meter
Trench and pipe - DN40	€ 0,	€ 320,	€ 320,	1024,3	€ 327.767,55	Meter
Trench and pipe - DN50	€ 0,	€ 400,	€ 400,	1140,8	€ 456.307,08	Meter
Trench and pipe - DN65	€ 0,	€ 520,	€ 520,	760,2	€ 395.292,97	Meter
Trench and pipe - DN80	€ 0,	€ 640,	€ 640,	406,2	€ 259.983,83	Meter
Substation	€ 50.000,	€ 4.000,	€ 54.000,	4,0	€ 216.000,	Equipment
Transport						
Trench and pipe - DN100	€ 0,	€ 800,	€ 800,	583,6	€ 466.919,83	Meter
Trench and pipe - DN125	€ 0,	€ 1.000,	€ 1.000,	692,3	€ 692.301,81	Meter
Trench and pipe - DN80	€ 0,	€ 640,	€ 640,	4,0	€ 2.560,	Meter
Heat source	€ 0,	€ 0,	€ 0,	1,0	€ 0,	Equipment

ROLL-OUT PLANNING & INVESTMENT ANALYSIS

Comsof Heat

- Phase roll-out over multiple years

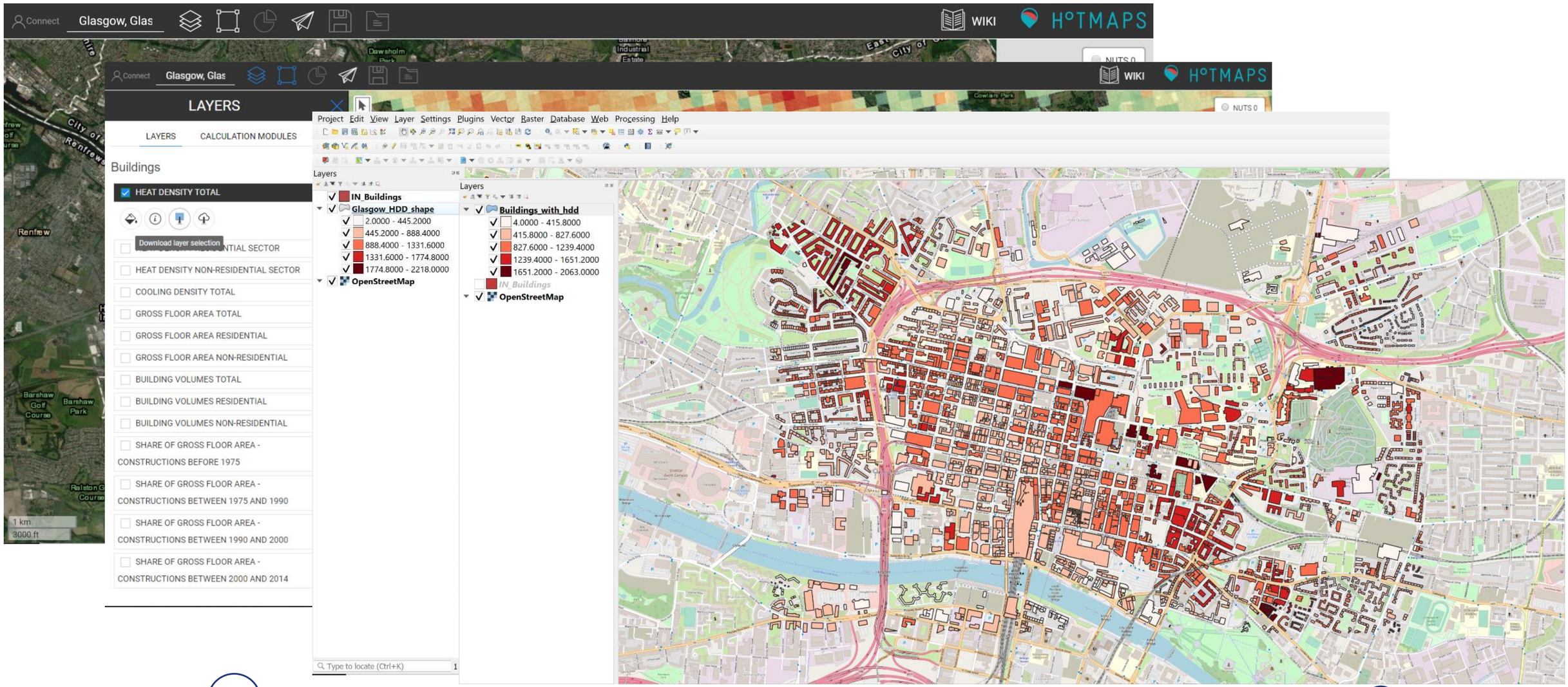


- Investment analysis
  - Net present value, IRR, Payback time
- Inputs
  - Phased network CAPEX
  - Heat production cost
  - Network maintenance cost
  - Heat sales tariff

ENERGY CONSUMPTION DATA

Heat demand data

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723677.



