scottish renewables

LOW-CARBON HEAT CONFERENCE

24 APRIL 2018 GLASGOW

HEADLINE SPONSOR

INVEST IN FIFE

What comes next?

Richard Leyland

Deputy Director - Heat Programme
BEIS, UK Government

Heat decarbonisation

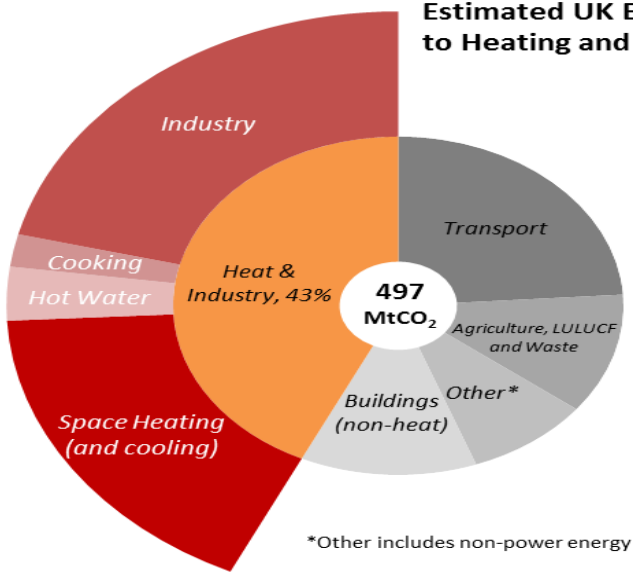
April 2018

Department for
Business, Energy
& Industrial Strategy

Heat in the context of climate change goals…

- The Climate Change Act sets an 80% decarbonisation target by 2050.
- Decarbonisation achievements in the power and waste sectors need to be replicated in “harder to reach” sectors.
- Meeting this target implies decarbonising nearly all heat in buildings and most industrial processes.

Estimated UK Emissions Attributable to Heating and Industry, 2015



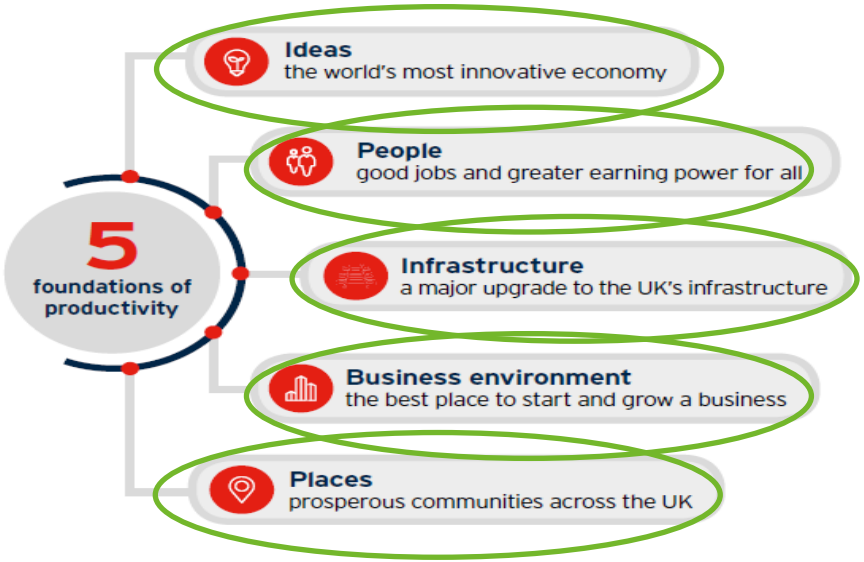
*Other includes non-power energy use in industry and power

Source: BEIS estimates derived from ECUK 2016, Energy and Emissions Projections 2016, GHG Inventory 2017, BEIS IAG guidance 2017

Low carbon heat and the Industrial Strategy

Maximising the advantages for UK industry from the global shift to clean growth

Boosting productivity and earning power:



