Are heat networks the answer?

David Pearson

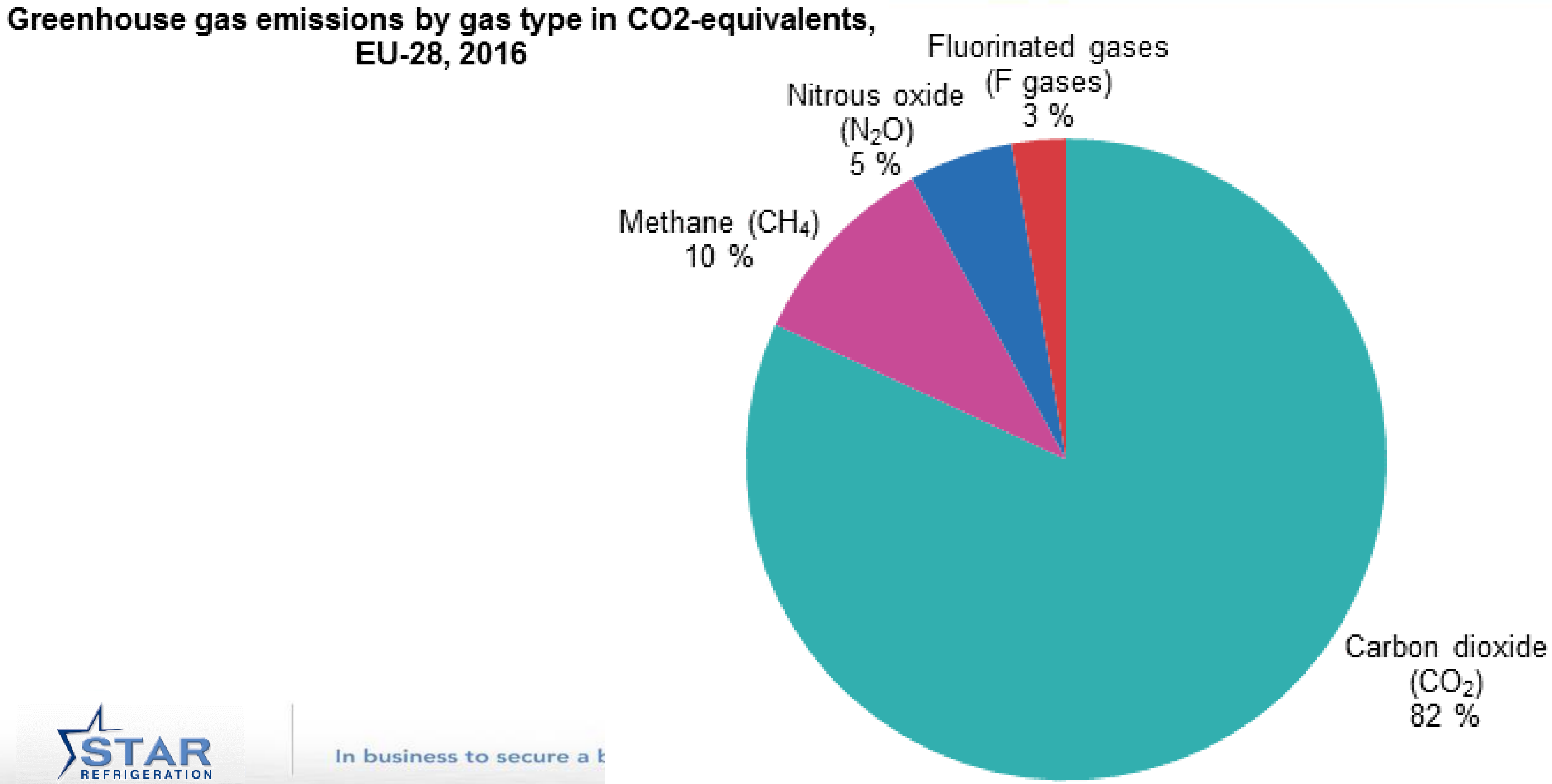
STAR RENEWABLE ENERGY

1st question is what sort of future do we aspire to?