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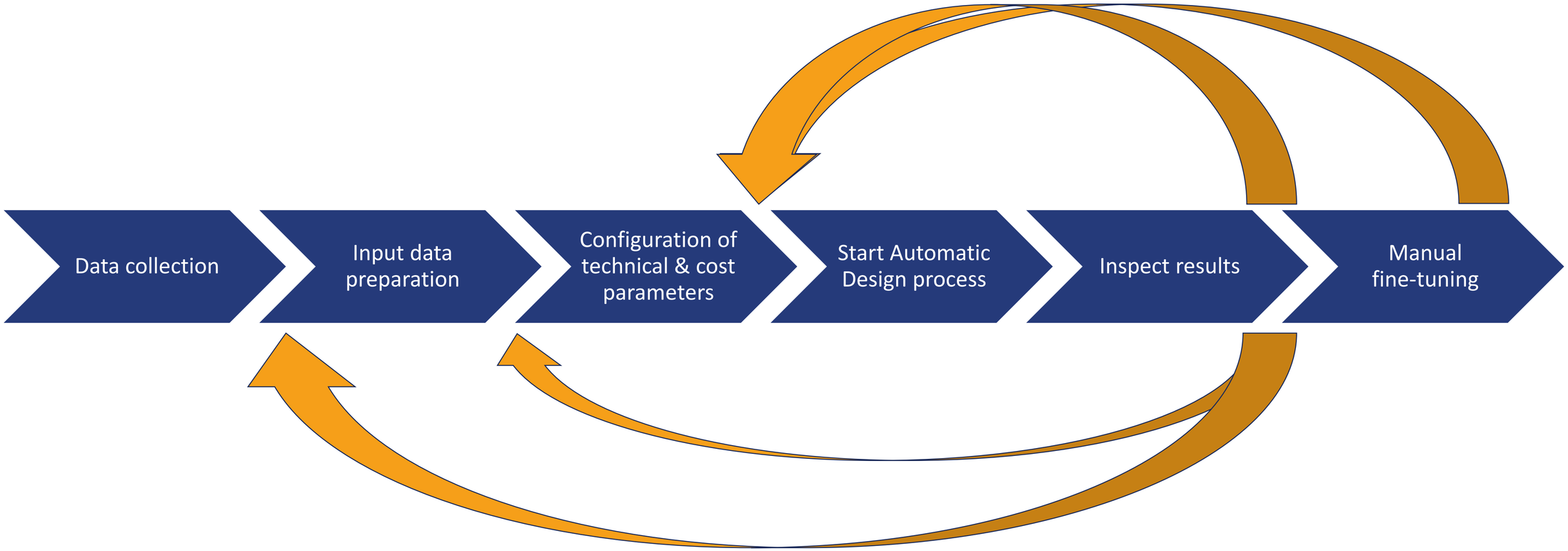
OPTIMIZE THE DESIGN

COMSOF HEAT



Create and compare multiple scenarios

COMSOF

What vision did we present the first time round?

4 districts- each with a heat pump, located on a barge in the River Clyde.

~40MW of heat required

~12MW grid connection required for the heat pumps.

Deployment over 10 years providing 100% coverage and 100% uptake.

~£100 million.

15,000 tCO_2e abated, annually.