Grand Challenges to put the future of the UK at the forefront of the industries of the future:

AI & Data Economy
We will put the UK at the forefront of the artificial intelligence and data revolution

Future of Mobility
We will become a world leader in the way people, goods and services move

Clean Growth
We will maximise the advantages for UK industry from the global shift to clean growth

Ageing Society
We will harness the power of innovation to help meet the needs of an ageing society

We are pursuing important policies in the short and medium term

Reducing the amount of heat used

Energy efficiency measures
Moving as many homes as possible to an EPC Band C rating by 2035, where practical, cost-effective and affordable.

Boiler Standards
Introducing a new minimum performance standard for domestic boilers to drive efficiency and give consumers greater control

Industrial Heat Recovery Scheme
Supporting the recovery and use of industrial heat that otherwise would be wasted

New Build Standards
Improvements to building regulations requirements.

Strengthening current support for low carbon heat technologies

Renewable Heat Incentive
Reforming the RHI to shift the scheme focus and maximise its effectiveness

Heat Networks Investment Project
Promoting heat networks through capital funding and other support

Developing a framework for the 2020s

2020s Policy Framework
Developing a post RHI framework to phase out oil heating – based on ambition of approx. 500,000 homes with heat pumps by 2030.

Heat Networks
Examining the measures required to create a long-term framework and subsidy-free market growth

Reforming the RHI

BEIS is currently delivering RHI reforms that were announced in December 2016 to improve value for money and shift the scheme towards a more strategic mix of technologies:

- Some tariff changes and domestic heat demand limits were implemented in Autumn 2017.
- The main RHI reform regulations are in Parliament and need to be debated in both Houses – first one was yesterday (23 April).
- Key policy changes include:
    - New biogas/biomethane feedstock requirements, and an uplift in the tariff for these technologies
    - Introduction of Tariff Guarantees – to support large non-domestic projects
    - Introduction of Assignment of Rights to help those without up-front capital
    - Removal of wood fuel drying and waste drying or processing (from Autumn 2017 consultation.

Policy in 2020s: Call for Evidence

We have published a call for evidence, as a first step in developing the policy framework for the 2020s. The call published on 16 March and will be open for 12 weeks.

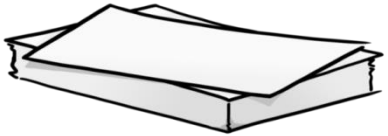
We are looking for evidence to help:

- support to help today's oil sector manage the transition to a low carbon future
- develop the evidence base we have on the technologies that can be used as alternatives to oil and coal heating systems
- understand what further opportunities there are for further innovation and cost reduction
- examinine the barriers to uptake of clean heating systems, and looking at what can be done to address these
- understand how we can build the consensus around cleaner heating.

Next steps

Renewable Heat Incentive:

- Government response and regulations to follow up remaining issues from Autumn 2017 consultation – expected in May. Covering biomethane registration, multiple plant, very large plant.



Call for evidence:

- Responses requested by 11 June to https://www.gov.uk/government/consultations/a-future-framework-for-heat-in-buildings-call-for-evidence

- We aim to publish a response to the Call for Evidence **in Autumn 2018**.

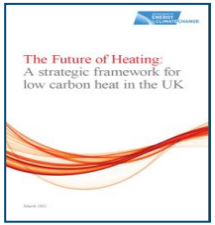
Analysts and stakeholders agree our 2050 goals pose special challenges for heat

The plethora of relevant studies and reports over recent years include….