- **Do we want……..**

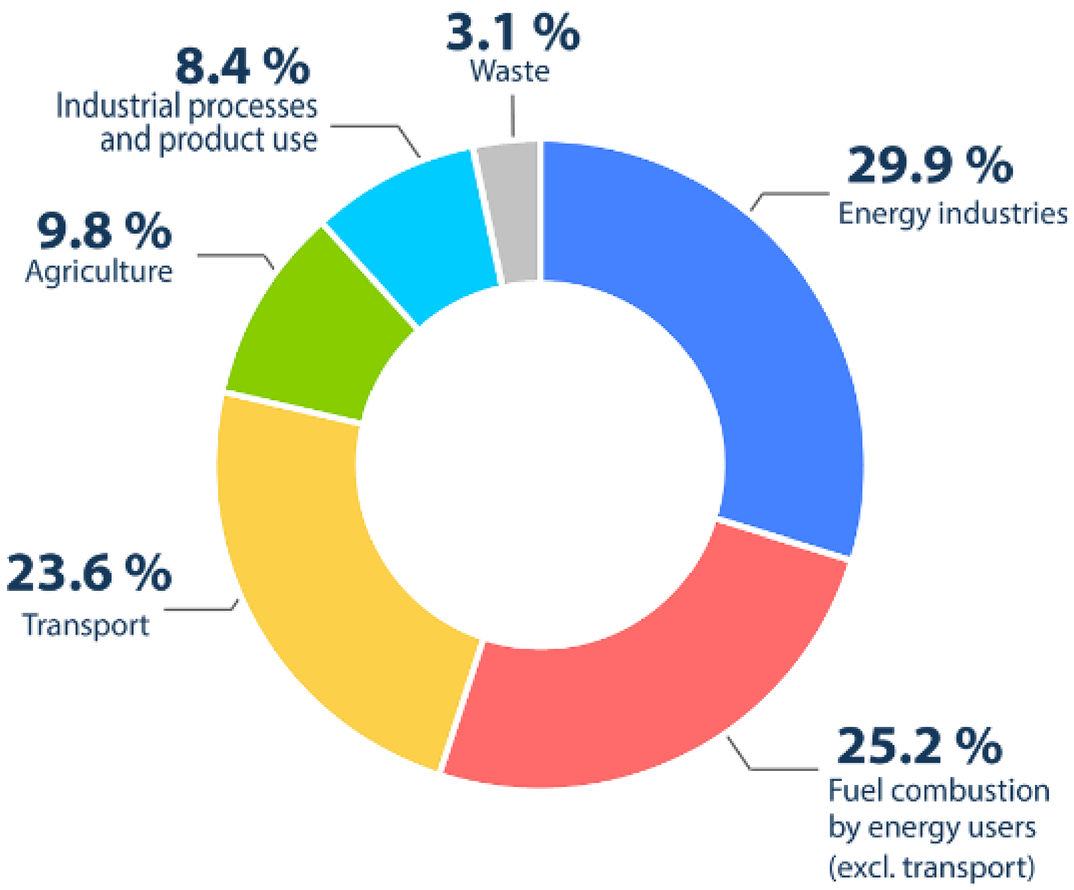
Renewable Energy | Energy efficiency | Clean air | Supply security | Local jobs | Smart grids | Less imports

2nd question is “what’s stopping that?”



3rd question is "why?"

