District Heating Workshop

Irvine

2 November 2017

Introduction

Phil Brennan

Head of APSE Energy

Mobile phones off

Toilets

Fire drill

Sign in sheet

Introduction

Phil Brennan

Head of APSE Energy

Introduction

Rate of change

Use your assets

Use your powers

Have a strategy – energy, investment, asset management, carbon reduction…

Introduction

APSE Energy

The municipalisation of energy

Why are we here?

Craig Hatton
North Ayrshire Council

‘The policy context for heat’

Peter Roscoe
APSE Energy Associate

Heat networks – the policy context

PETER ROSCOE – APSE ENERGY ASSOCIATE

Contents

- Heat networks and the energy transition
- The hurdles
- The policy framework
- Conclusions

Climate Change Economics

EVIDENCE BASED POLICY ADVICE

Heat Networks and the Energy Transition

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Heating and hot water for UK buildings **make up 40%** of our energy consumption...

...and **one fifth** of our greenhouse gas emissions

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CO_2 emissions from heating

Meeting the UK's 2050 climate obligations will require the near complete decarbonisation of heat. This is achievable if action is taken now.

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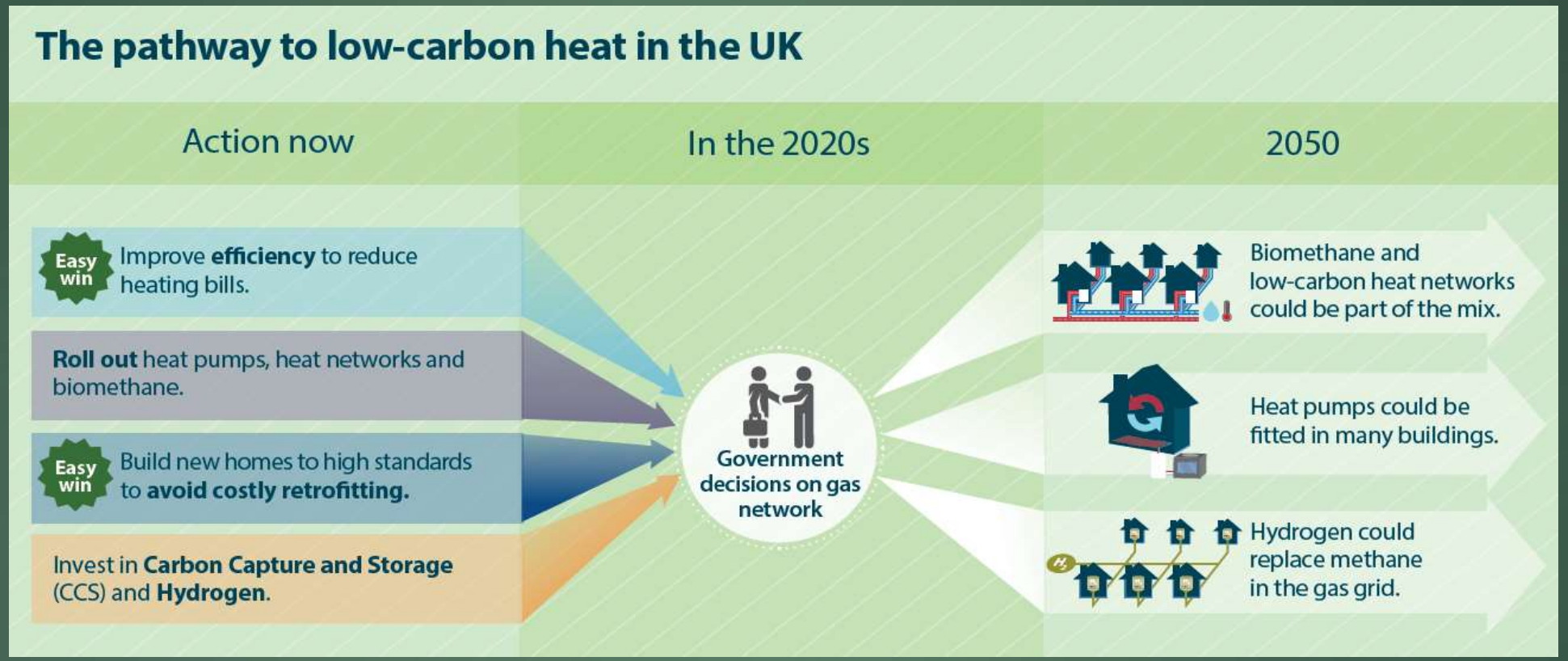
The Energy Transition



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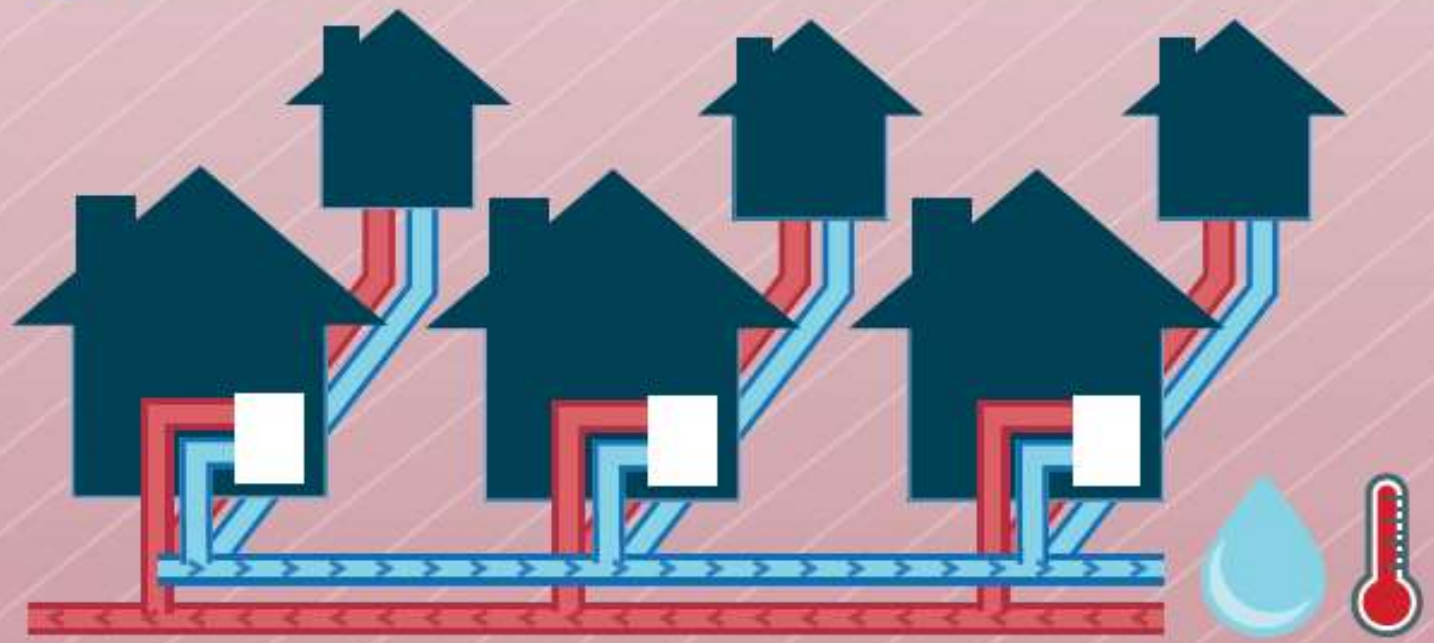
Low-carbon heat networks

- Also know as 'central heating for cities' or 'district heating'.
- Could provide **20%** of UK heating by 2050. In Denmark, **60%** of heating in homes is from low-carbon heat networks.
- Can use a range of low-carbon heat sources.
- (!) Requires coordinated take-up and enough local heat demand.



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The Benefits

- Fuel poverty
- Carbon
- Local energy
- Revenue
- Local jobs

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The Hurdles

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Hurdles

- Traditional heating approaches embedded
- High capital costs of new approaches
- Financial risk

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Solutions

- Good Heat Networks very acceptable to consumers
- Coordination reduces costs
- Zoning
- Recognise carbon savings

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The Policy Framework

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Scotland's Energy Strategy

- A whole-system view
- A stable, managed energy transition
- A smarter model of local energy provision
- Local Heat and Energy Efficiency Strategies

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Heat and Energy Efficiency

- Energy efficiency and heat decarbonisation national infrastructure priorities
- £500m to invest to 2020

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Instruments on the table

- Grants, subsidised loans,
- Regulated markets,
- Incentives for private partners,
- Carbon tax?
- Consumer protection.

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Local Heat and Energy Efficiency Strategies

- Socio-economic assessments – at strategic local authority level
- And for District Heating Concessions

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Funding

- Low Carbon Infrastructure Transition Programme
- Renewable Energy Investment Fund
- District Heating Loan Fund
- Renewable Heat Incentive
- Public Private Partnerships

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Conclusions

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Conclusions

- Local solutions for your community
- Private and public partners
- Clear governance structures
- Thorough analysis

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‘The policy context for heat’

Peter Roscoe
APSE Energy Associate

‘Opportunities, barriers and lessons’

Stewart Boyle
VERT Associates

OPPORTUNITIES, BARRIERS AND LESSONS FROM UK DISTRICT HEATING PROJECTS

APSE Seminar

22nd November 2017, Irvine

PRESENTATION

- Stewart Boyle – background-experience
- VEA-SEWF – partner with Re:heat and APSE
- Opportunities
- Lessons Learned:
    - Technical Lessons
    - Low carbon Options and Lessons
    - Financial issues and lessons
    - Governance

Stewart Boyle

- Energy Consultant for past 18 years – specialist biomass energy and district heating
- Technical sales – boilers, CHP and wood fuel
- Previously author and journalist
- Currently Senior Associate Vert Energy Associates (SEWF)

VERT ENERGY ASSOCIATES - SEWF

- South East Wood Fuels (SEWF) - started as Producer Group in 2004-5
- Now - major chip (and pellet) supplier across South-East and beyond with >70 major contracts and >28,000 tonnes chip p/a
- SEWF Consultancy re-branded as Vert Energy Associates (VEA) in 2016 as increasingly working outside of South-East England and beyond biomass
- Other Associates with engineering, governance, low-carbon technology and financial modelling expertise . HNDU-HNIP experience
- Work in Scotland (Isle of Bute and Community Woodlands) and able to carry out detailed analysis on gas-CHP, biomass-CHP, GSHP, biomass heat, solar PV, etc
- Last three HNDU projects - significant biomass, gas-CHP, GSHP technology input. Detailed master planning, techno-economic modelling experience
- HNIP investment and other grant-funding programmes