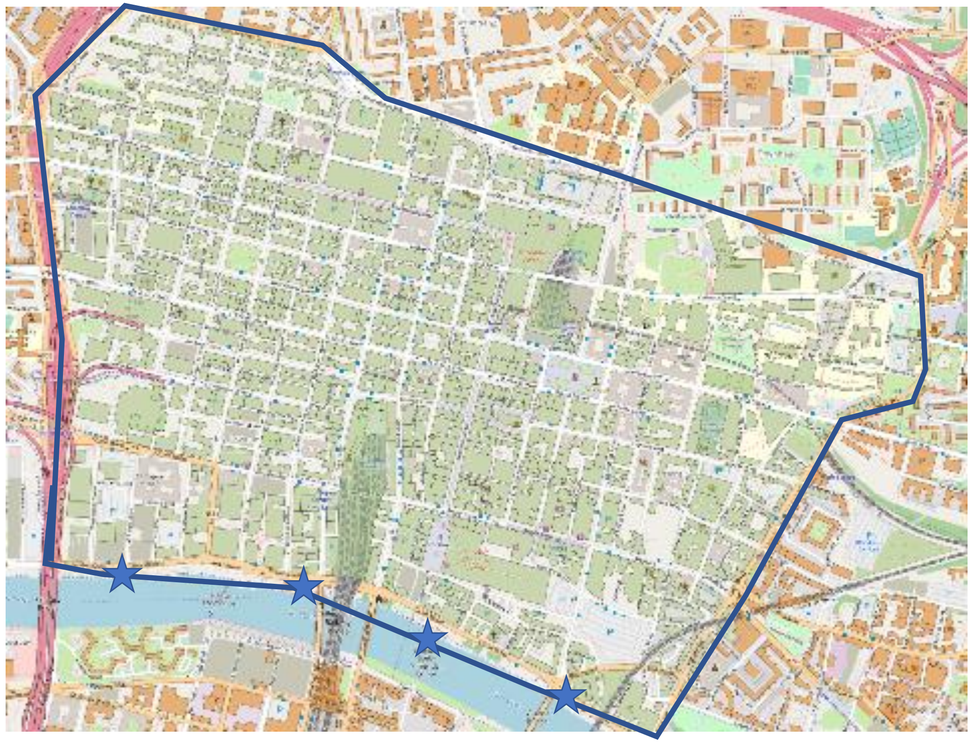
Clean air for the city - no emissions from gas boilers.

Energy resilience based on locally generated renewable electricity to run heat pumps