Share of EU greenhouse gas emission by source, 2015



Energy industries: *Emissions from fuel combustion and to a certain extent fugitive emissions from energy industries, for example in public electricity, heat production and petroleum refining.*

Fuel combustion by users (excl. transport): *Emissions from fuel combustion by manufacturing industries and construction and small scale fuel combustion, for example, space heating and hot water production for households, commercial buildings, agriculture and forestry.*

Transport: *Emissions from fuel combustion of domestic and international aviation, road transport, railways and domestic navigation.*

Agriculture: *This includes among others emissions from livestock-enteric fermentation – greenhouse gases that are produced when animals digest their food, emissions from manure management and emissions from agricultural soils.*

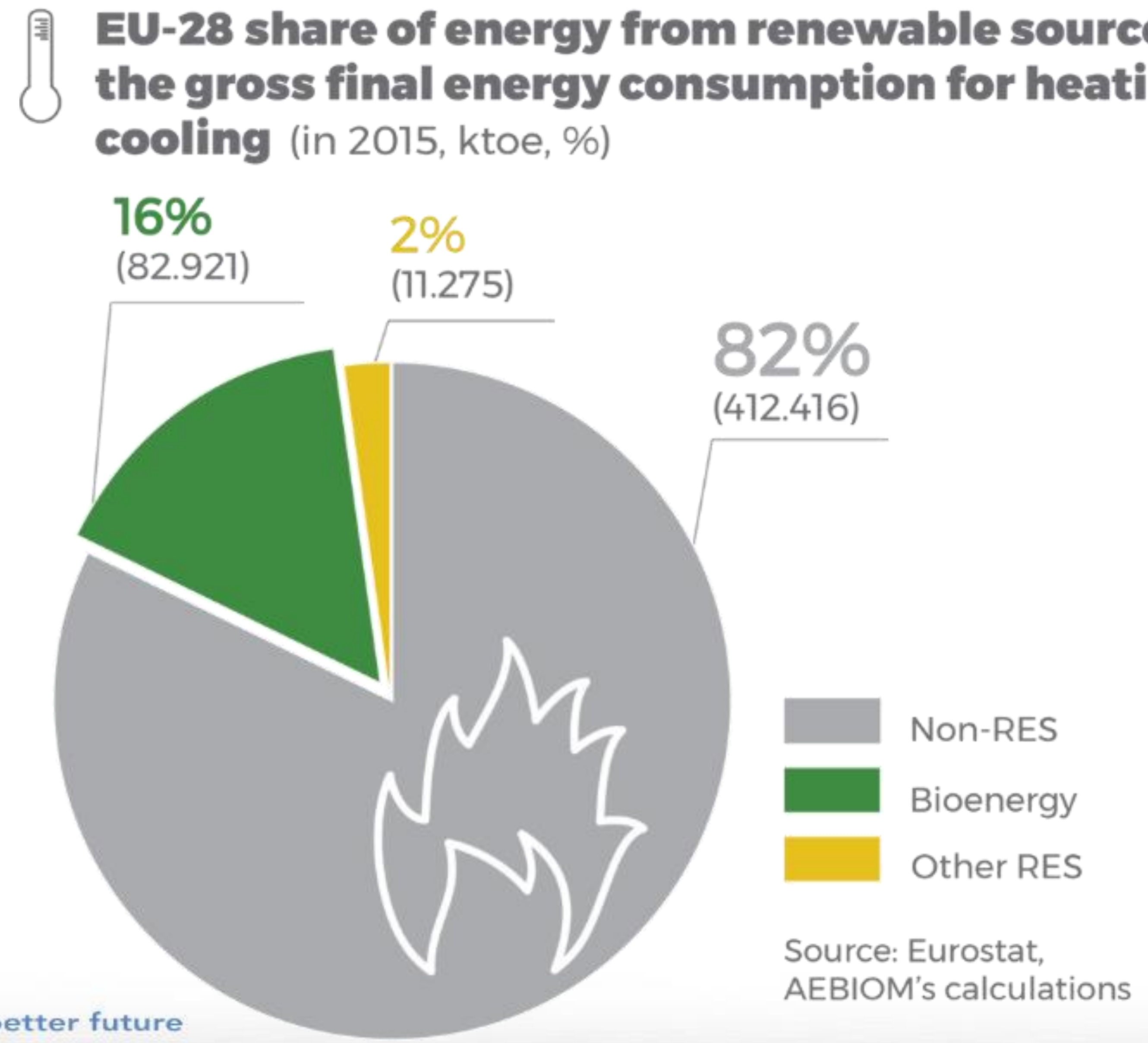
Industrial processes: *Emissions occurring from chemical reactions during the production of e.g.: cement, glass etc.*