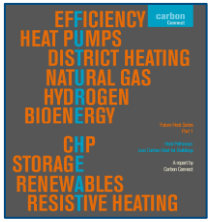
2011

2012

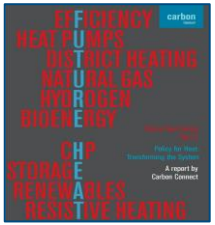
2013



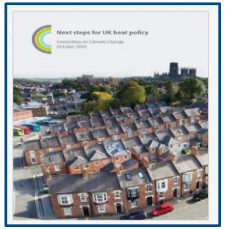
2014



2015

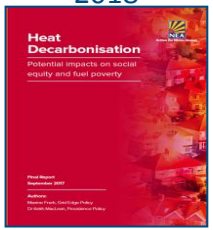


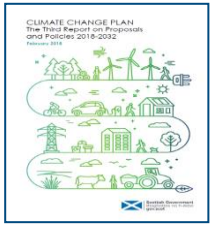
2016

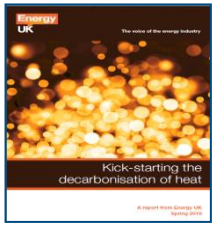


2017

2018







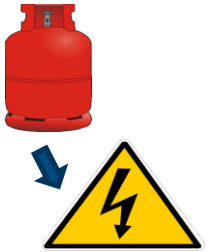
Department for Business, Energy & Industrial Strategy

But there is no consensus solution

A wide range of technologies hold potential, but all have pros and cons and there is no definitive answer on which approaches will work best at the scale needed

Electrification

- conversion to electric heat pumps or other electric technologies
- particularly useful for buildings not on the gas grid

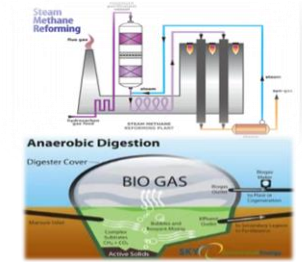


District heat networks

- cost effective where there is sufficient density of heat demand
- an important part of the mix in the long term

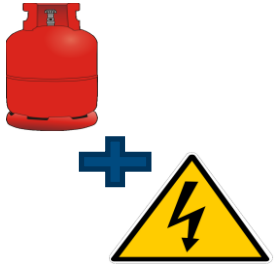
Decarbonising the gas grid

- using hydrogen or biogas
- more work is needed to assess cost and potential



Hybrid solutions

- different heating technologies and energy sources working together



We are strengthening & synthesising the evidence base

Biogas Availability

International Research

Hybrid Heat Pump Evidence

New projects

Hydrogen Appliances

Research & development

Biogas Technology

Consumer research

H2 costs & performance

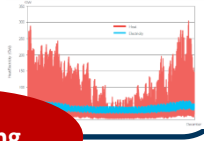
New innovation projects

Whole system and vector modelling

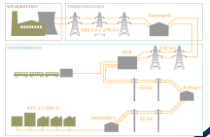
New modelling tools

Hydrogen

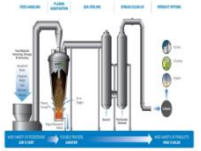
Demand Profiling



Electricity Networks



Biogas



Heat Networks

Analysis of the impacts of different decarbonisation pathways – the key barriers, risks, opportunities & uncertainties

And supporting innovation

At least £150m is being invested out to 2021 by BEIS, Innovate UK and the Research Councils in energy efficiency, new heating technologies and the gas network, with further funding from Ofgem for innovation by gas and electric network companies. This will address key innovation challenges to meet our long-term goals including:

A £10 million challenge fund will focus on making low carbon heating technologies more attractive to the consumer

A £25 million project on using hydrogen as an alternative to natural gas

Research Councils investing around £19 million to research how people's energy choices can help them stop wasting as much energy.

Research Councils supporting a £18 million hydrogen and fuel cells programme

Ofgem providing GB gas network companies with up to £195 million for them to develop and demonstrate new technologies

A new £20 million competition for industry fuel-switching projects

Paving the way for decisions on our long-term heat strategy…

As set out in the Clean Growth Strategy:

- We will **lay the groundwork** in this Parliament to set up **decisions in the first half of the next decade** about the long term future of heat.
- We will **publish initial findings from commissioned research** into different heat demand scenarios.
- We will **publish a full report on the review of the evidence** for decarbonising heat, by summer 2018.