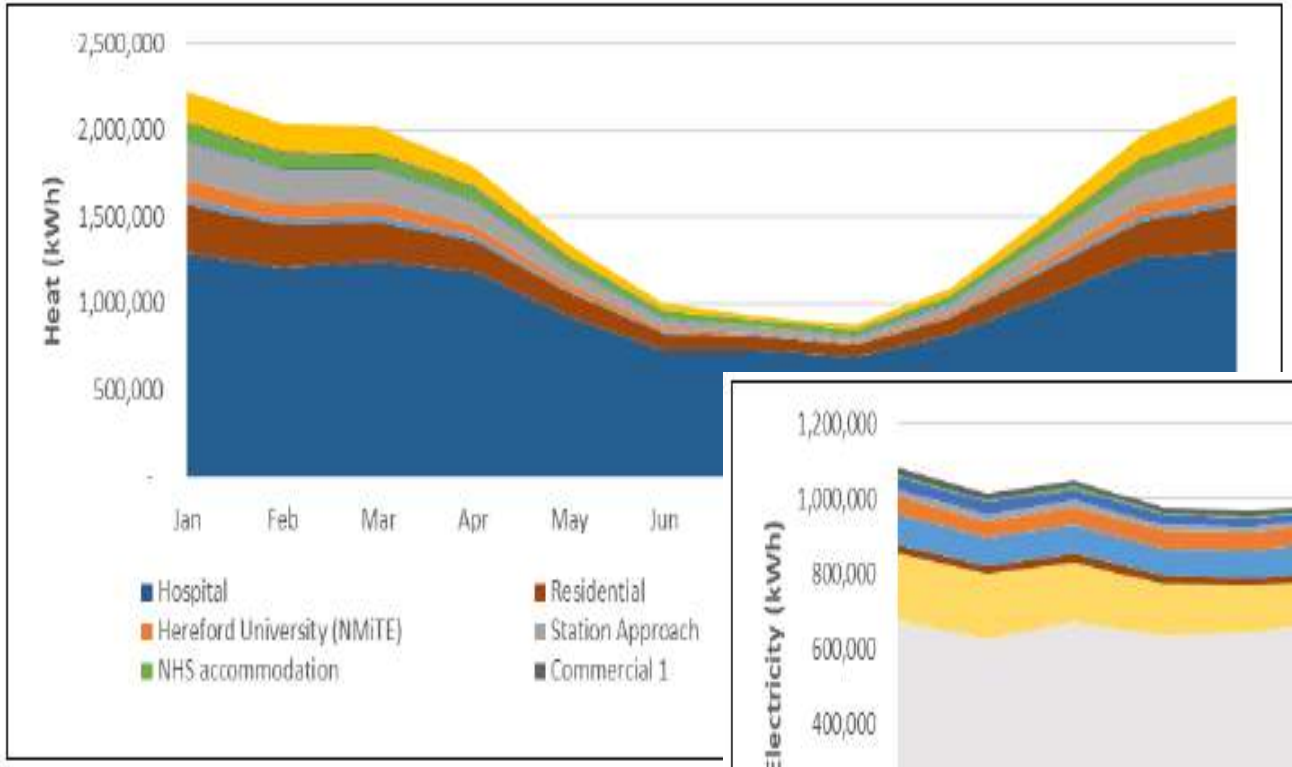
OPPORTUNITIES FOR DISTRICT HEATING

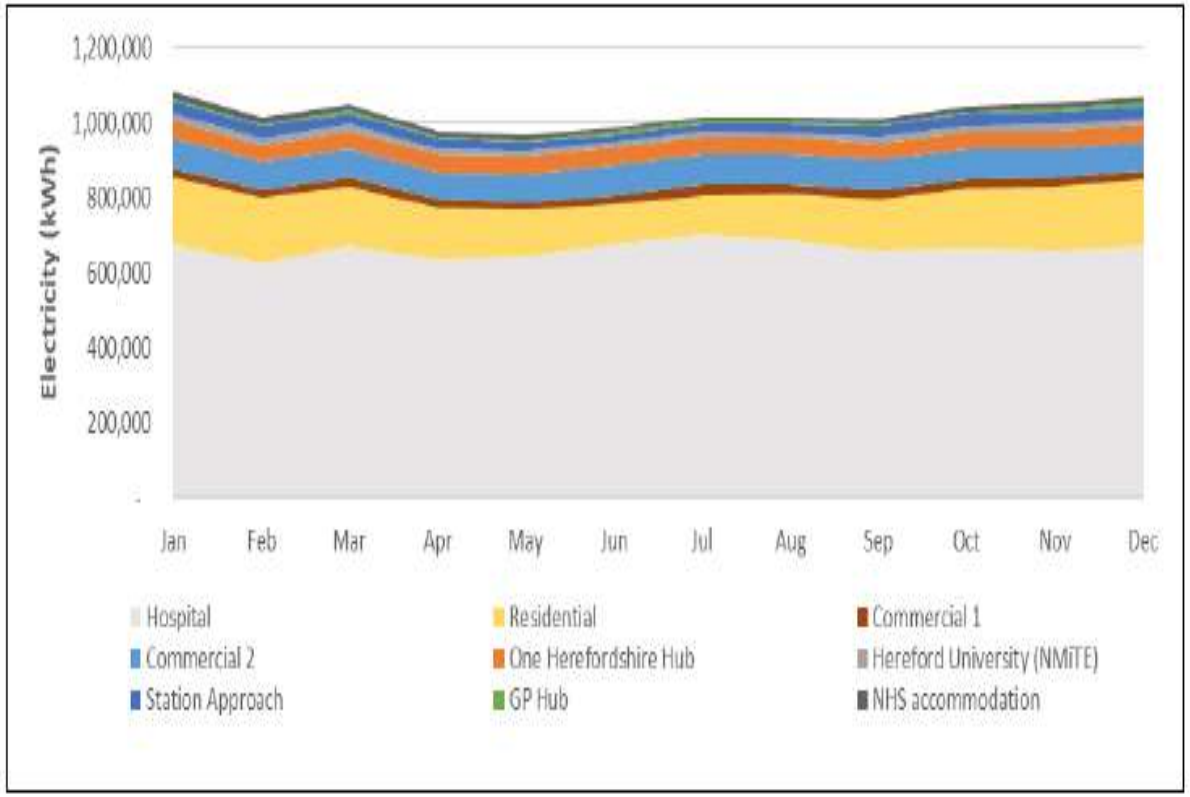
- <3% of UK heat is from District Heating (DH) – well below levels in Scandinavia, Germany, France etc
- UK has a number of good DH examples – e.g. Aberdeen, Shetland, Leicester, Woking, Olympic Park, Nottingham, London
- Existence proof of gas-CHP, water and ground based HP, biomass heat, waste heat technologies, with other technologies coming through
- Many lessons learned through mistakes and successes
- Potential for significant DH expansion high – BEIS est. market worth >£2 billion of investment in next 25 years – c.10% of heat market. Scotland £1/2bn to leverage £14bn
- Opportunities exist around new commercial + residential developments, particularly where low-carbon options exist (e.g. water and ground based heat pumps, local biomass fuel)
- Synergy between energy efficiency and low carbon

LESSONS LEARNED FROM UK DISTRICT HEATING

- Energy Data – the foundation block. Real world data – adjusted for degree days, delivered energy, estimated future heat loads, benchmarked data etc
- Sizing of heat (and power) systems
- Diversity factors + design of network - minimise losses
- Heat storage + managing loads throughout the year – heating-cooling synergy
- Blending different technologies to maximise financial benefits, low-carbon aspects and future-proofing
- More local economic factors – the synergy of local energy production, fuel, jobs etc

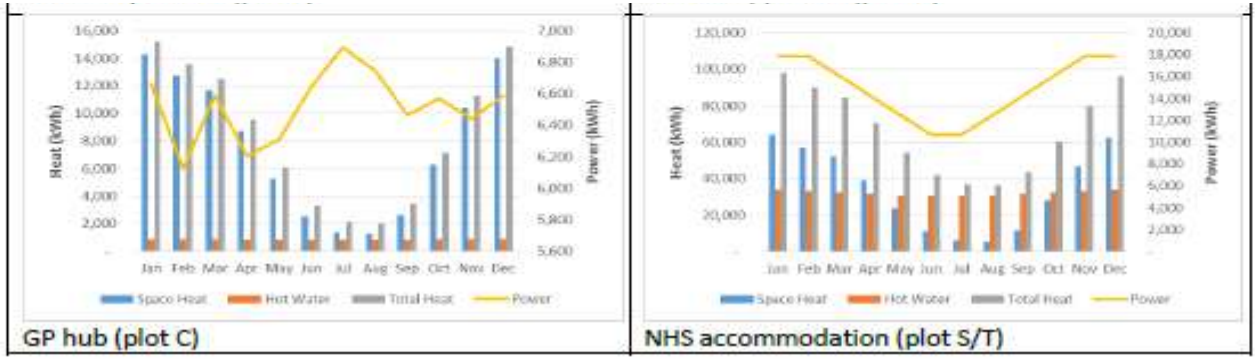
Energy Data, Master Planning, Sizing and Design





Hereford hospital

All sites combined



GP hub (plot C)

NHS accommodation (plot S/T)

Sizing Heat Systems – Heat storage + Diversity

- Looking to run CHP systems 6000+ hours/yr + sized accordingly. Ditto for biomass CHP (even higher hours needed)
- Biomass heat systems – run at least 3000 hours, prefer 4,500 hours plus
- Geothermal – if you run for heat and cooling can have v. high utilisation
- The more heat loads there are the greater the **diversity factor** can be designed in – 70%, whereas just a few large heat loads and maybe only 90% diversity factor
- Accumulator (hot water storage) tanks critical with the heating network to reduce losses, reduce the size of low-carbon technologies/improve efficiencies

Low-carbon technologies

- Gas-CHP
- Biomass-CHP
- Biomass Heat
- GSHP + water based HP
  - Slinky Type heat pump system
  - Underground Thermal Energy Storage (UTES) –
    - ATES (Aquifer Thermal Energy Storage) and
    - BTES (Borehole Thermal Energy Storage)
  - Deep geothermal well
  - Sewage heat HP
  - Water based heat pumps
- Industrial Heat Recovery
- Energy from Waste

Gas-CHP

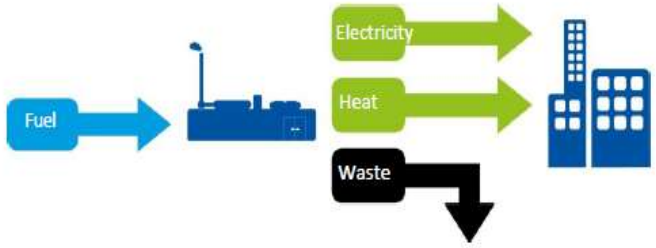
What is CHP?

Overview of CHP

Single unit **fuel** converted into **Electricity** & **Heat**

1. **Electricity** produced by engine-powered alternator

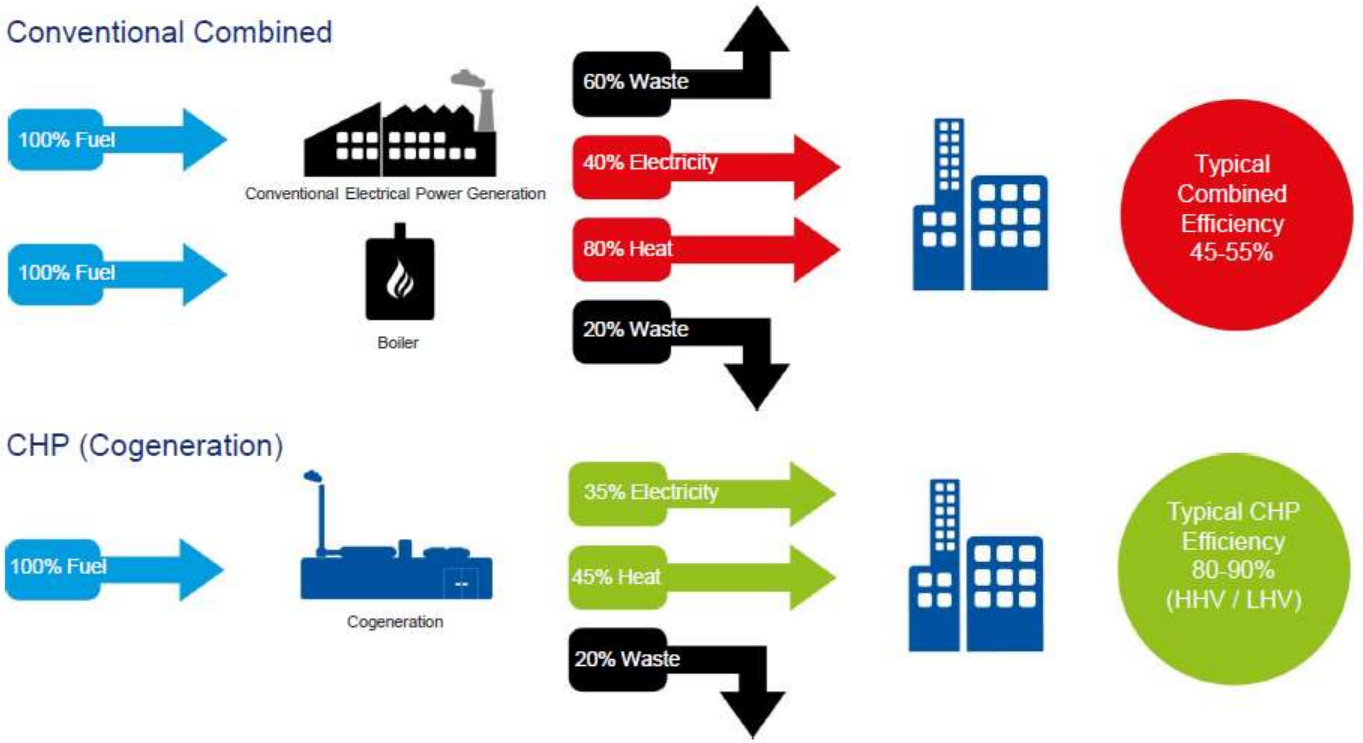
2. **Heat** is a **by-product** captured from:
   a) Engine jacket water and lubrication oil
   b) Engine exhaust gases



Gas-CHP

Comparison of Combined Efficiencies

Overview of CHP

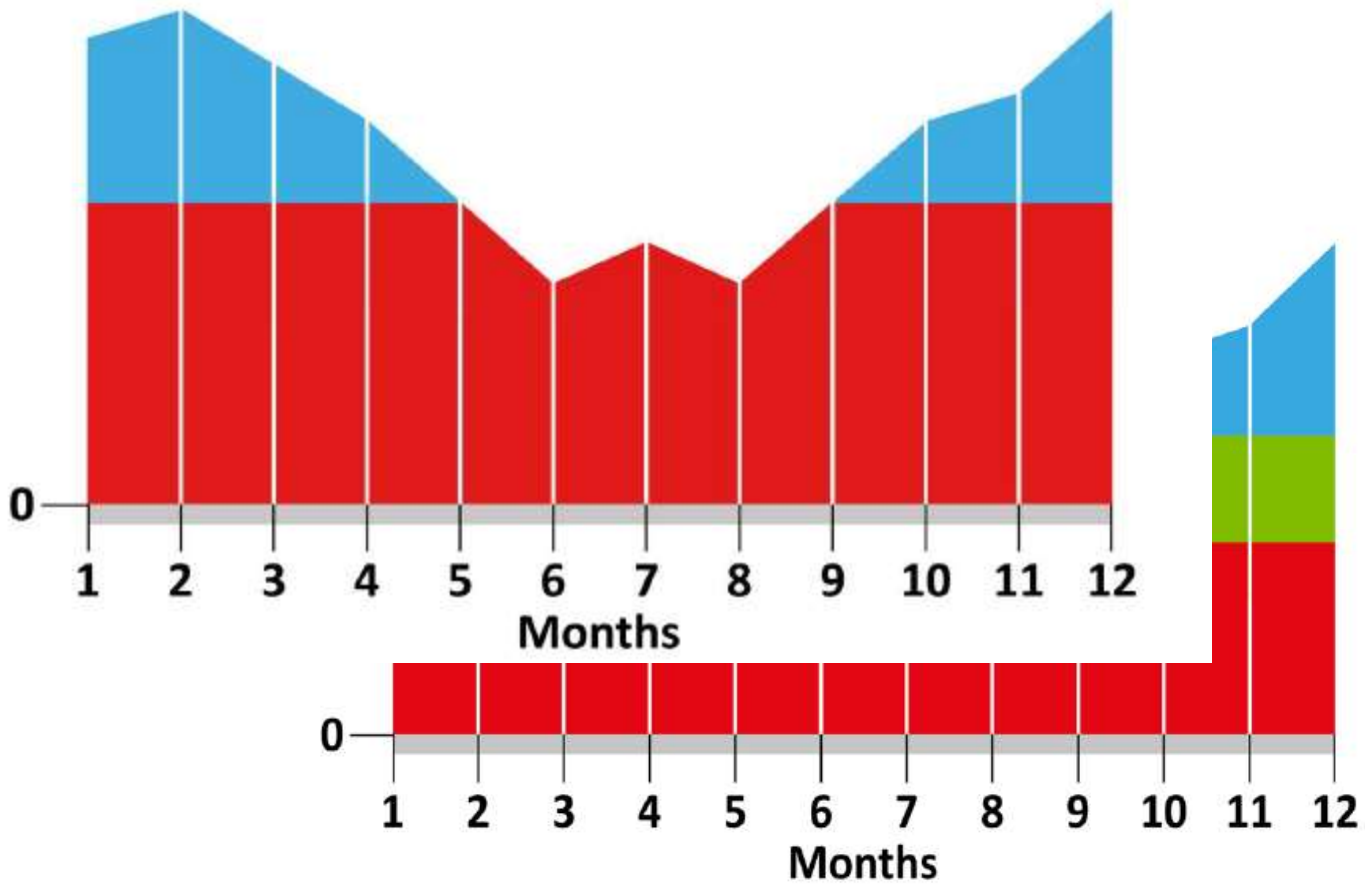


* *Energy efficiency figures reproduced from GPG388 (Carbon Trust, 2004)*

Gas-CHP - Sizing

Baseload Thermal (Method 1)