Waste: *Emissions from landfills, wastewater treatment and composting among others.*

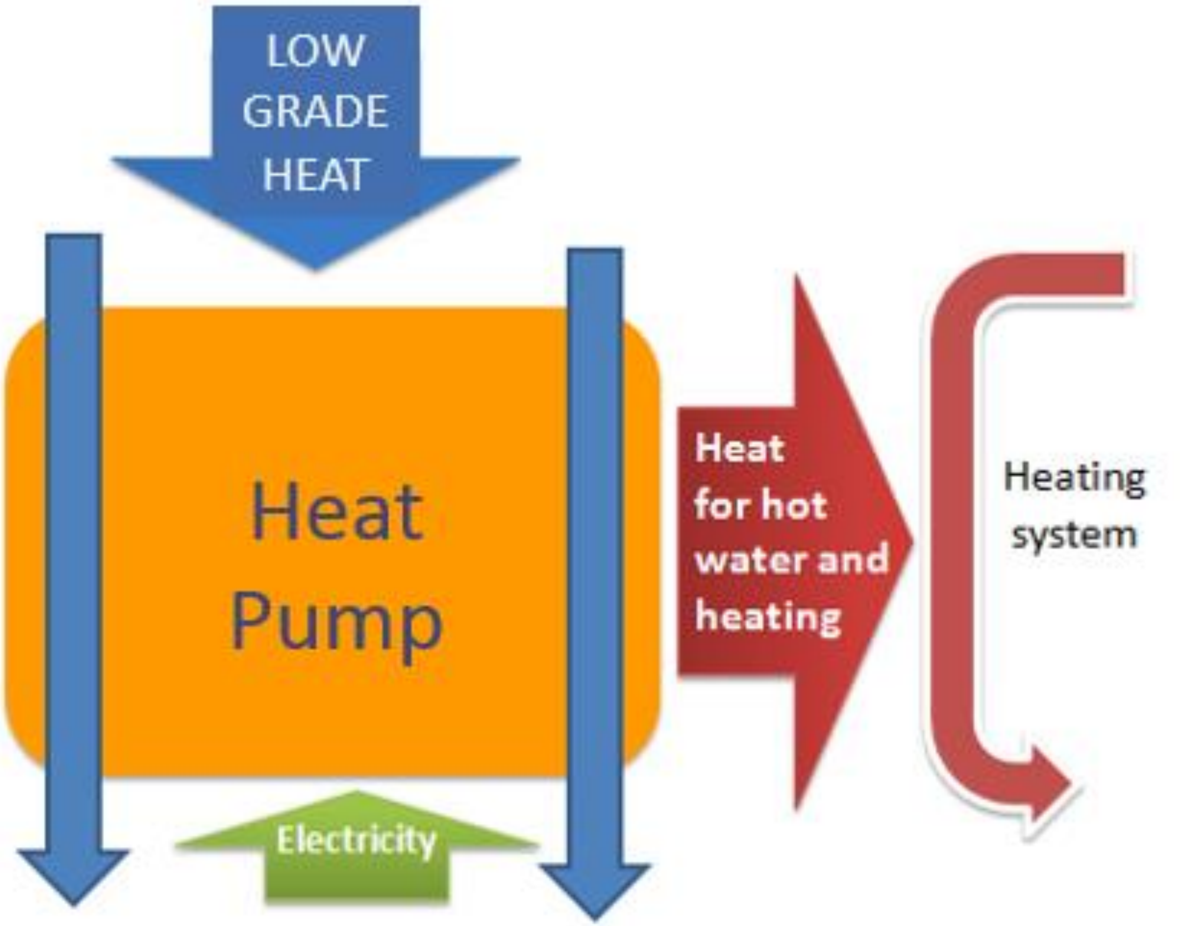
Data including international aviation, excluding indirect CO2 emissions and land use, land use charge and forestry.