Ross Loveridge

Head of Heat Regulation, Heat & Energy Efficiency Unit

Scottish Government

Scotland's Emissions Reduction Targets

Scotland's Climate Change Plan

- Requirement of the Climate Change (Scotland) Act 2009
- Policies and proposals for reducing emissions by **66% by 2032** across all sectors
- Allocates emission reductions across economy (TIMES)
- Articulates the on the ground changes that Scottish Government will take forward with its partners
- Published 28 February 2018
- **Proposed Climate Change Bill – increasing target to 90% by 2050**

Scottish Energy Strategy – the Future of Energy in Scotland

‘Whole-system’ view

- Economic modelling, informing view of Scotland’s future energy supply and demand
- Integrated approach to heat, power and transport
- New 50% ‘all energy’ 2030 renewables target
- Renewed focus on energy efficiency and energy demand reduction

Stable energy transition

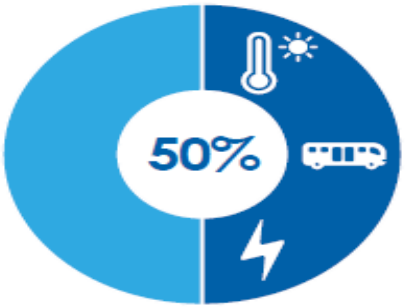
- Long-term plan, consistent with requirements of the Climate Change Plan
- Flexible to future changes in technology and patterns of energy use
- Managed transition of energy supply, post-nuclear

A smarter model of local energy provision

- Encouragement for new localised models of energy supply and use
- Enhanced role for local planning and local ownership
- New economic opportunities of energy storage and ‘smart’ energy solutions

2030 whole-system targets

The Strategy sets two new and ambitious targets for 2030:



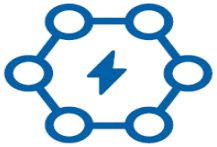
THE EQUIVALENT OF **50%** OF THE ENERGY FOR SCOTLAND'S HEAT, TRANSPORT AND ELECTRICITY CONSUMPTION TO BE SUPPLIED FROM RENEWABLE SOURCES