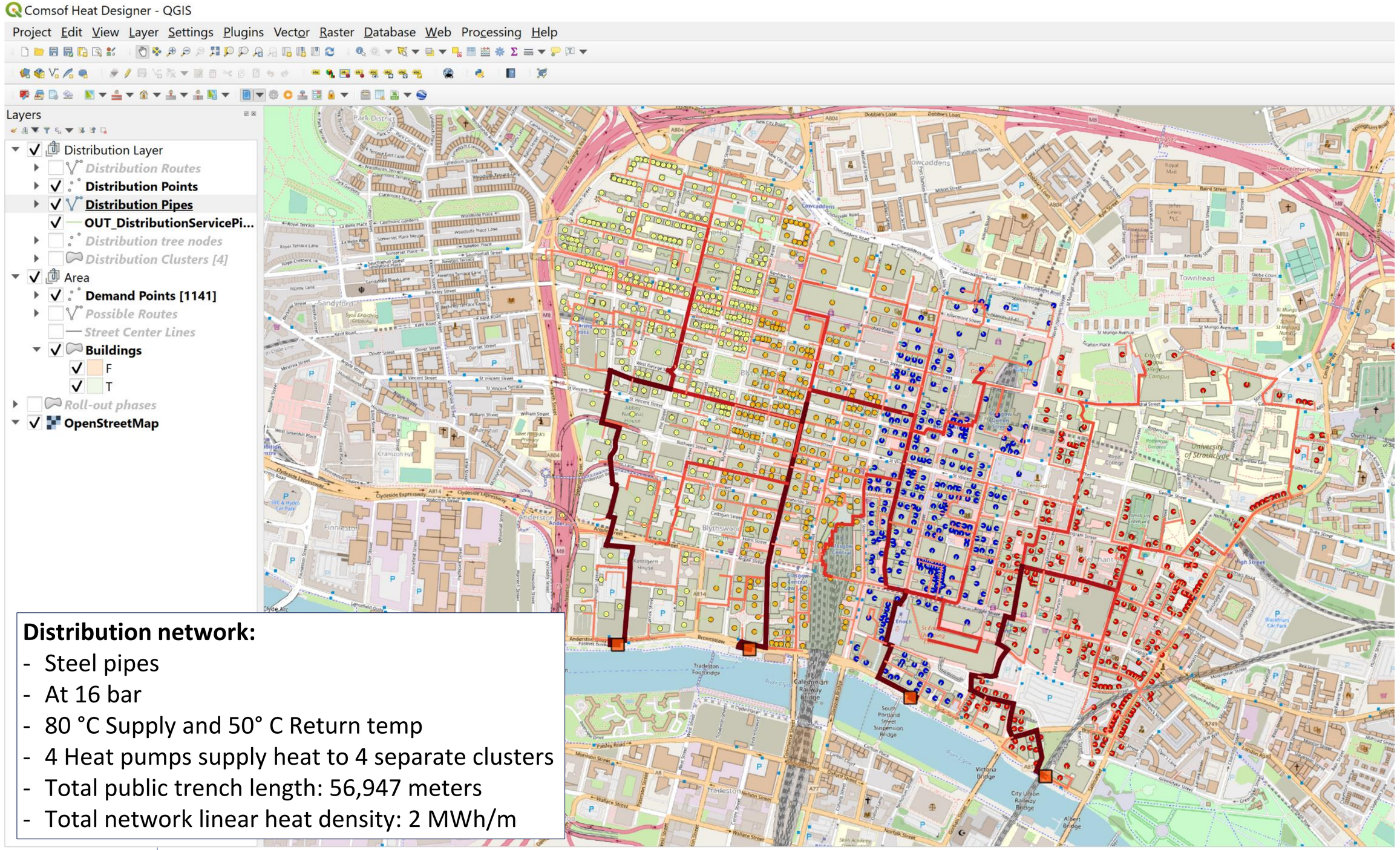
Multiple heat sources at the river

District Heating

- 4 Heat sources, approx 10 Mega Watt peak per source
- Providing heat to 4 different clusters (groups of buildings)
- Supply temperature: 80°C
- Return temperature: 50°C



★ Source locations


Comsof Heat Designer - QGIS
Project Edit View Layer Settings Plugins Vector Raster Database Web Processing Help
Layers
Distribution Layer
Distribution Routes
Distribution Points
Distribution Pipes
OUT_DistributionServicePi...
Distribution tree nodes
Distribution Clusters [4]
Area
Demand Points [1141]
Possible Routes
Street Center Lines
Buildings
F
T
Roll-out phases
OpenStreetMap
Distribution network:
- Steel pipes
- At 16 bar
- 80 °C Supply and 50° C Return temp
- 4 Heat pumps supply heat to 4 separate clusters
- Total public trench length: 56,947 meters
- Total network linear heat density: 2 MWh/m


5/2/2020 1:32 pm
Anderston
Finnieston
Glasgow
Dennistoun
Gorbals
DP 1
DP 2
DP 3
DP 4
© 2020 Google
Google Earth

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DEPLOYMENT COST CALCULATION (ASSUMPTIONS)

Glasgow

- Based on sample costs per meter pipe network including
  - Excavation
  - Supply & return pipe
  - Welding & installation costs
  - Refill and repair of top layer
  - Project management overhead

- Heat source cost (Heat pump)
  - 550,000 GBP / Megawatt

- Heat delivery unit cost

Activation Type	Lower Bound	Upper Bound	Cost
			Material
Power	1	50	£3,000.00
Power	50	100	£10,000.00
Power	100	400	£20,000.00
Power	400	1000	£50,000.00
Power	1000	∞	£75,000.00

Pipe definitions

Nominal diameter	Cost (£/m)
	Material cost
DN25	£1,000.00
DN32	£1,000.00
DN40	£1,000.00
DN50	£1,000.00
DN65	£3,000.00
DN80	£3,000.00
DN100	£3,000.00
DN125	£3,000.00
DN150	£3,000.00
DN200	£3,000.00
DN250	£3,000.00
DN300	£3,000.00
DN350	£3,000.00
DN400	£3,000.00
DN450	£3,000.00
DN500	£3,000.00
DN600	£3,000.00