Source: European Environment Agency

So what portion of heat is a problem?



So where do we use heating?


LOW
GRADE
HEAT
Heat
Pump
Electricity
Heat
for hot
water and
heating
Heating
system

New Build Houses – just do it!

Existing Low Density- simple but needs H.A.S. business model

Policy needs?

Heat as Service= Investment and risk carried by 3rd party, with maximised volume in neighbourhood

Industrial Heating – Heat pumps emerging at over 120C ……..

Higher density………… = heat networks………but how

No Gas
Not Direct Electric
Available now

= Heat pump

Whether new zones or existing, District heating can deliver now……

But what comes first? DH or Customers?

Create demand with Low Emission Zones and Obligation to Reduce Emissions

And networks will emerge

CASE STUDY: DISTRICT HEATING

DRAMMEN (the original success in 2010)

- District heating system in Drammen, Norway
- 13.2MW water sourced heat pump
- High temp (90^{o}C) water generated from 8^{o}C fjord
- Proves 85% of hot water needed to heat the city
- World’s largest 90^{o}C ammonia heat pump
- Average COP of 3.05 (over 8 years running)
- Renewable energy source
- Fully natural refrigerant
- Easily repeatable technology

CASE STUDY: DISTRICT HEATING-Queen Quay-2020 Commissioning

- 5.2MW river water sourced heat pump
- High temp (80^{o}C) water generated from 5^{o}C river
- UK's largest 80^{o}C ammonia heat pump
- Typical COP of 3
- **CO_2 circa 45% of Gas and falling**
- Zero Local NO_x