Thermal Modulation (Method 3)



*Allowance within CHP Quality Assurance (CHPQA) to trim up-to 30% of excess heat, while still meeting Quality Index of >105

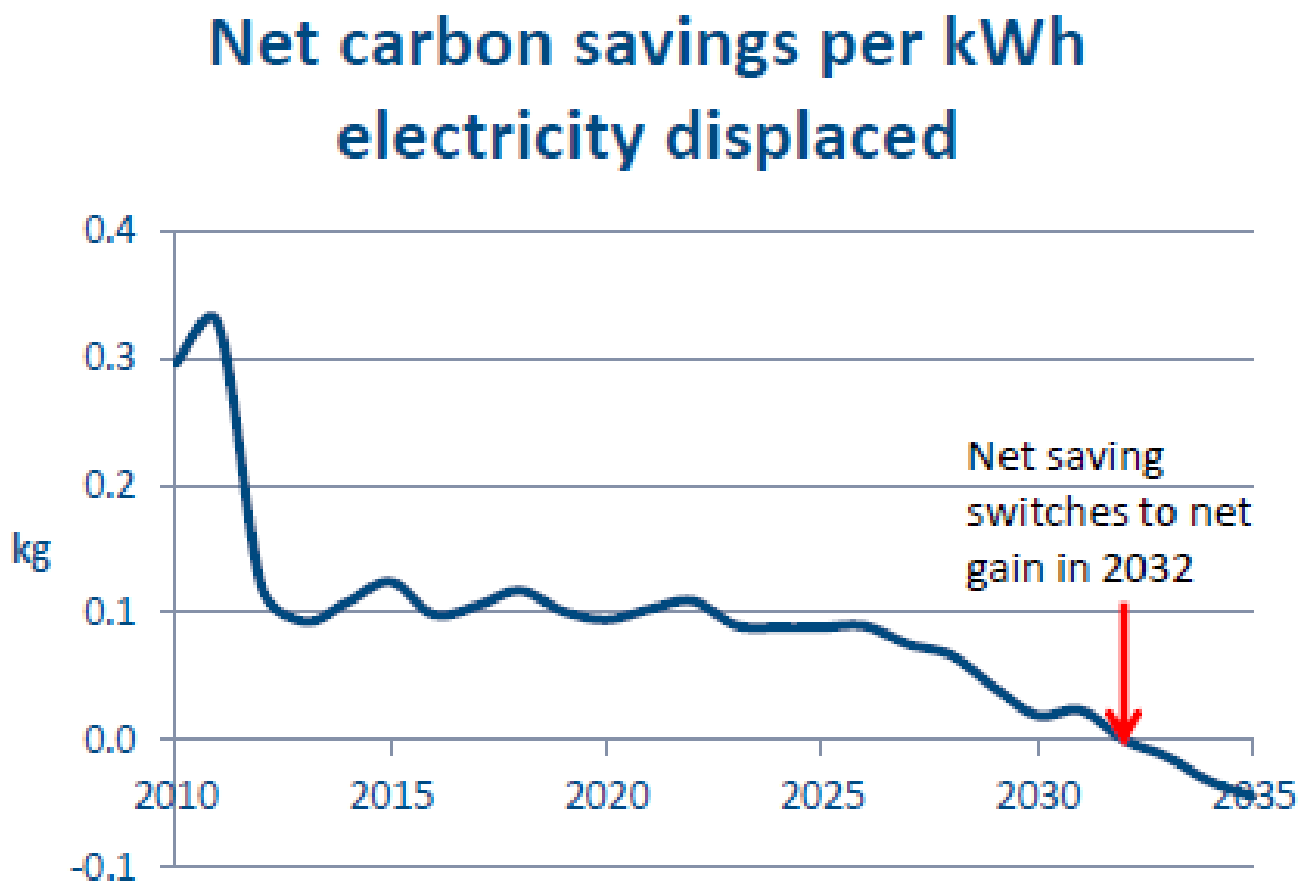
Gas-CHP

Gas-CHP - Private Wires

- Used as a way of subsidising heat in district heating by selling power to a select range of customers cf purchasing from grid
- Grid price 10-12p/kWh – gas at 2p/kWh – good margin
- Easier with small number of interested non-residential customers, unless new build, where private wires built in from start
- Retrofit is harder and quite expensive
- Administratively burdensome - need skilled people to work with DNOs to achieve licence and agreements

Gas-CHP – CO2 benefits?

- Around 20% CO2 benefits today cf gas boilers and grid power BUT…
- Over time this benefit will reduce to zero as the grid decarbonises



Biomass-CHP

- Micro-scale biomass CHP (<50kW(e)) had a significant lift in period 2014- early 2017. Hundreds of systems installed
- A combination of ROCs, RHI (x2) and improved technology led to the financials for biomass-CHP being very attractive
- Key lessons:
  - Getting quality (fine grade and dry – 10-13% MC) wood chip (or wood pellet) consistently available. Advent of chip driers has helped
  - Regular servicing, cleaning and replacement of key items
  - Having a local team of engineers and mechanical servicing people key – can't do this solely by remote monitoring
- 2017 – economics not that attractive as CFD approach makes it much harder to get a contract for a low-carbon biomass system
- Bigger biomass–CHP systems – steam and ORC = low electrical efficiency; gasification system = higher electrical efficiency but less than gas


arborElectroGen
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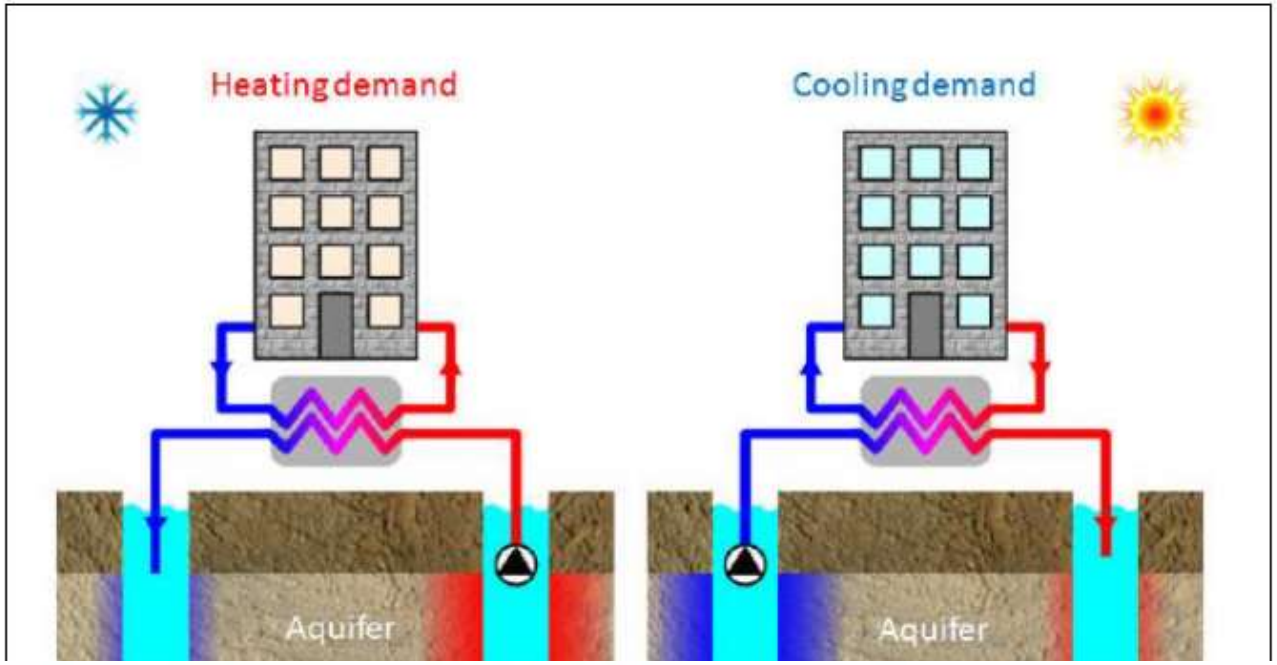
Geothermal – GSHP ('Slinky' Option)

Geothermal - ATES



Dynaciat heat pump (Courtesy Dynaciat)

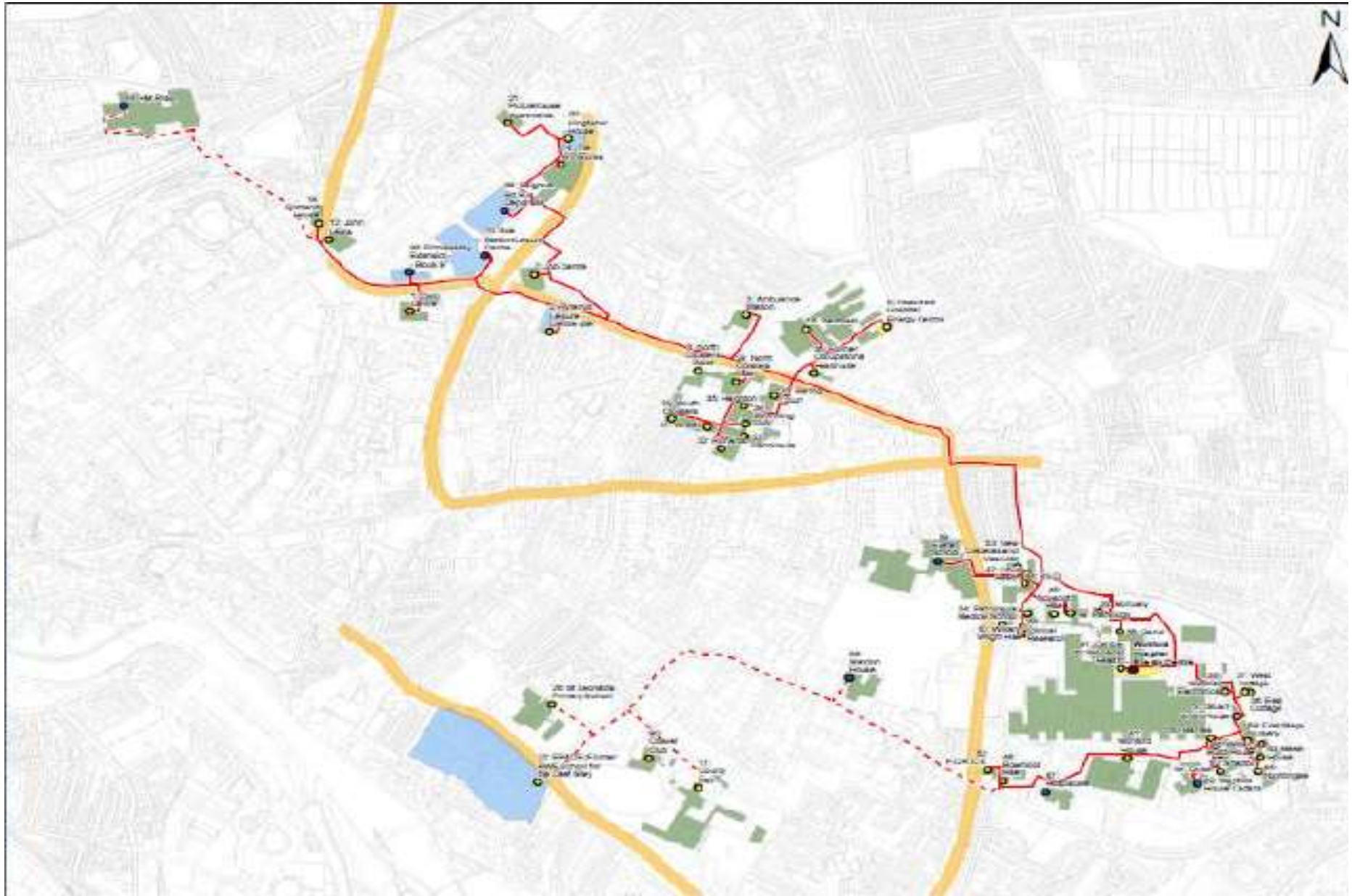
Heat pump interface unit (Courtesy IFTECH)

Biomass Heating

Biomass Heating – Current Issues

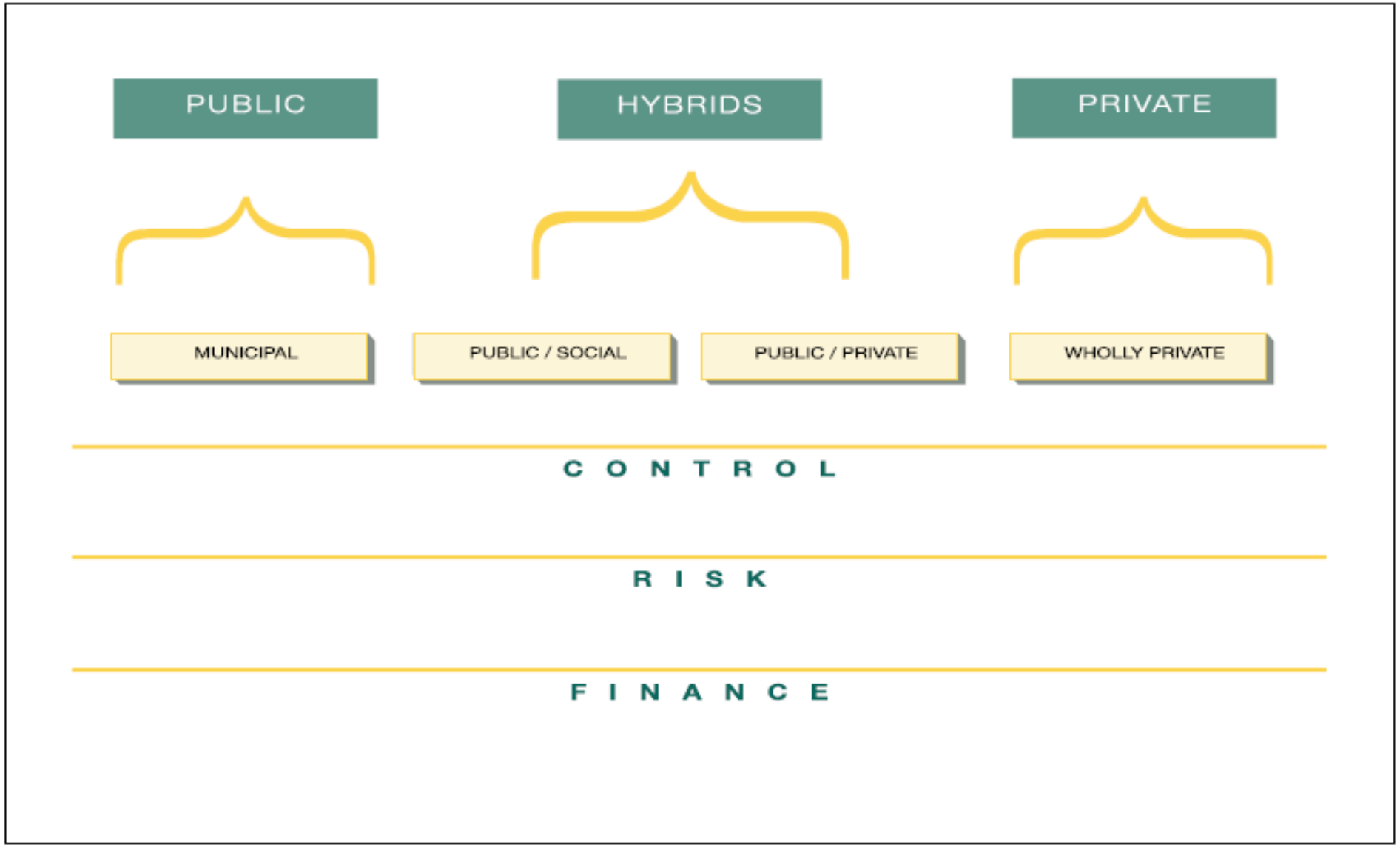
- Current RHI tariff at 3p/kWh means smaller boiler systems (<1-2MW) less attractive than pre- 2017
- Need high boiler utilisation levels to be cost-effective
- Emissions – NOx and PMs – assessment and technology (e.g. ceramic filters)
- Biomass fuel – BSL, other sustainability issues
- Fuel handling – below ground, spatial needs etc
- Transport – frequency of deliveries and local impacts