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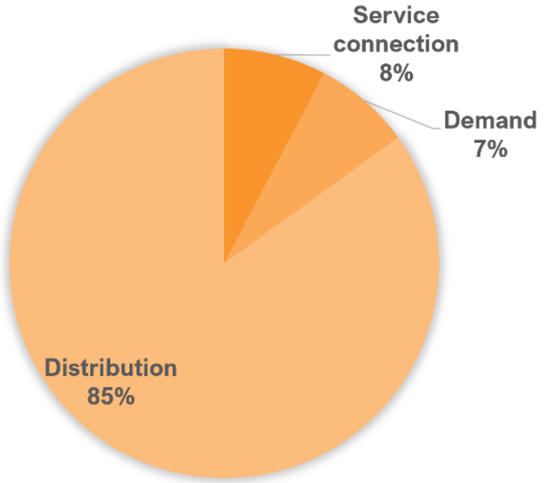
RESULTS

Glasgow

- Cost breakdown

Results

Total Cost of Project	£104,260,323.38
Total Public trench length (m)	47,354.03
Total Network linear heat density (MWh/m)	2.408
Deployment Cost per Home	£91,376.27



Cost Breakdown

	Network Cost	%
Service connection	£8,032,470.92	8%
Demand	£7,635,000.00	7%
Distribution	£88,592,852.45	85%
Total	£104,260,323.38	100%

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What did we want to take into the second round of analysis?

Whole supply of heat model

Offtake surety

Cost of heat will be crucial to making such an endeavour

investable

Better costings, more granular

Explore the financials and produce a first pass business model

What other stakeholders have a shared interest?

(Y)Our City Centre Project

Carbon Neutral Glasgow City Innovation District

New Analysis Inputs

60-year lifetime

Total area increased to match up with the (Y)Our City Centre area

100% uptake

No subsidies

4% IRR- level acceptable to public funding

1,341 buildings (domestic, apartment blocks and commercial)

£2000 a metre for pipework

£500K per 1MW for a heat pump

Energy centre includes: pontoon, grid connection, back up boilers with flues, abstraction etc.

Comparing 10p/kWh grid electricity versus 4.5p/kWh local private wire

DEPLOYMENT COST CALCULATION (NEW ASSUMPTIONS)

Glasgow

- Based on sample costs per meter pipe network including
  - Excavation
  - Supply & return pipe
  - Welding & installation costs
  - Refill and repair of top layer
  - Project management overhead
- Heat source cost (Heat pump & Energy Centre)
  - 1,600,000 GBP / Megawatt
- Intermediate pump cost – 60,000 GBP / Megawatt
- Heat delivery unit cost

Heat exchangers

Activation Type	Demand Identifier	Lower Bound	Upper Bound	Cost	
				Material	Labour
Power		1	50	£2,500.00	£750.00
Power		50	100	£10,000.00	£2,000.00
Power		100	400	£20,000.00	£10,000.00
Power		400	1000	£75,000.00	£150,000.00
Power		1000	∞	£100,000.00	£150,000.00

Activation Type: Home | Identifier

Tariff

Identifier	Tariff (£/kW)	Connection fee (£/Building)	Monthly fee (£/Home)
<default>	£0.12	£0.00	£15.00

Pipe definitions

Nominal diameter	Cost (£/m)
	Material cost
DN25	£2,000.00
DN32	£2,000.00
DN40	£2,000.00
DN50	£2,000.00
DN65	£2,000.00
DN80	£2,000.00
DN100	£2,000.00
DN125	£2,000.00
DN150	£2,000.00
DN200	£2,000.00
DN250	£2,000.00
DN300	£2,000.00
DN350	£2,000.00
DN400	£2,000.00
DN450	£2,000.00
DN500	£2,000.00
DN600	£2,000.00
DN700	£2,000.00
DN800	£2,000.00
DN900	£2,000.00
DN1000	£2,000.00