VITAL ENERGi

STAR REFRIGERATION

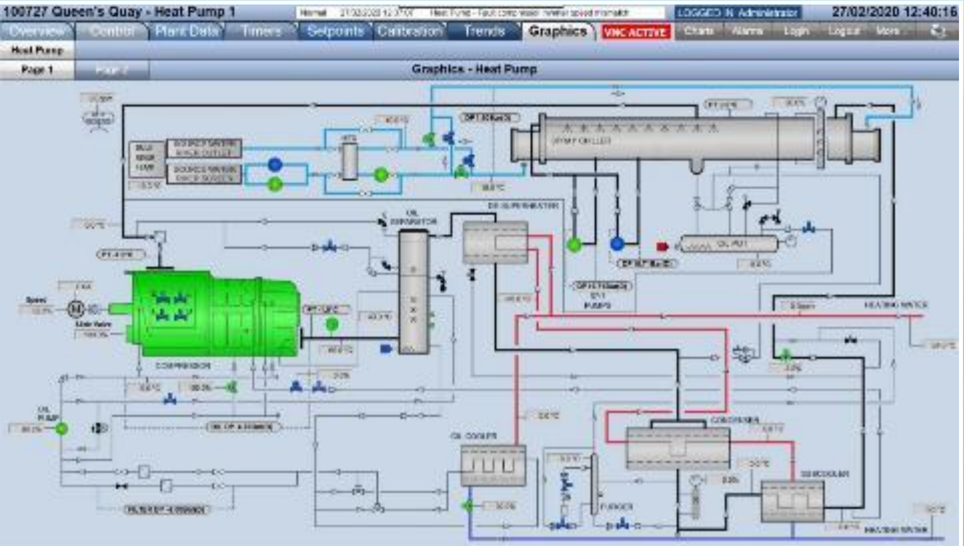
In business to secure a better future

CASE STUDY: DISTRICT HEATING-Queen Quay-2020 Commissioning

VITAL ENERGi

STAR REFRIGERATION

CASE STUDY: DISTRICT HEATING-Queen Quay-2020 Commissioning



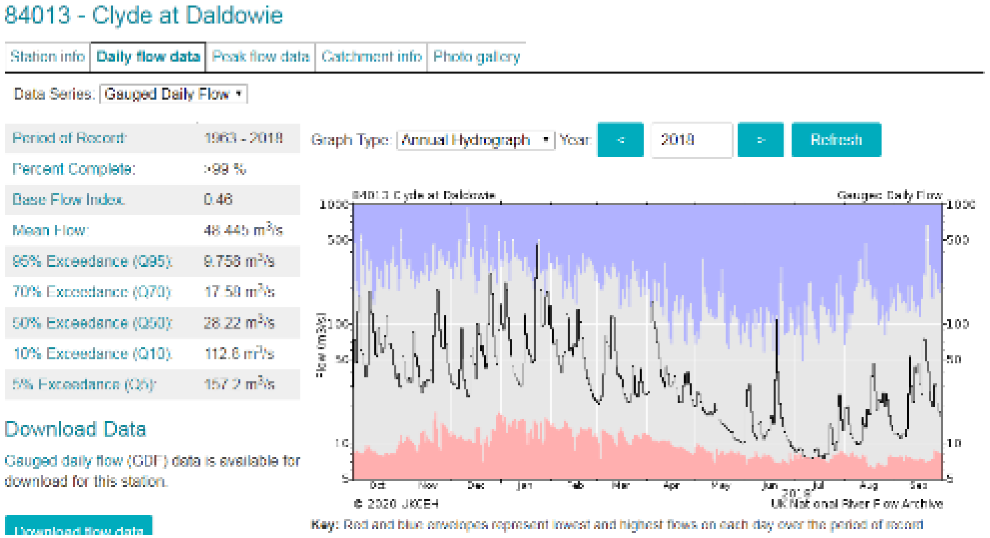
STAR REFRIGERATION

In business to secure a better future

CASE STUDY: DISTRICT HEATING-Queen Quay – UK’s Largest HT River Heat Pump

- Harnesses local energy
- Doesn’t create NOx (so clean air)
- Creates local jobs
- Allows more wind generation
- Produces cooling as well
- Can use cheapest tariff
- 3 units heat for 1 unit electricity
- 2050, 2045, 2030 Ready!

BIG river source heatpumps
as energy source



Heat Vision 2030

- Supply temp 80° C or higher
- Cascading of multiple units of 5 Mega Watt peak
- **River can support > 200 Mega Watt**

What makes District Energy happen? Over & Over

What makes District Energy happen over & over?

Low Risk

Predictable

Repeatable

R.O.I.