DH – Other Design Issues and Lessons

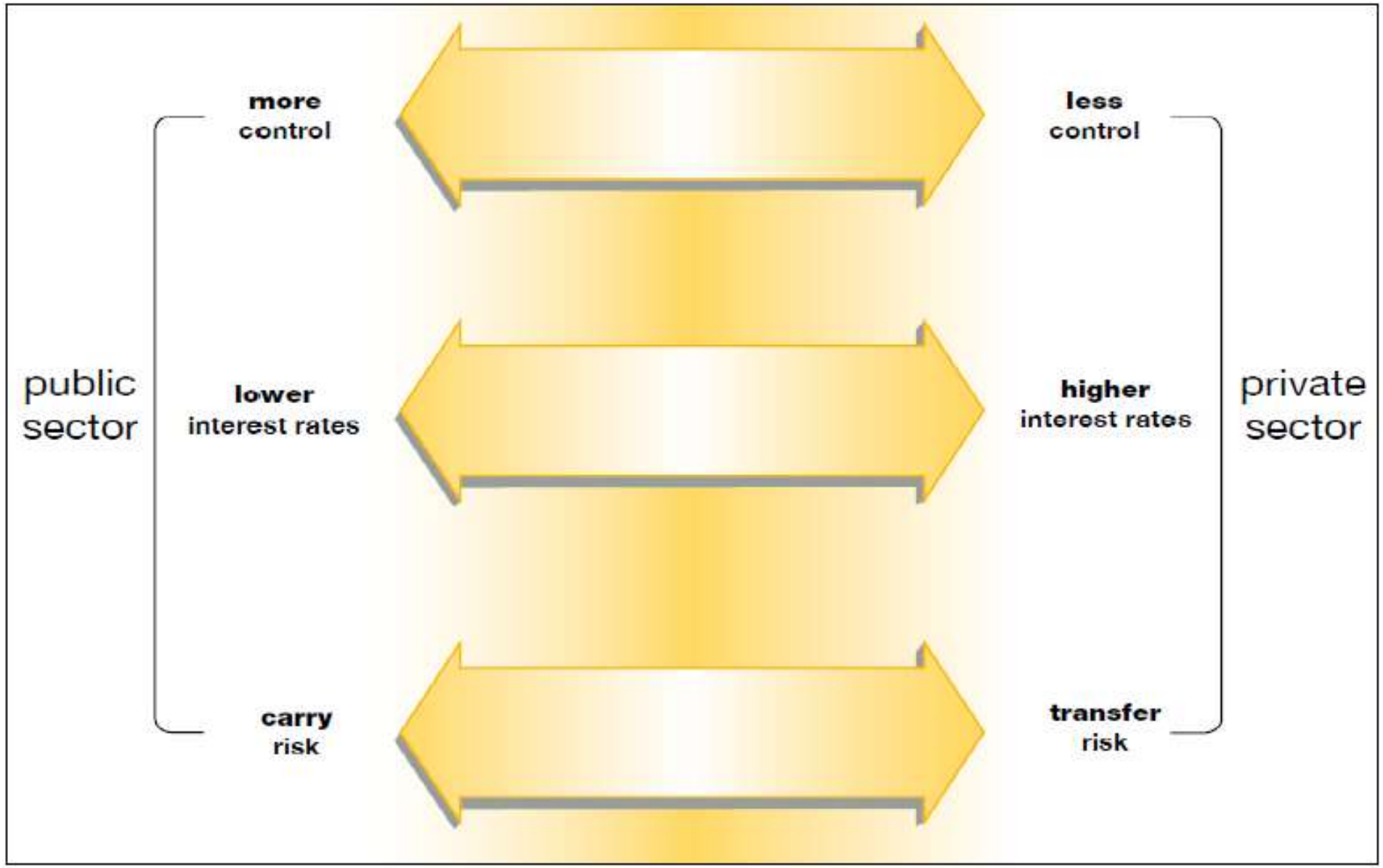


Heat Network routes, Pipework, HEUs etc

Governance


PUBLIC
HYBRIDS
PRIVATE
MUNICIPAL
PUBLIC / SOCIAL
PUBLIC / PRIVATE
WHOLLY PRIVATE
CONTROL
RISK
FINANCE

Governance


public sector
more control
less control
lower interest rates
higher interest rates
carry risk
transfer risk
private sector

SUMMARY and CONCLUSIONS

- District Heating (DH) – in the right conditions – can offer an efficient, low-carbon and future-proof solution for heating, power and cooling
- DH can increase from the current <3% of heat to close to 10% over next 25 years
- It requires a long-term approach and outlook – hence the need for Master Planning and detailed techno-economic appraisal
- LAs need to be clear over what their objectives are – low-carbon economic development, local control, future income streams, other?
- Experience in both the UK and Europe has shown that with careful design, and strategic planning, financial and political support, DH can offer cost-effective solutions for a wide range of customers
- The potential in Scotland is significant. Carry out the analysis, think about governance early (HUBco, other) and look towards strategic investments

‘Opportunities, barriers and lessons’

Stewart Boyle
VERT Associates

Discussion / Q&A

Break

‘Dealing with practicalities’

Steve Luker

APSE Energy Associate and Re:Heat

Dealing with the practicalities: planning and designing biomass district heat schemes in the public sector

November 2017

Current experience in district heating

Implementation

National Trust – x 4 Nunnington Hall and Wallington Hall in Northumberland, Beninbrough Hall in North Yorkshire and Ravenscar in North Yorkshire: (2015/17)
Rosehill Care Home (2016)
North Ayrshire Council- Dalry Sheltered Housing (2017)

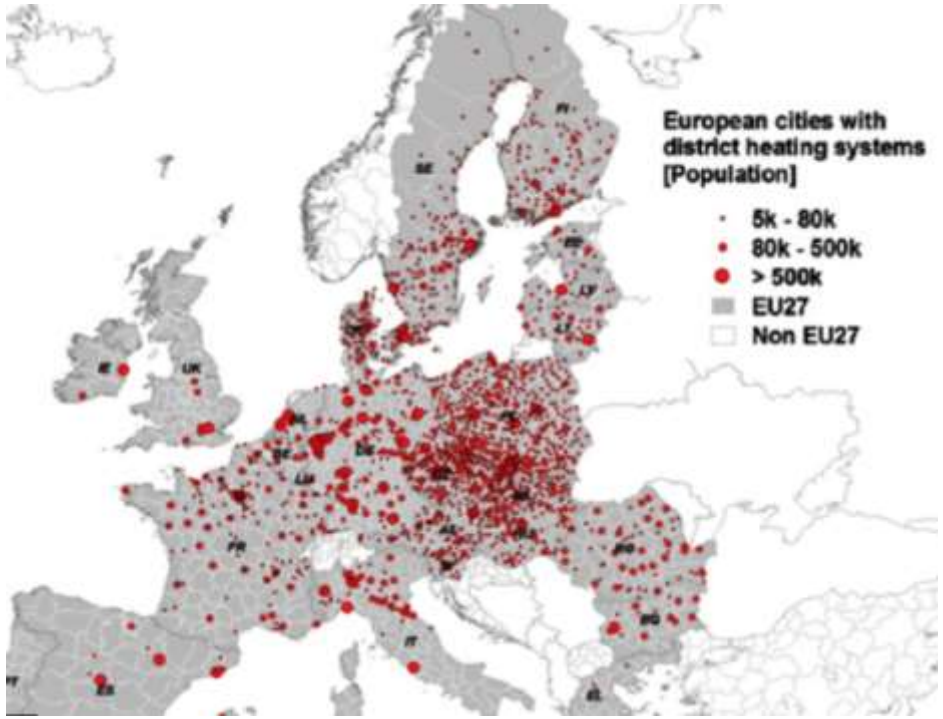
Repairs and system problems

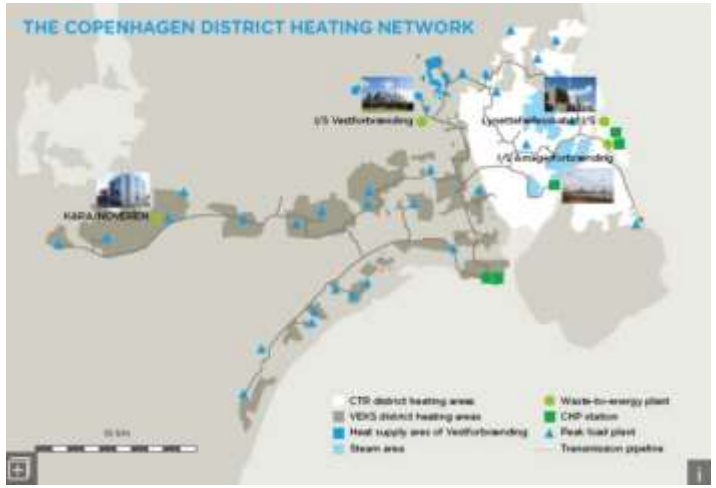
Caledonia Housing Association Biomass District Heating Scheme -Inverness (2017). X 2
Caledonia Housing Association Biomass District Heating Scheme -Dundee (2015).
Stockport Homes Group Biomass District Heating x 7 (2015 to 2017)
Kinnaird Woodland Cottages District Heating review (2015)
Whitelee Farm Biomass (2016)

Business planning

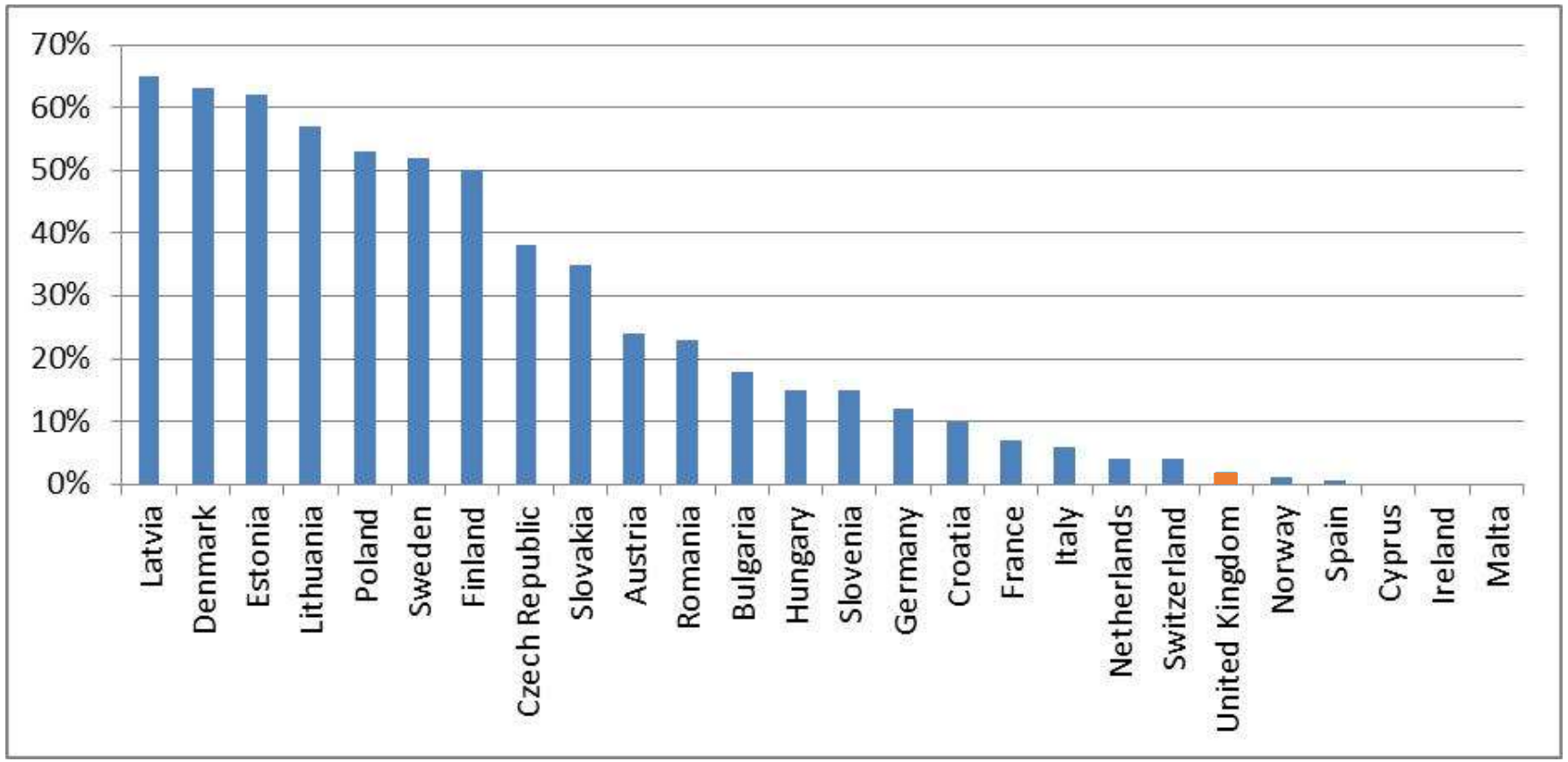
North Ayrshire Council Auchenharvie (2016).
Aurivo Dairy Products Mill District heating scheme (2017).
Carrick on Shannon district heating scheme (2017).
Stirling District heating Scheme (2015)
Kirkhill Residential District Heating Scheme (2015)

Its normal in most places….