AN INCREASE BY **30%** IN THE PRODUCTIVITY OF ENERGY USE ACROSS THE SCOTTISH ECONOMY

Scotland's energy priorities

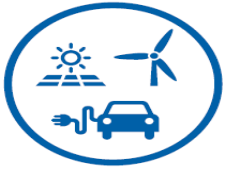
Consumer engagement and protection

Energy efficiency



System security and flexibility

Innovative local energy systems

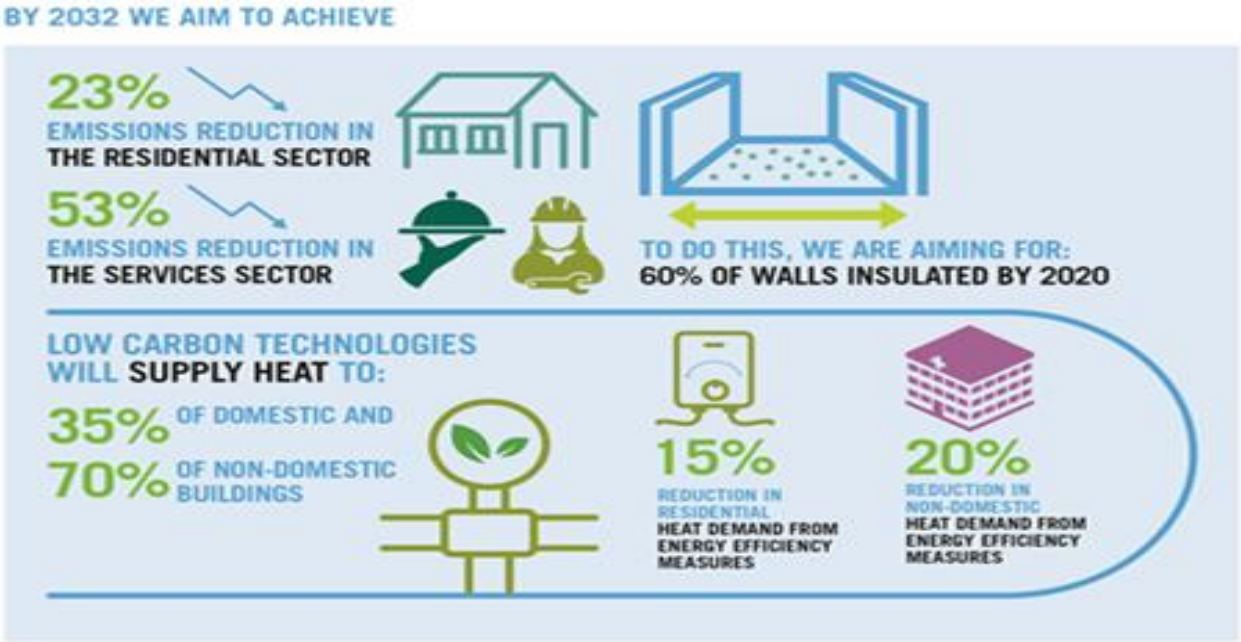


Renewable and low carbon solutions

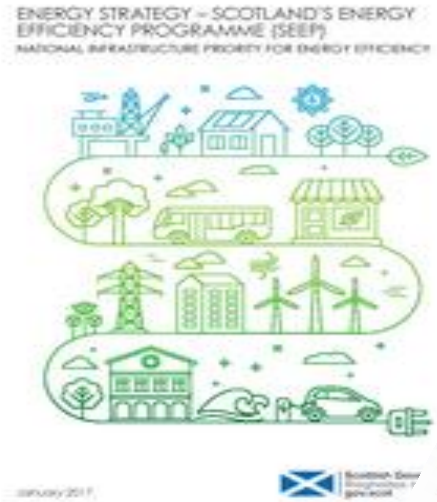
Oil and gas industry strengths

Heat and Energy Efficiency of Buildings

- Energy efficiency a National Infrastructure Priority
- Scotland's Energy Efficiency Programme (SEEP)



What is Scotland's Energy Efficiency Programme (SEEP)?



20 year programme

Homes and non domestic

Heat & Energy Efficiency

Public and private investment

Regulatory framework

Incentives and enabling

Scottish Government
Riaghaltas na h-Alba
gov.scot

Heat within SEEP

- Up to mid-2020s focus on:
  - Local authority strategic approach – LHEES and DH regulation
  - Low regrets decarbonisation options:
    - energy efficiency
    - district heating in heat dense areas
    - off gas grid renewable heat
- Continuing our existing support programmes to individuals and business and public sector:
    - Home Energy Scotland – HEEPS cashback loans
    - Resource Efficient Scotland – SME cashback loans
    - Renewable Heat Incentive – domestic and non-domestic
    - District Heating Loan Fund

Heat within SEEP…

- Post-2020
  - Working with UK Government to consider evidence base and future decision on heat decarbonisation
  - The Strategy considers two indicative scenarios for the energy system in Scotland in 2050:
    - An electrified future
    - A hydrogen future
  - Both scenarios consistent with Scotland's climate targets and informed by sector specific analysis and 'TIMES' modelling
  - Designed to help us understand what infrastructure and behaviours might be required under different future scenarios