Scenario 2: multiple 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

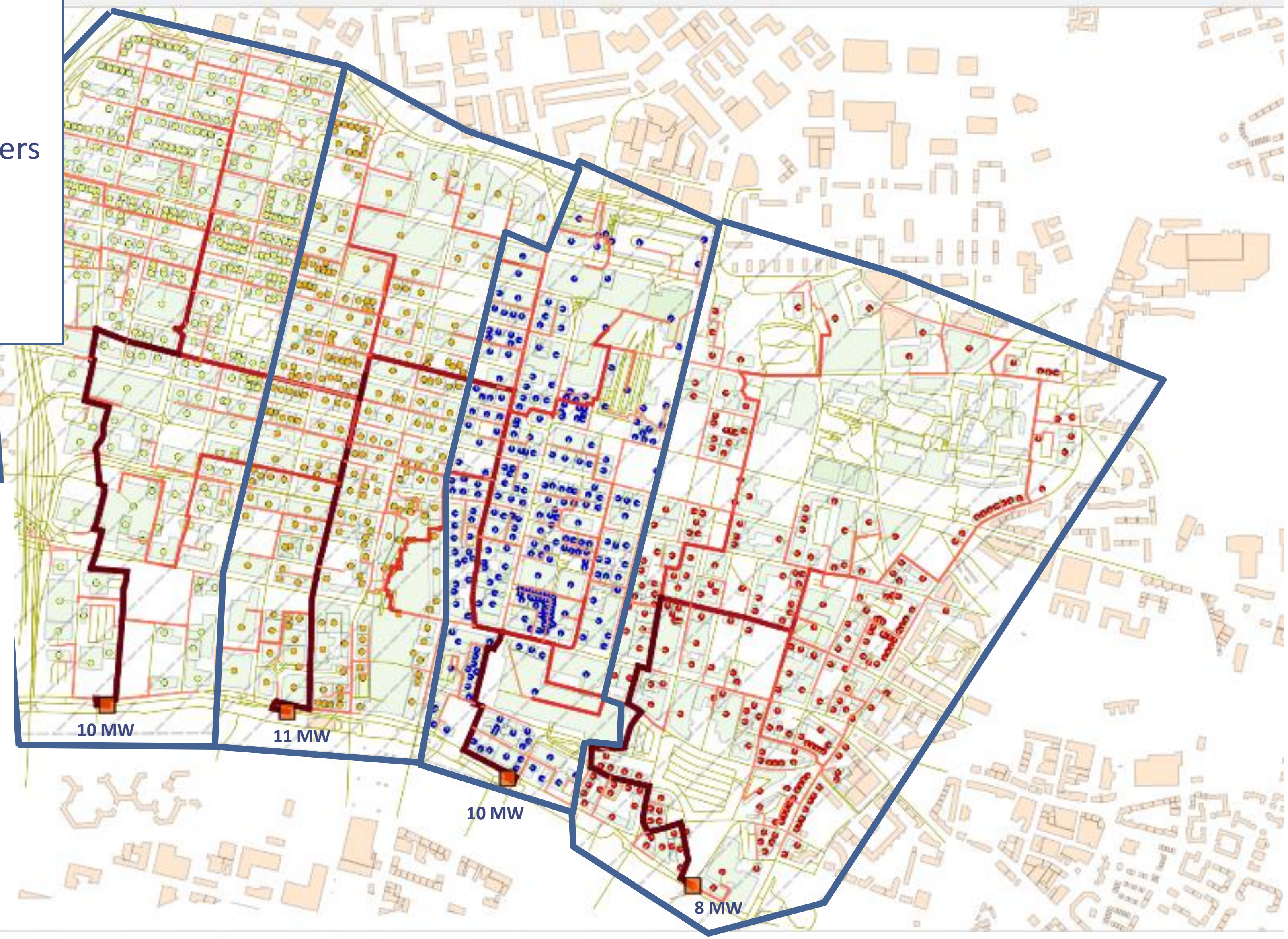
★ Source locations

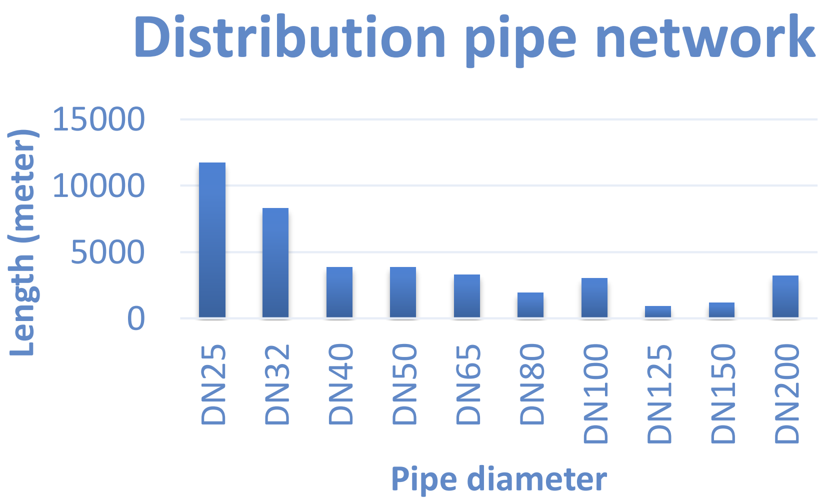
Distribution network:

- Steel pipes
- Operating at 16 bar
- 80 °C Supply and 50° C Return temp

- 4 Heat pumps supply heat to 4 separate clusters
- Clusters size: 10, 11, 10 and 8 MW

- Total public trench length: 46639 meters
- Total network linear heat density: 2 MWh/m