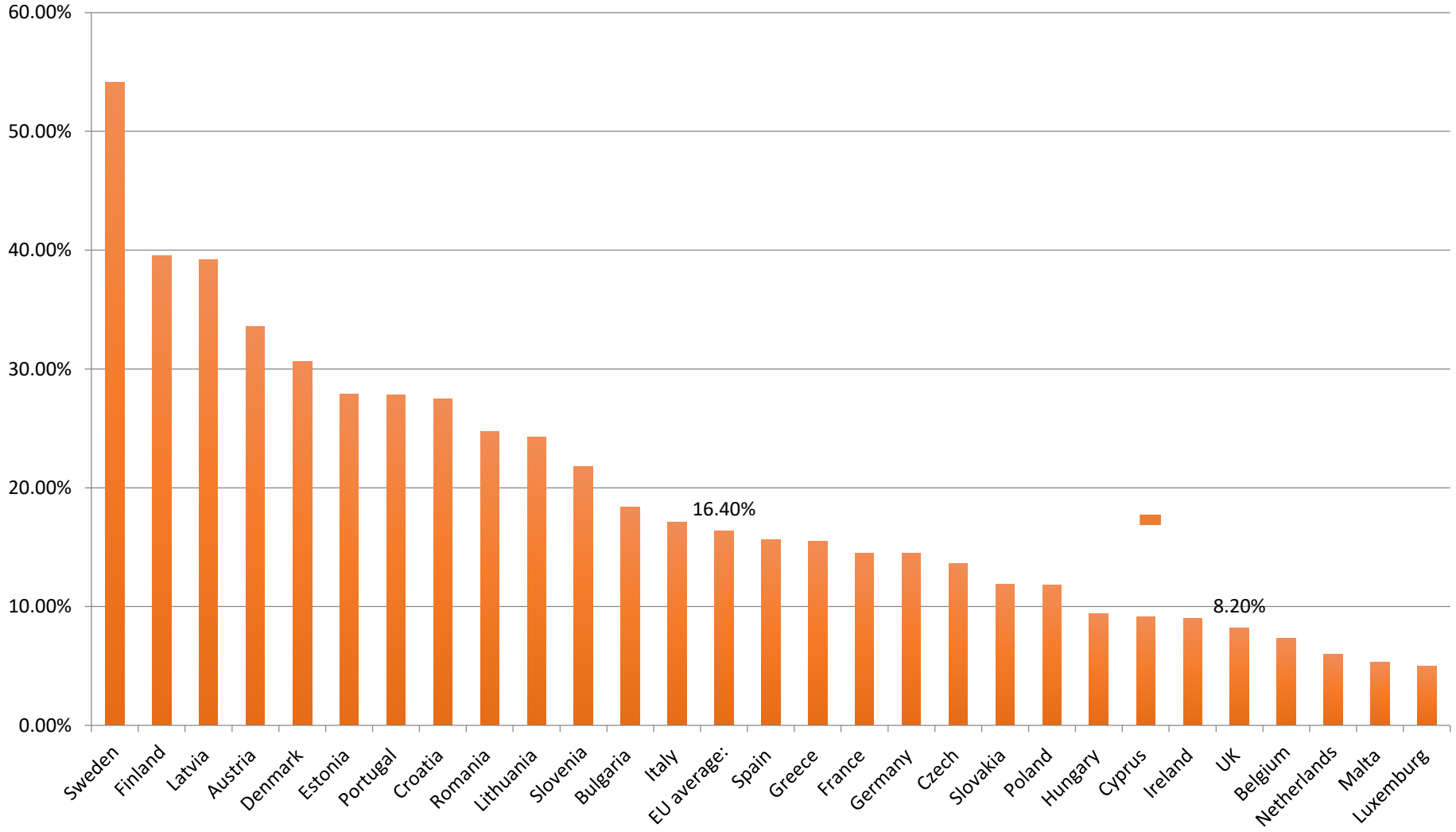


Its not so normal here….



Percentage of Population Served by District Heating (EU26, 2013)

The link between district heating and renewable energy progress….



Percentage of Renewable Energy (EU26, 2015)

Where biomass district heating works in the Local Government Estate?

Key opportunities:

1. Retrofit (new build can be costly – back-up)
2. Off gas first (oil/coal/LPG) – but gas ok
3. Modern heat systems better than old
4. Combined heat bills above £40k to £50k perfect = 1,000MWh +
5. Aim for circa 1MW installed and above
6. RHI now ideal = 2 year window
7. Large nearby properties

So….

- Social rented high rise
- Schools – high and primary
- Leisure Centres
- Civic offices
- Sheltered Housing

District Heat Network
Connections (below or above ground pipework) for the distribution of thermal energy from a central source to multiple buildings (2 or more) or sites.

Heat Supplier
A person or organisation (charity, company, etc…) who supplies and charges for the supply of heating, cooling or hot water to a final customer through one of the above.

Final Customer
Is the person or organisation who purchases heating, cooling or hot water from the Heat Supplier for their own consumption.

Heat Meters

3 main parts :

- pair of temperature sensors
- calculator/integrator
- flow meter

- Key point: where it measures
- Key point: Final Customer HM
- Key point: How to manage loss between the 2

The Heat Network (Metering and Billing) Regulations 2014

- To notify NMRO of the existence of their network (https://www.gov.uk/government/organisations/national-measurement-and-regulation-office)
- To fit heat meters where appropriate to accurately measure, memorise and display the consumption of fin customers
- To ensure heat meters are continuously operating, maintained and periodically checked for errors
- To bill customers fairly, transparently and based on actual consumption where cost effective to do so.

Some key issues to bear in mind

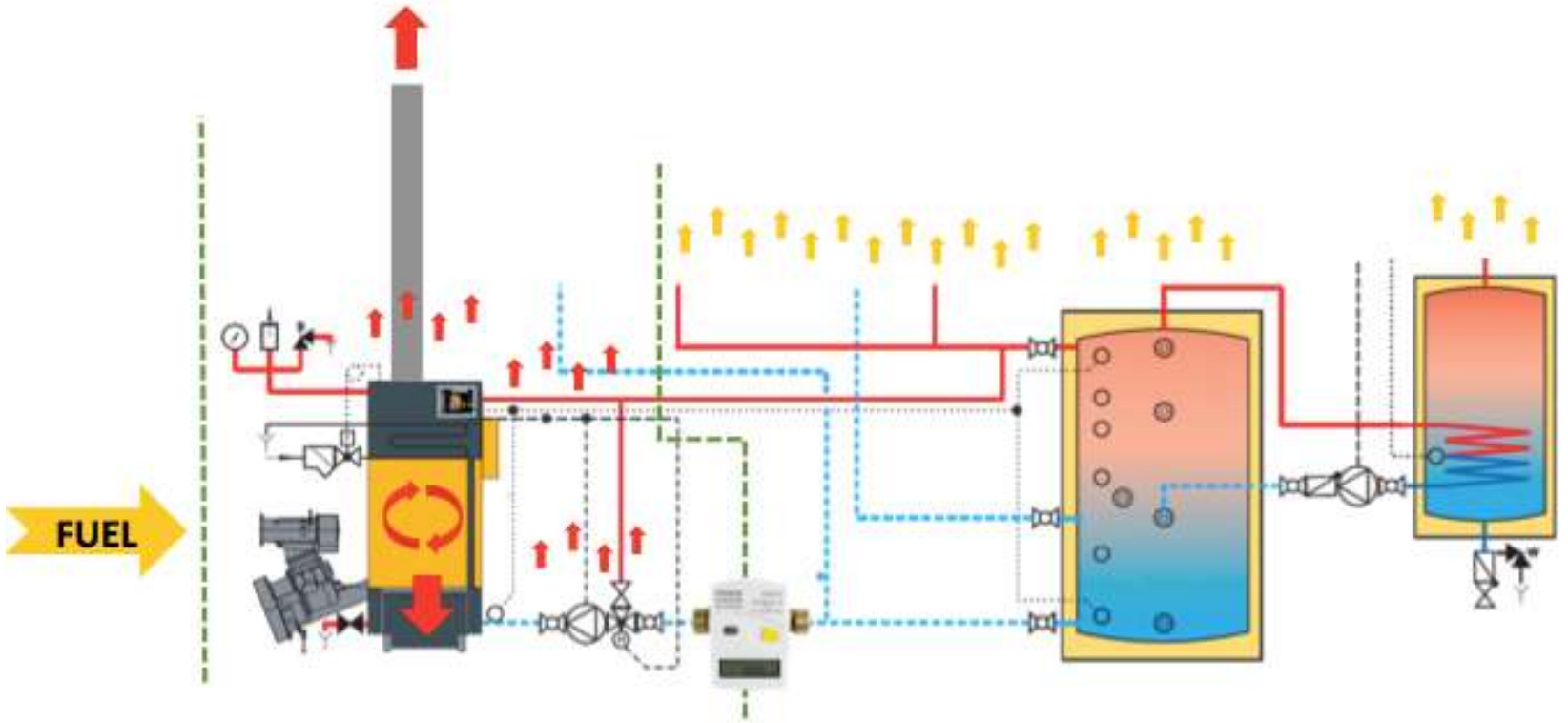
1. A complimentary mix of heat loads
2. The scale needs to be large enough
3. A single heat customer is better/simpler
4. Can be phased to other customers of course
5. Calculate the business case based upon real world losses
6. RHI income is at £29/MWh for 20 years (new RHI)
7. Generated biomass heat costs £35/MWh
8. Delivered biomass heat costs £60/MWh to £100/MWh

In simple terms a few large users are the most viable

Make the heat supplier take the heat loss risk?

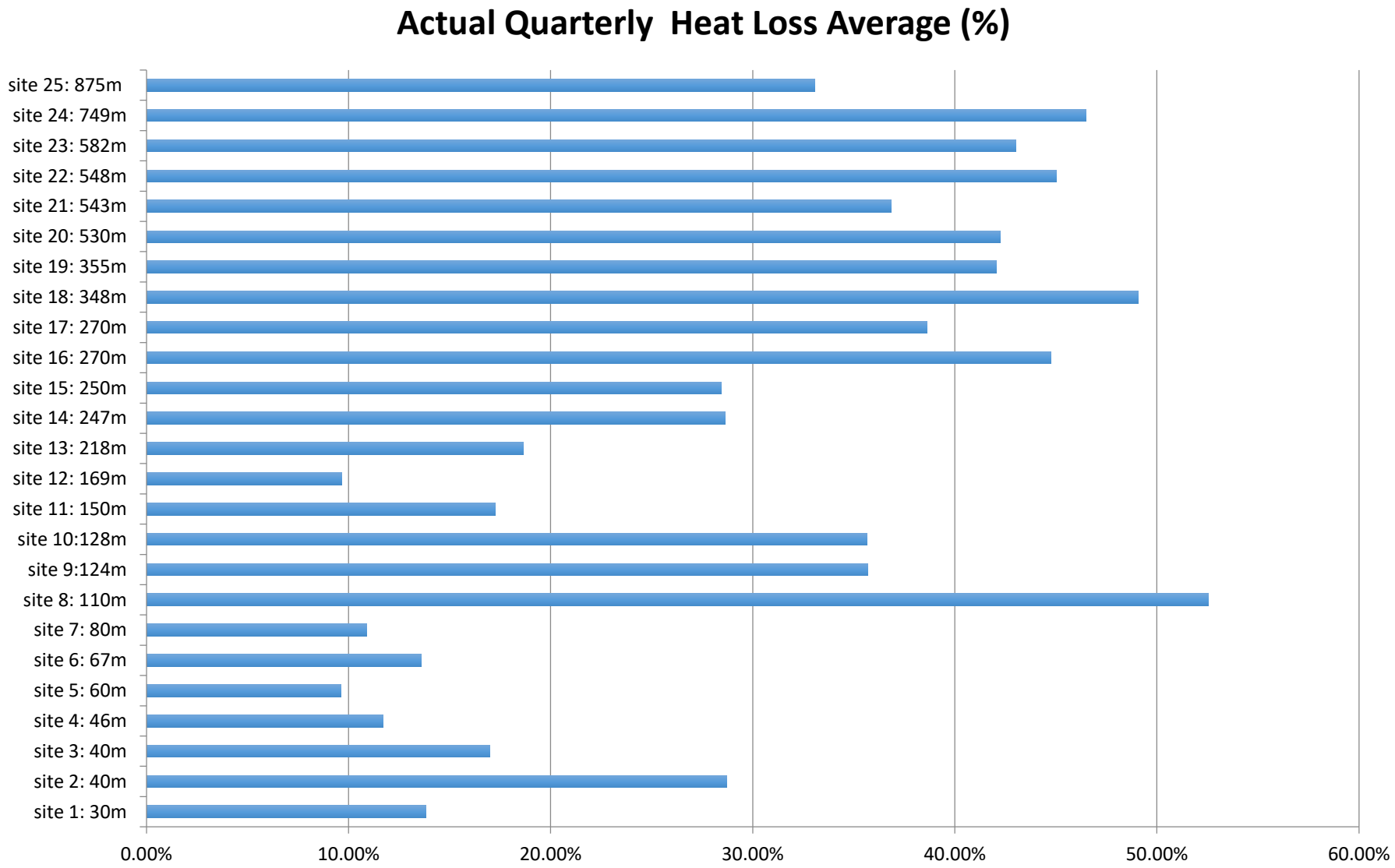
Rely on existing fossil as back up to save capital cost