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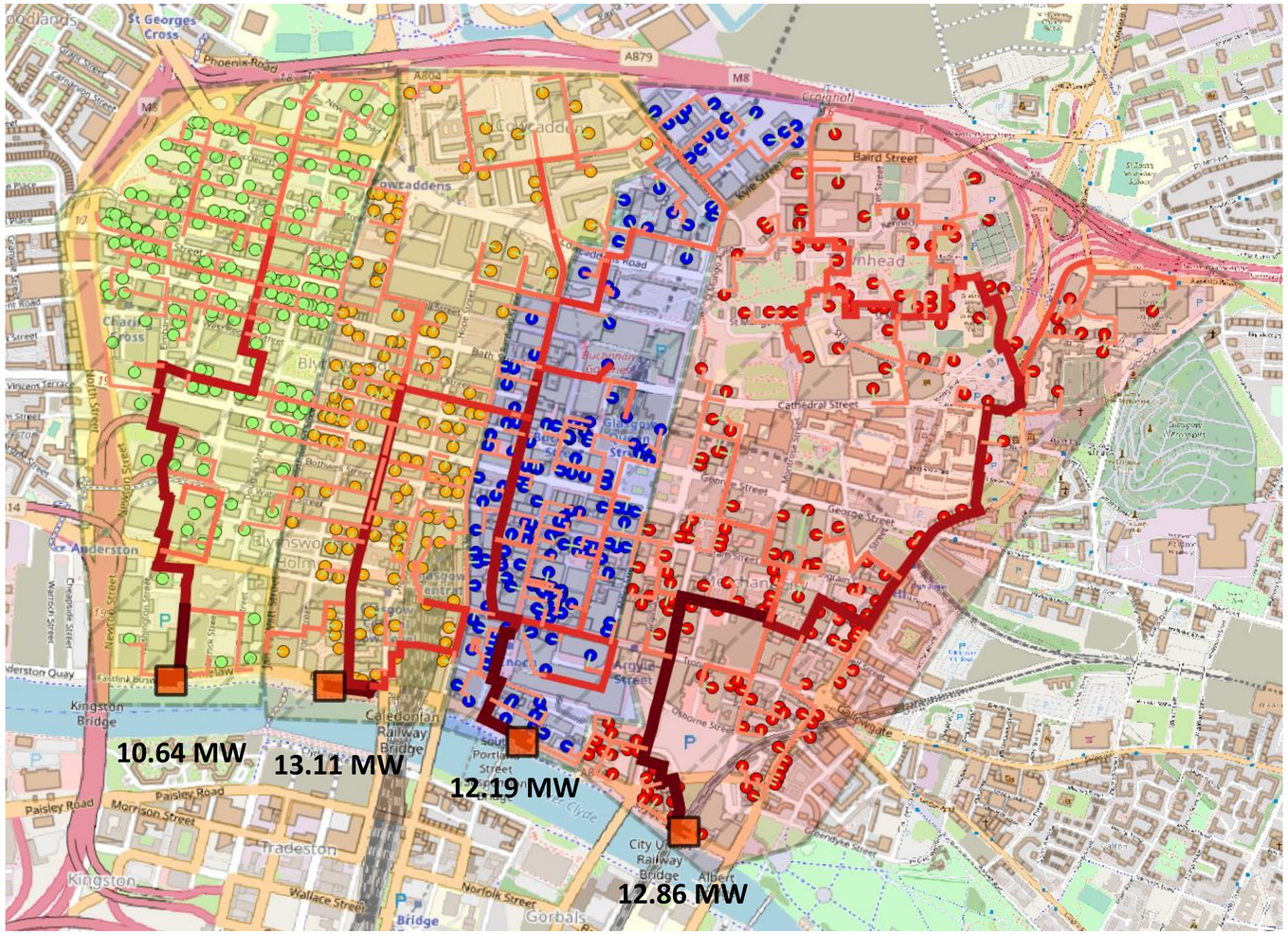
MODIFIED NETWORK DESIGN

Glasgow



74km of pipework

49MWth of river-source heat pump

140GWh of Heat Sales

Can we get a private wire agreement with Polmadie EfW?

Plenty of electricity and waste heat just a couple of miles down the road…

DP

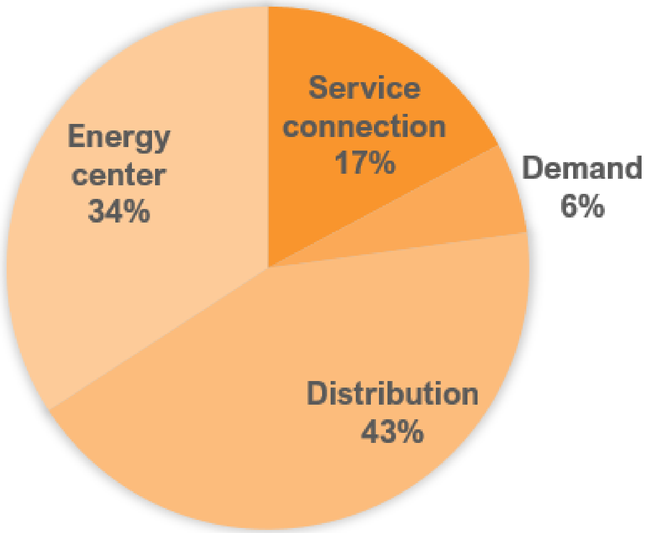
NEW RESULTS – 100% UPTAKE

Glasgow

- Cost breakdown

Results

Total Cost of Project	£252,394,095.39
Total Public trench length (m)	73,674.32
Total Network linear heat density (MWh/m)	1.904
Deployment Cost per Home	£188,213.34