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

Deployment cost calculation - pipes

- Pipe cost per meter deployment

- Costs per meter pipe network include:
  - Excavation
  - Supply & return pipe materials
  - Welding & installation costs
  - Expansion loops and extra material
  - Refill and repair of top layer
  - Project management overhead

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	£1,000.00
DN80	£1,500.00
DN100	£1,500.00
DN125	£1,500.00
DN150	£1,500.00
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

Deployment cost calculation

Glasgow

- Heat source cost (Heat pump)
  - £450,000 GBP per 1MW Heat pump

- 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

Network Deployment cost

Glasgow

Calculation Information

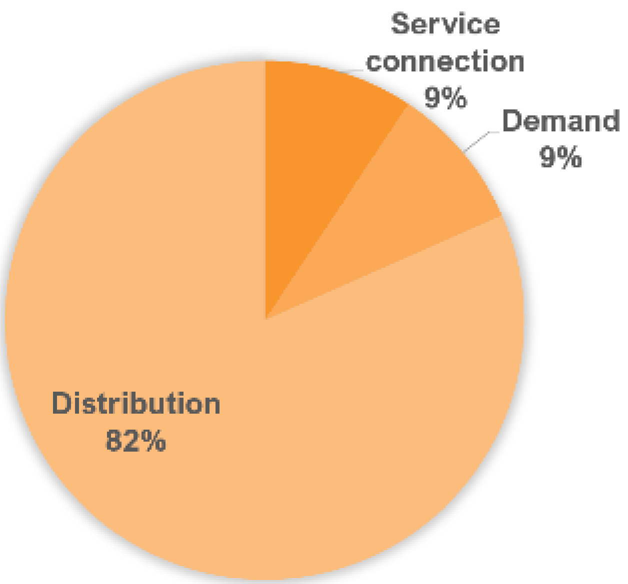
Area Name	Glasgow PoC
Design Rules	Rules2
Number of Homes	1141
Household Density (hh/sqkm)	0,00

Cost Breakdown

	Network Cost	%
Service connection	£7.911.875,18	9%
Demand	£7.635.000,00	9%
Distribution	£69.072.754,04	82%
Total	£84.619.629,23	100%

Results

Total Cost of Project	£84.619.629,23
Total Public trench length (m)	46.639,43
Total Network linear heat density (MWh/m)	2,445
Deployment Cost per Home	£74.162,69



Generated by Comsof Heat

In business to secure a better future

conclusions

- Need to expand teams technical input
  - Vital Energi – More accurate deployment cost information (NOT YET FACTORED IN THIS WORK)
  - IES – More accurate load modelling (NOT YET FACTORED IN THIS WORK)

- Economical lessons learnt (hints)

  - Less than £100M for city centre network deployment with an energy usage of approx 200GWhr/year
    - £2.5M over 40 years £2.5M / 200GWhr → 1.25 p/kWh for CAPEX payback (@0% cost of capital)

  - 200 GWhr / yr creating 15000 T of CO_2 emissions or
    - 0 T CO_2 with heat from heat pumps with clean power supply (15,000T if grid)
    - Cost of heat at 1/3 of cost electricity
      - If electricity 6p/kWh ➔ cost of heat : 2p/kWh
      - If electricity 9p/kWh ➔ cost of heat : 3p/kWh
    - So heat at 3.25p/kWh to 4.25p/kWh (assumes zero cost of capital)

  - Simple economics won't make this happen. **We need surety of offtake**

So DH will work if we create surety of offtake…….but how

- Work with cities to create a concession zone
- Work with cities to educate around NOx / CO2
- Set NOx/CO2 phase down targets >3% per year
- Issue improvement notice if 9% behind OR
  - Join DH; setup as a “fairopoly”

What is a fairopoly.....

www.fairopoly.com

STAR REFRIGERATION

So an end to end energy strategy joining our surplus to our needs

- With improvement notices avoided in favour of DH…
- bring private wire power on a big scale @ <£60/MWh
- Build the new paradigm of energy
- #CLEANHEAT

Let's get on and do it………..

David Pearson

STAR RENEWABLE ENERGY