Heat losses and normal and inevitable

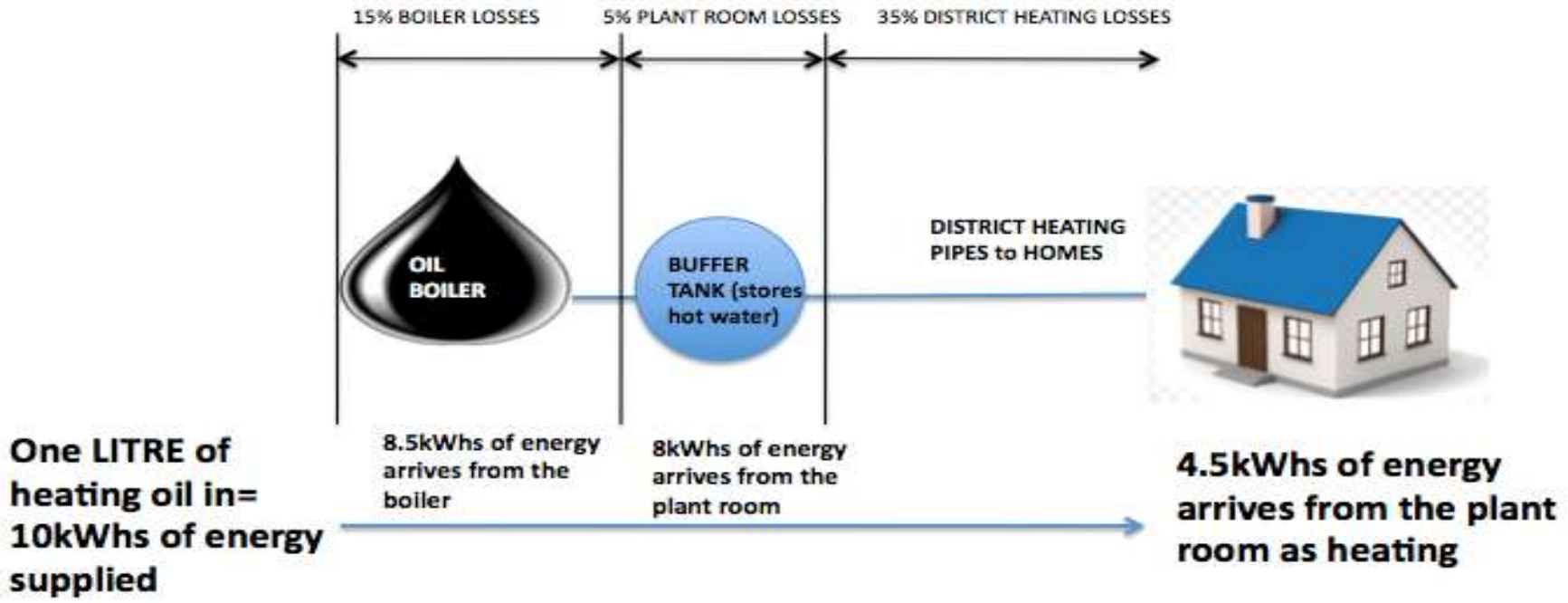


Boiler-related losses	Plant room losses	District heating losses	*Range of total expected annual losses on entire system*
6% to 20%	5% - 10%	15% to 40%	***26% to 70%***

Measured losses in district heating



This applies to fossil fuels as well



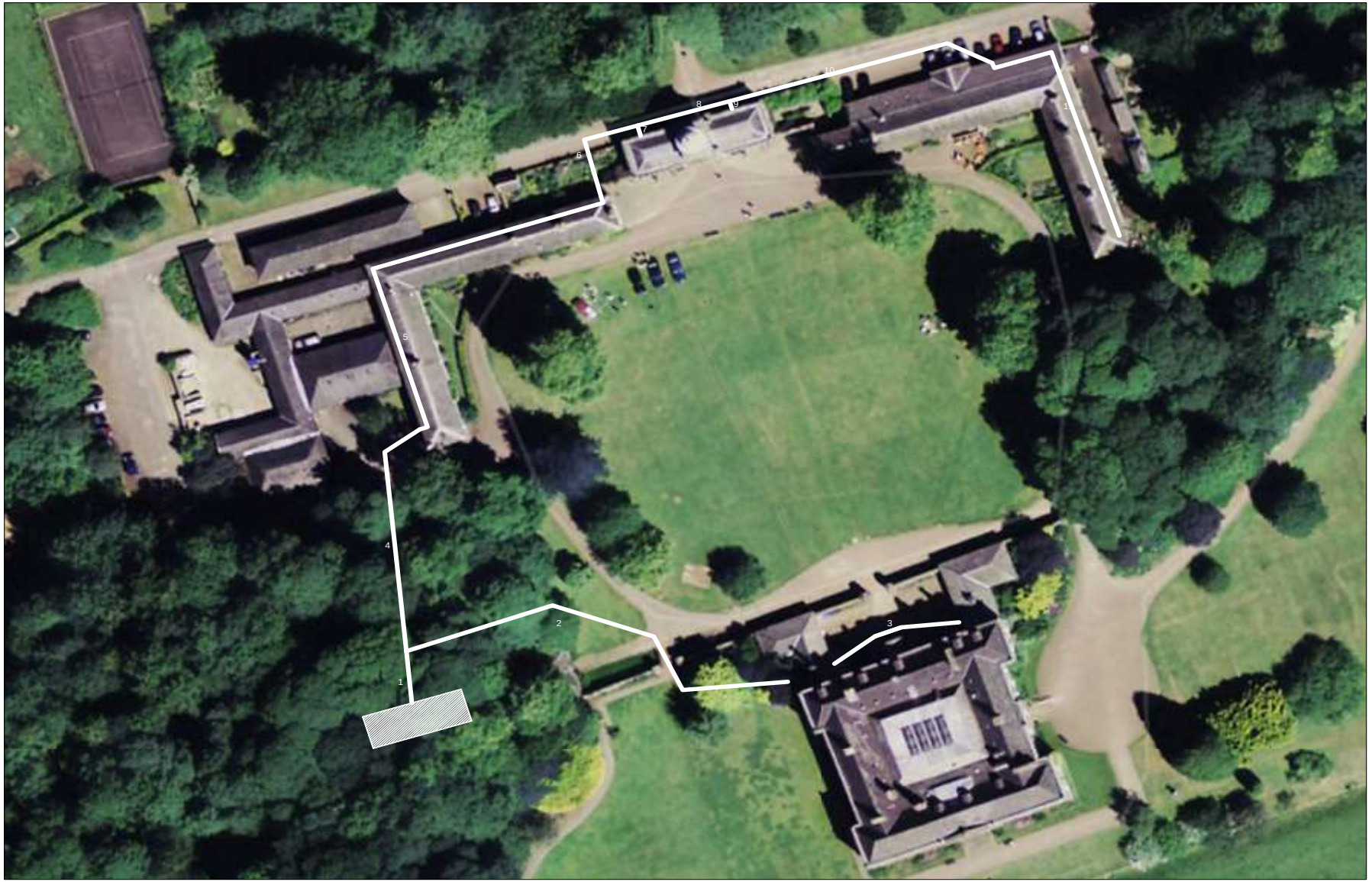
Key point: District Heating is not ‘inefficient’ – but it has losses: these must be calculated and managed

District heating: an example of what is possible

Nunnington Hall in Northumberland
Wallington Hall in Northumberland
Beninbrough Halls in North Yorkshire
Ravenscar in North Yorkshire.

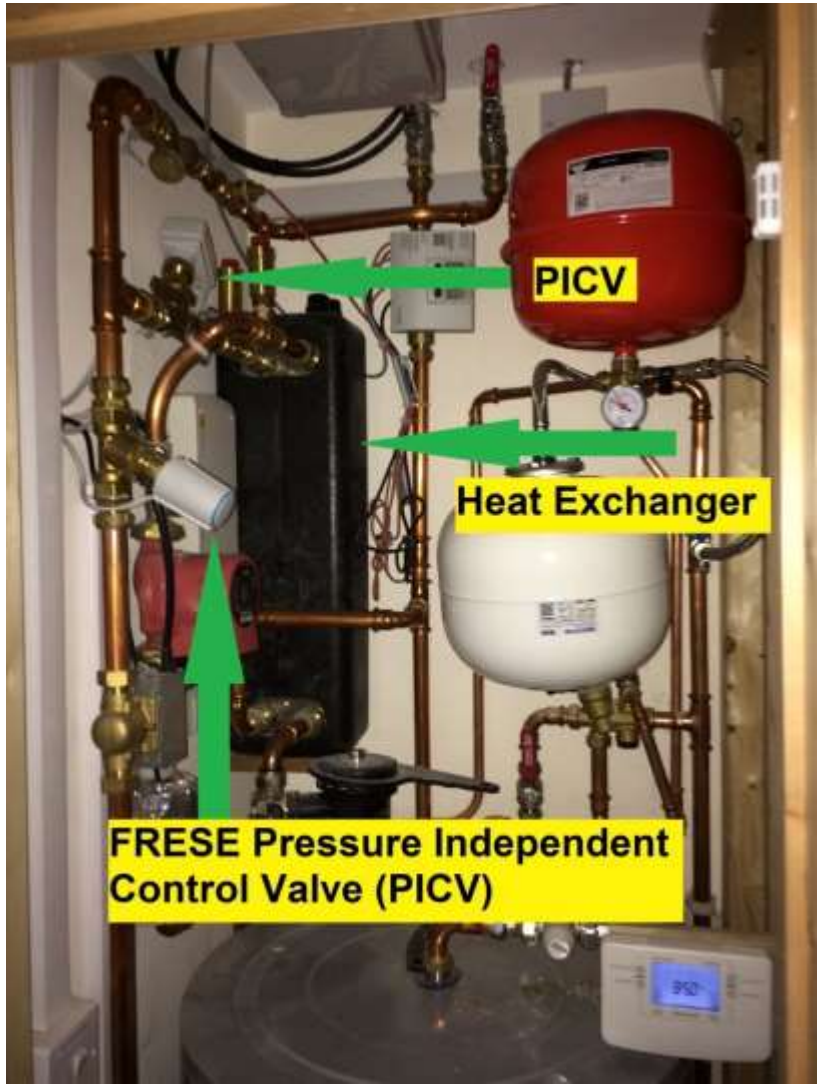
These are retrofit biomass district heating projects with numerous interfaces and they heat older and historic properties. If it works here it can work everywhere

National Trust Biomass Schemes



National Trust Biomass Schemes

National Trust Biomass Schemes



Design outcome – low losses on network

By a combination of:

- Pressure independent control valves
- Temperature settings
- Combustion settings
- Buffer stratification
- Weather compensation sensors
- Design and selection of good quality pipes and other products with insulation

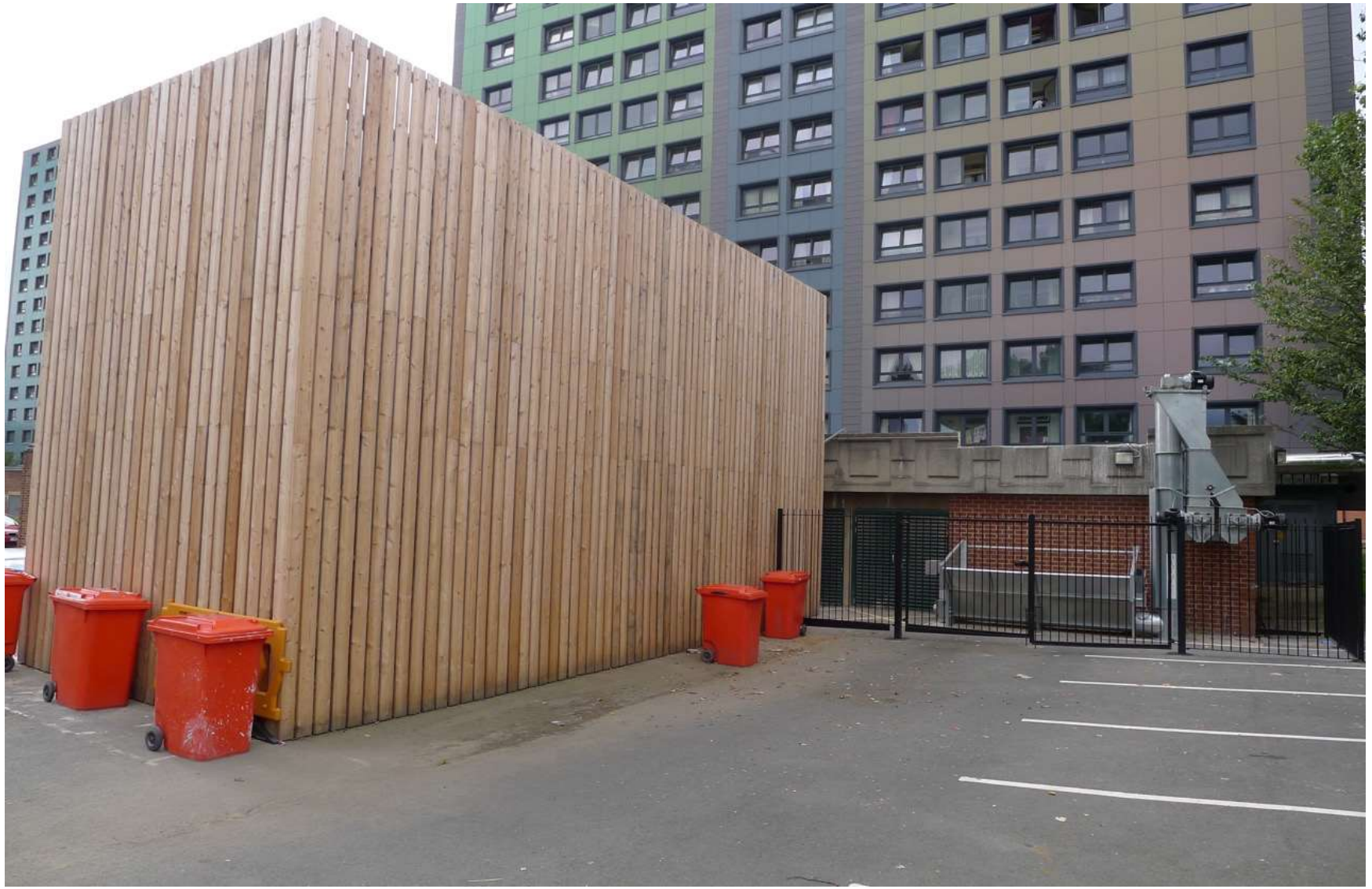
Stockport Homes Biomass Schemes

- 7 projects
- Installed by British Gas
- 350kW to 1,000kW
- About £600,000 a year in biomass
- 2000+ flats
- 6,000 tonnes a year of wood chips
- Heat purchased by the £/MWh
- @£37/MWh

- Schemes were installed and commissioned between January 2013 and September 2014
- Part of a range of wider ECO works to upgrade and improve the high rise blocks (over cladding, new internal radiators etc).
- Represent one the UKs largest biomass heating projects, and certainly a leading example of biomass installed in a social rented heating context.