Cost Breakdown

	Network Cost	%
Service connection	£43,419,181.63	17%
Demand	£14,223,250.00	6%
Distribution	£108,498,847.76	43%
Energy center	£86,252,816.00	34%
Total	£252,394,095.39	100%

DP

COMSOF

Financial Modelling

Cost of Electricity (grid)	£33/MWh		
Price of heat	IRR	NPV	Payback time
£0.12	3.00%	-£37,212,251.00	32.00
£0.10	1.47%	-£87,247,726.00	43.00
£0.08	-0.049%	-£137,283,201.00	N/A
£0.06	-3.96%	-£187,318,676.00	N/A
Cost of Electricity (private wire)	£15/MWh		
Price of heat	IRR	NPV	Payback time
£0.12	4.40%	£15,778,670.00	26.00
£0.10	3.08%	-£34,256,804.00	32.00
£0.08	1.570%	-£84,292,279.00	42.00
£0.06	-0.35%	-£134,327,755.00	N/A

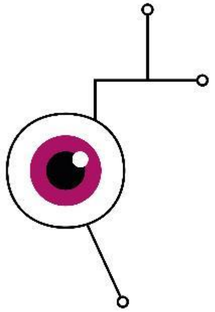
Note: We can add in a connection fee per building which is standard practice in Holland e.g. approximately 5,000 Euros initial connection fee

Financial Modelling

Maximum after full deployment (year 12 onwards)							
Price of heat	IRR	Annual Operational expenditure	Annual Revenue	Heat supply MWth/ Annum	tCO2e of natural gas (.225kg/kWh)	tCO23 UK Grid at current carbon intensity (.83kg/kWh)	tCO2e zero carbon private wire/ future grid (0.0kg/kWh)
£0.06	-0.35%	£ 4,447,861.75	£ 9,822,427.25	140,000	31,500	11,620	-

Note: We can add in a connection fee per building which is standard practice in Holland e.g. approximately 5,000 Euros initial connection fee

Conclusions

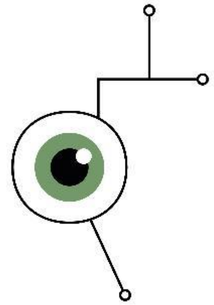


- Electricity at £15/MWh
- Heat at 6p/kWh
- Publicly funded build of £250 million
- OpEx cost of £250 million
- Revenue of £750 million
- Additional government subsidy of ~ £2.25 million annually over lifetime
- 31,500 tonnes of CO2e abated annually
- All end users buy into the heat network

A city centre heat network is for the Common Weal

- Private funding- X
- Heat below price of Gas- X
- End users get a choice of heat- X

Conclusions



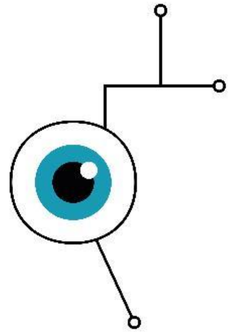
~£150 net cost to abate each tCO2e over project lifetime

versus

£350 social cost per tonne emitted

(Nature, September 2018)

Conclusions



BIG **Wins**:

Carbon Savings

Energy Resilience

Air Quality

Job Creation

BIG **Unknowns**:

Future heat loads?

What's in the ground?

Can we get cheap electricity and cheap heat locally?

Can we cooperate and collaborate?

BIG **Challenges**:

Fuel Poverty- fuel issue or poverty issue?

Price of heat- low price or low demand?

Get people to love the heat network?

The Gaps

HEAT VISION 2030
Accelerating Heat Network Deployment

Mandate gas consumption reporting per building

We need real data

Is legislation fit for purpose?

Are we being realistic about the timescale to accelerate deployment?

What additional benefits can DHN deliver- ‘Happier, safer, greener city’

Digging up the roads- highly complex and expensive

What is the tax back from the government spend?

How many jobs are created?

What does the future of Glasgow city centre look like?