Stockport Homes Biomass Schemes

Stockport Homes Biomass Schemes



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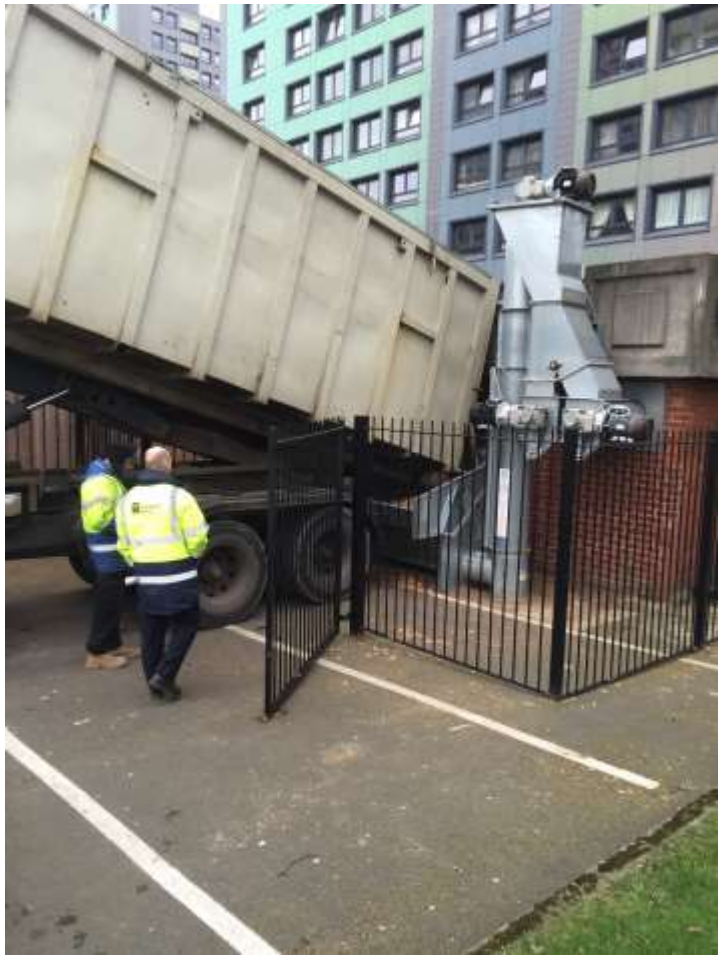
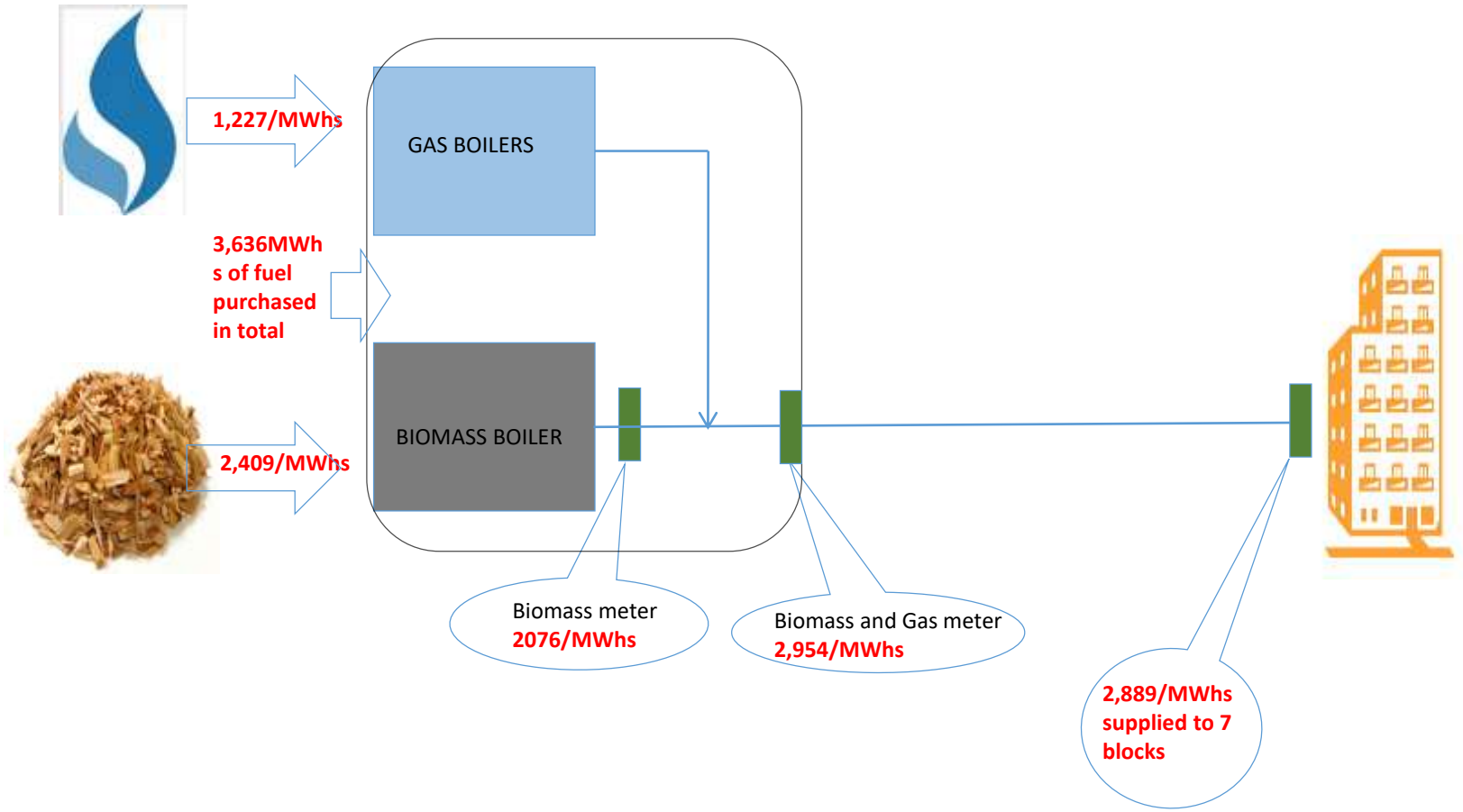


Stockport Homes Biomass Schemes

	Benchmark losses	Actual losses
Biomass boiler	6% to 20%	13.8%
Plantroom	11% to 30%	18.7%
Overall	26% to 70%	20.54% (to towers)



Street

Stockport Homes Biomass Schemes

We found some sites running at 20% to 60% losses

Reasons:

- Buffer tanks not properly configured or insulated
- User payment wrapped into rent not use
- No or poor interface controls: high flow temperatures
- Low Delta T- always ‘on’
- Plant room pipe work not insulated
- Poor pipework and pump design
- No metering oversight or BMS controls (no idea it has stopped)
- *‘Its not the underground pipes’*

CHA Biomass District Heating Scheme in Inverness

- 3 plant rooms serving about 40 properties
- Good quality systems and pipes
- But no controls and pump always on (low Delta T)

Caledonia Housing Association: heat costs reduced by 40% by improvements (heat purchase solution)

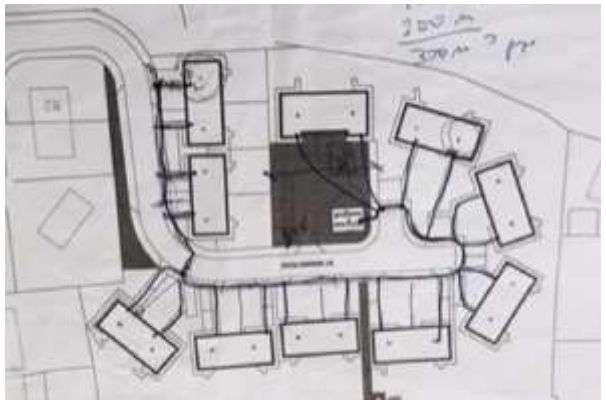


Figure 10: District heating pipes

Figure 6: 92kW Binder biomass boiler and buffer tank

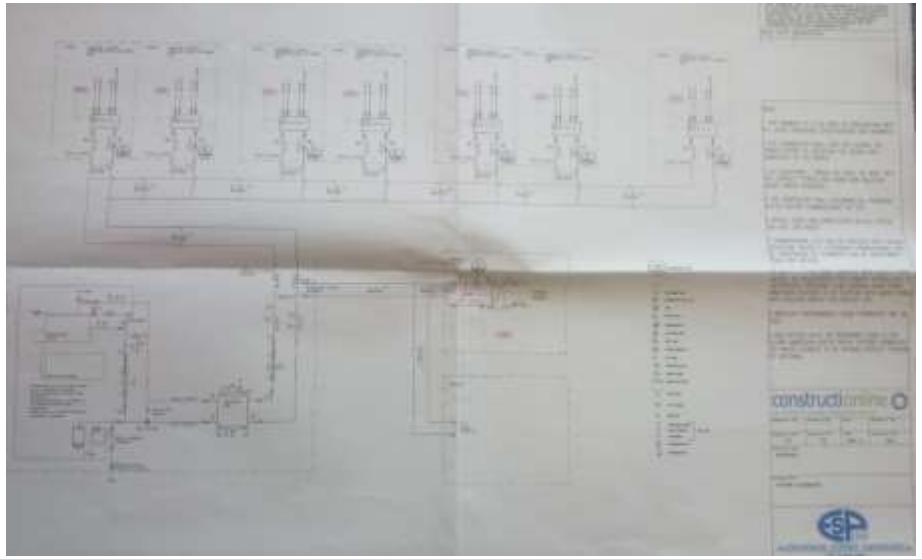
Whitelee Farm Biomass

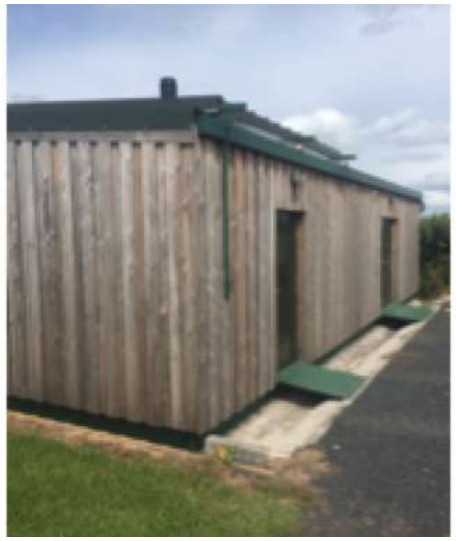
200kW scheme
Heating 7 cottages and a main large home
Circa £200,000 costs

We found running at 56% losses

Reasons:

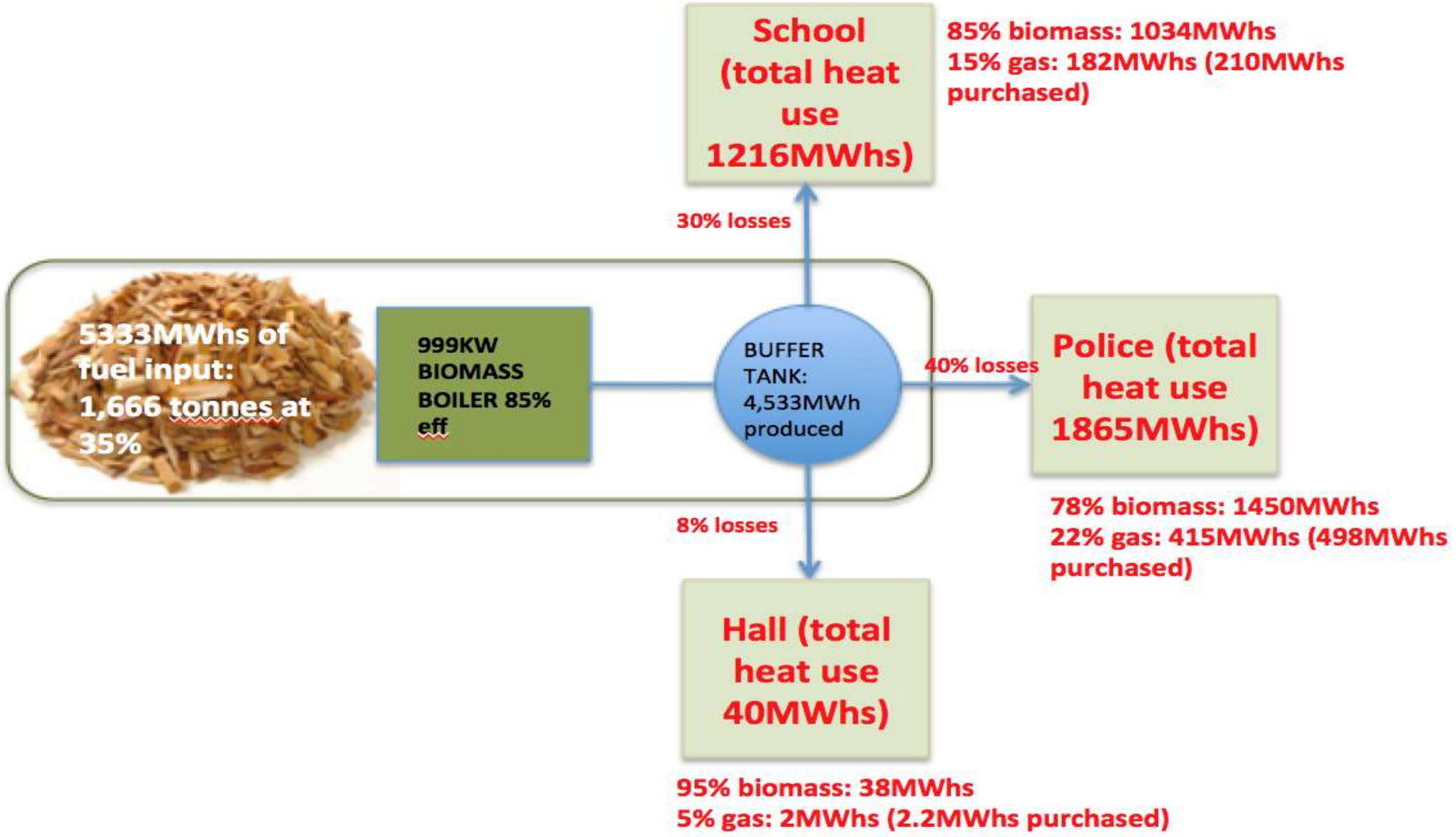
Buffer tanks not properly configured
No interface controls: high flow temperatures
Low Delta T- Always ‘on’





Local Energy Scotland/CARES
Police HQ/High School and Beechwood

Energy flows in the scheme



The scope and cost of a scheme

A £750k project
A 6/7 year payback
Heat prices pegged to current gas price (and CPI)
1,000 tonnes CO2 saved
2 jobs created

Conclusion – thanks for listening

1. Retro fit often best
2. Several large publically owned buildings
3. Design it well to reduce operating losses
4. Think about how its operated
5. Meter use for payment

‘Dealing with practicalities’

Steve Luker

APSE Energy Associate and Re:Heat

Case studies – district heating in N Ayrshire

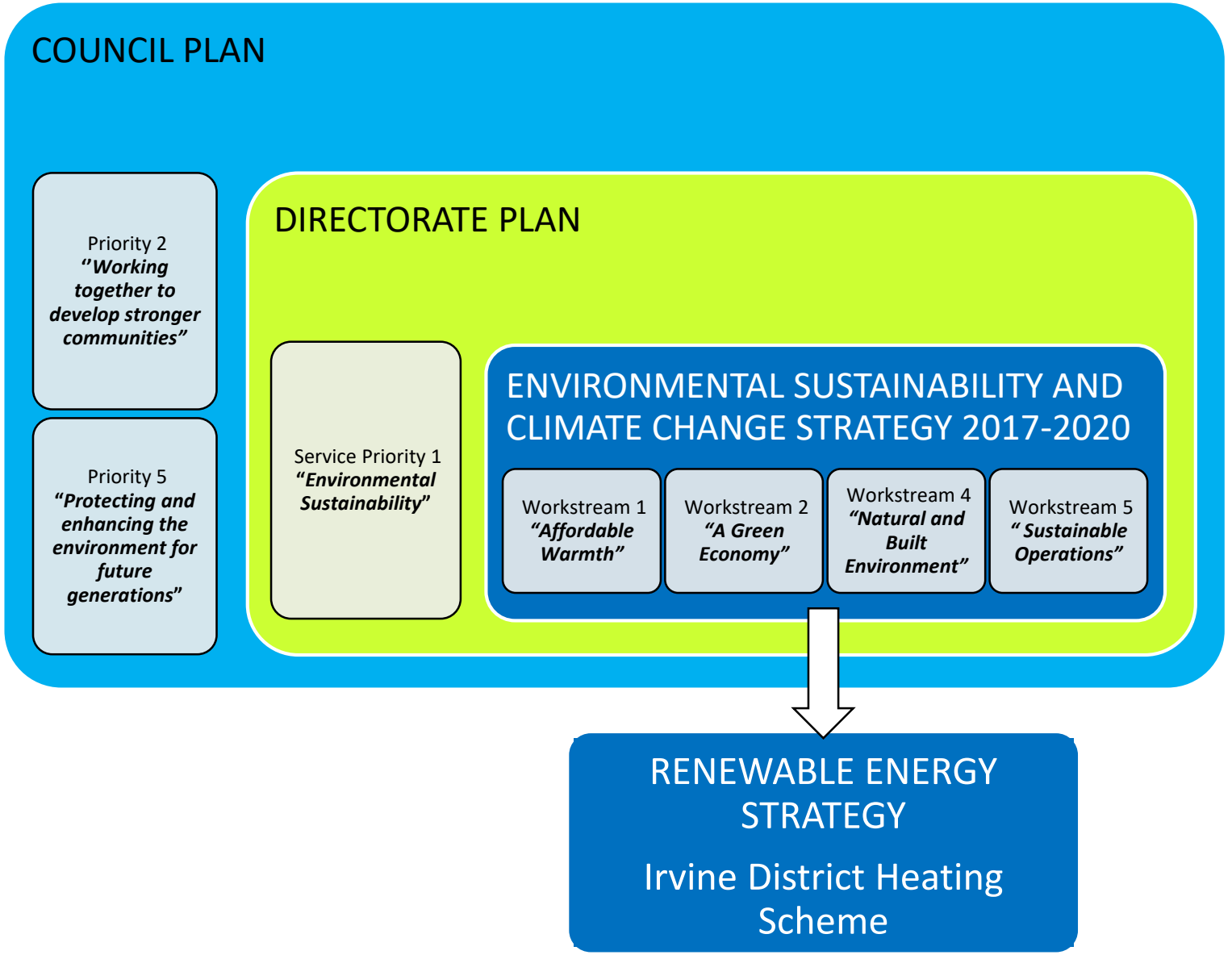
David Hammond
Senior Manager
North Ayrshire Council

Focus. Passion. Inspiration.

Culture eats strategy for breakfast.

- Peter Drucker

Irvine District Heating Scheme – Project Strategic Justification



The Journey so far…

- 2013/14- Environmental Sustainability & Climate Change Strategy (ESCCS) and Renewable Energy Strategy (Phase 1)
- Step change in our approach to sustainability and energy management
- Actions across five workstreams:
  - Affordable Warmth
  - Green Economy
  - Transport & Travel
  - Natural & Built Environment
  - Sustainable Operations

The Journey so far…

- ESCCS included an action to undertake a programme of biomass and solar pv installations
- Biomass investment of c£4m to date across 15 sites
- Total generation 4MW
- Net annual savings £300,000

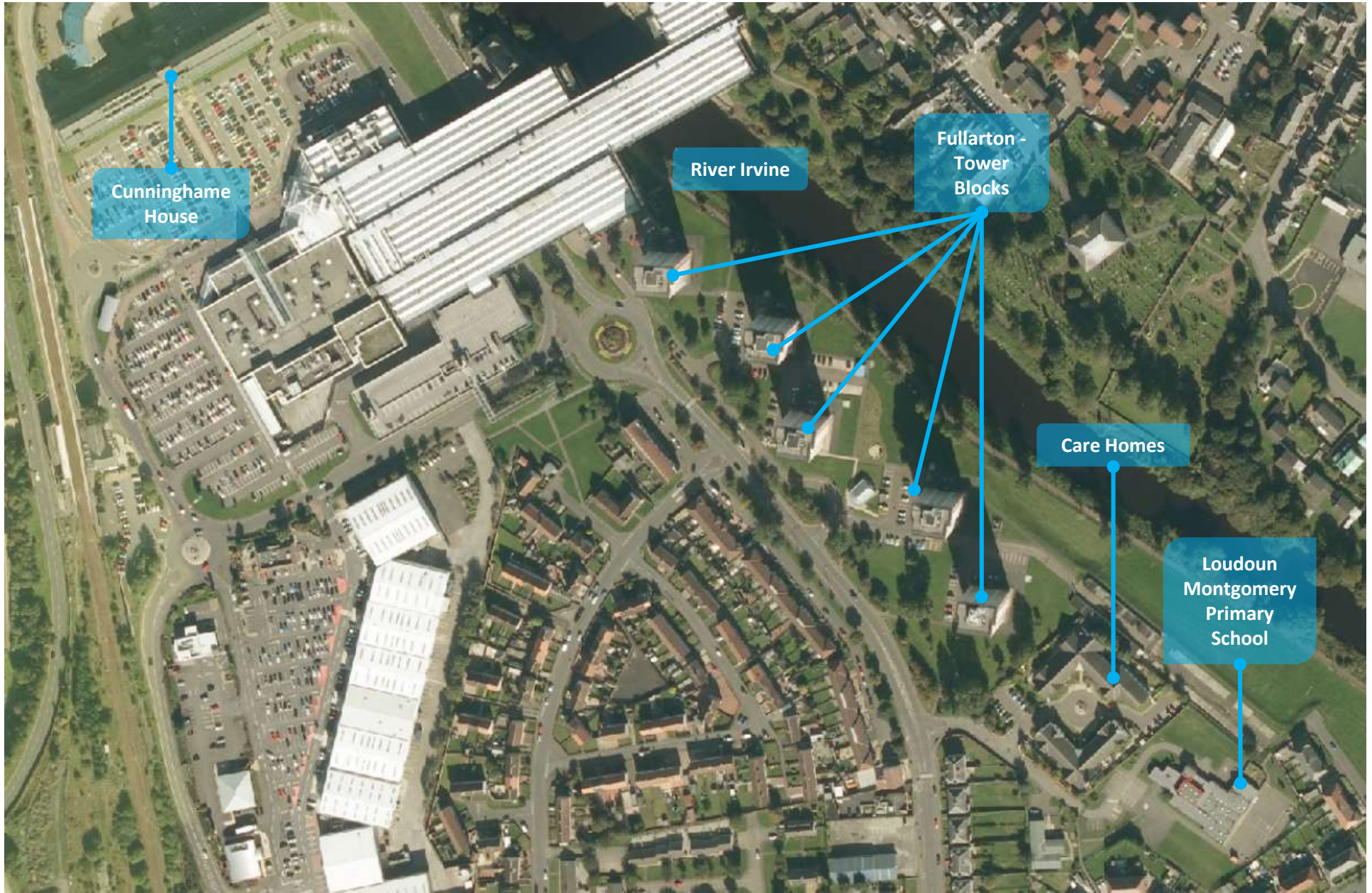
The Journey so far…

- ESCCS included an action to develop a business case for district heating scheme
- Winter 2015- Renewable Energy Strategy (Phase 2) completed, confirmed potential for scheme in central Irvine
- Summer 2016- outline business case for scheme commissioned, in part from LCITP grant funding
- Spring 2017- outline business case completed, findings presented to Cabinet
- Summer 2017- grant funding bid to LCITP for investment grade business case

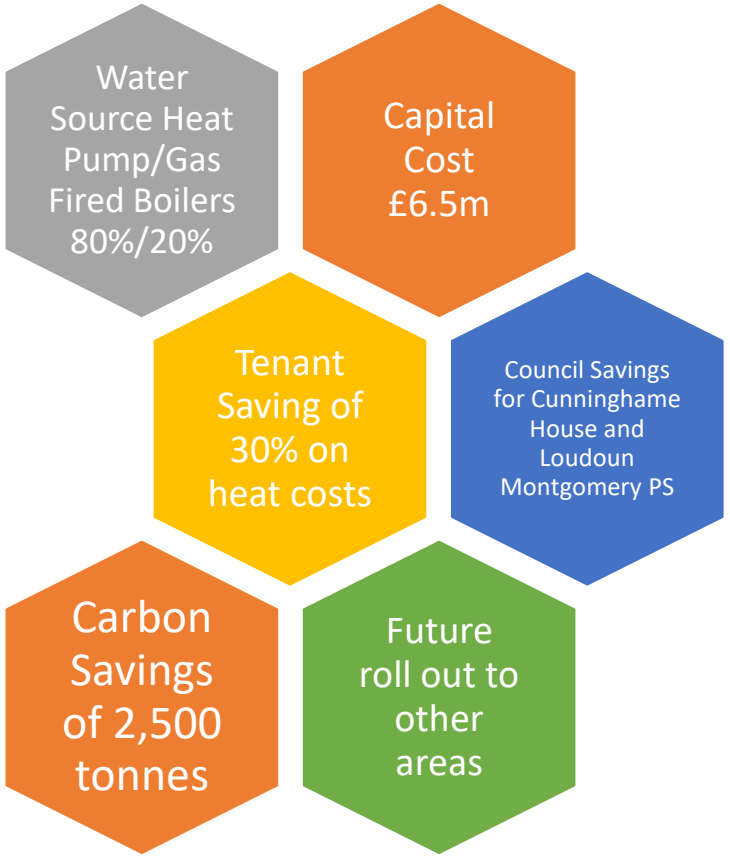
Irvine District Heating Summary

- Outline Business case examined a range of generation and connection option scenarios
- Anchor load to be provided by:
  - Fullarton Tower Blocks (275 flats across 5 blocks in the most deprived SIMD decile)
  - Cunninghame House
  - Loudon Montgomery Primary School
- Future connection options considered, and also waste heat recovery

Irvine District Heating Scheme – End Users *(full schematics provided in feasibility report)*



Irvine District Heating Summary



That’s not all…

- Administration included a manifesto commitment for more district heating schemes
- Two other smaller scale schemes in development
- 29 properties comprising Glencairn Sheltered Housing Complex/Glencairn Primary School (under construction, completion March 2018)
- 47 properties comprising Watt Court Sheltered Housing Complex, Local Housing Office, Supported Accommodation, and Dalry Primary School (technical design stage, completion Autumn 2019)
- Discount of c15% on heating costs, carbon emission reduction, and increased energy security, as well as sweating of existing assets

That’s not all…

- Partnership with the University of Glasgow during academic year 2016/17
- 200 MEng 4th Year students
- 24 projects completed under 4 themes
- Validation of our proposals!

Challenges

- Viability
- Legal Framework
- Metering & Billing (CIBSE Heat Networks: Code of Practice for the UK)

Next Steps

- Confirmation of long term anchor load certainty
- Preparation of investment grade business case
- Preparation of tender documentation
- Lessons learned from small scale roll out at Glencairn project
- Implications from current consultation on Local Heat & Energy Efficiency Strategies

‘Case studies – district heating in N Ayrshire’

David Hammond
Senior Manager
North Ayrshire Council

Discussion / Q&A

What can APSE Energy do to support you?

Capacity

Expertise

Holistic approach

Join APSE Energy

Just ask…

What can APSE Energy do to support you?

- Identification of opportunities – where is demand
- Business case
- Delivery and procurement options
- Design and implementation
- Operation and management

Contact me for any further info
Big Energy Summit – 8/9 March 2018
Ideas for future topics and venues are welcome

Phil Brennan

Head of APSE Energy