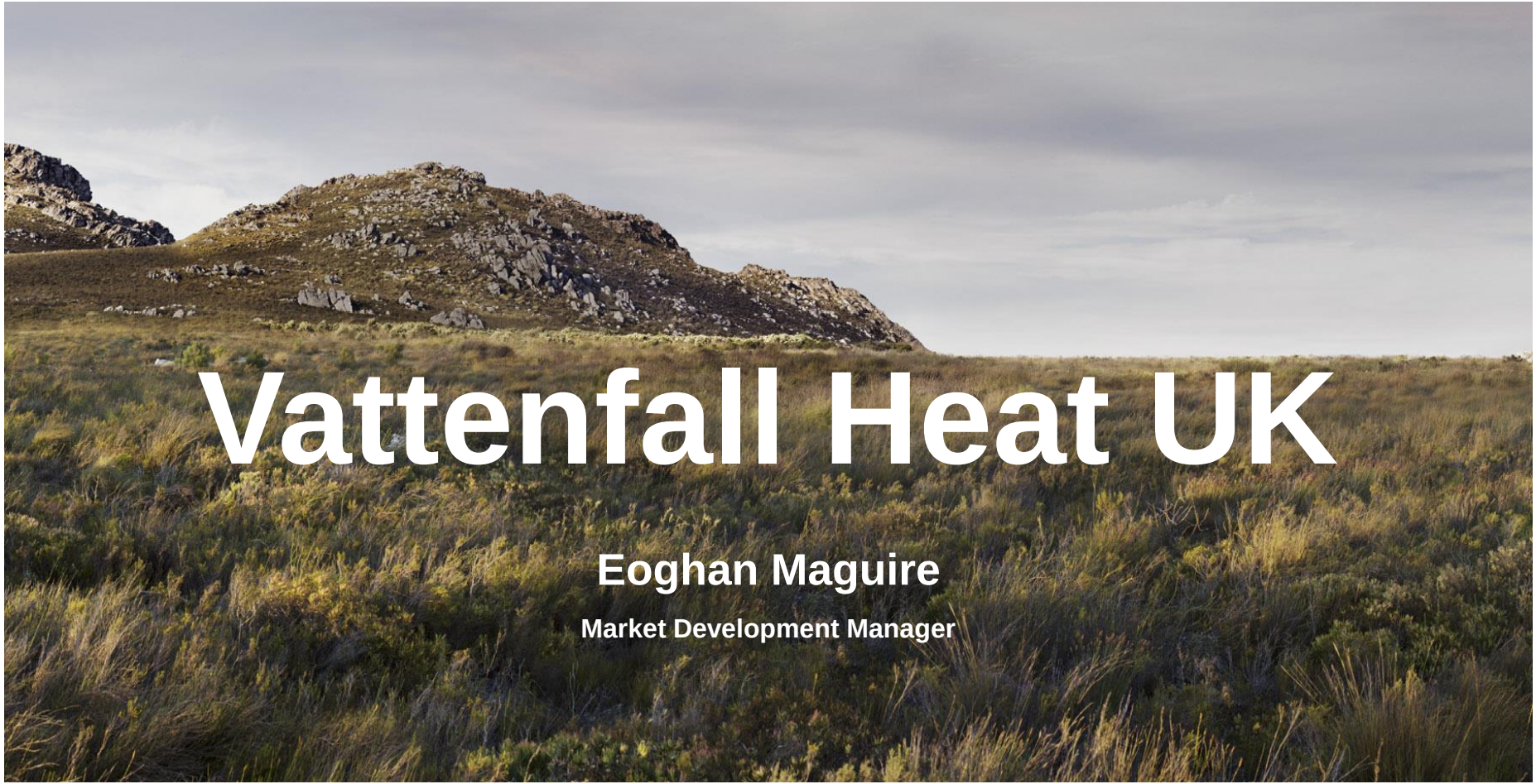
Next steps

- What's next?
  - Climate Change Bill
  - Warm Homes Bill
  - SEEP Routemap setting out direction and milestones
    - Further SEEP consultation and SEEP legislation – if necessary
  - Continuing partnership

Eoghan Maguire

Market Development Manager

Vattenfall



Vattenfall Heat UK

Eoghan Maguire

Market Development Manager

VATTENFALL

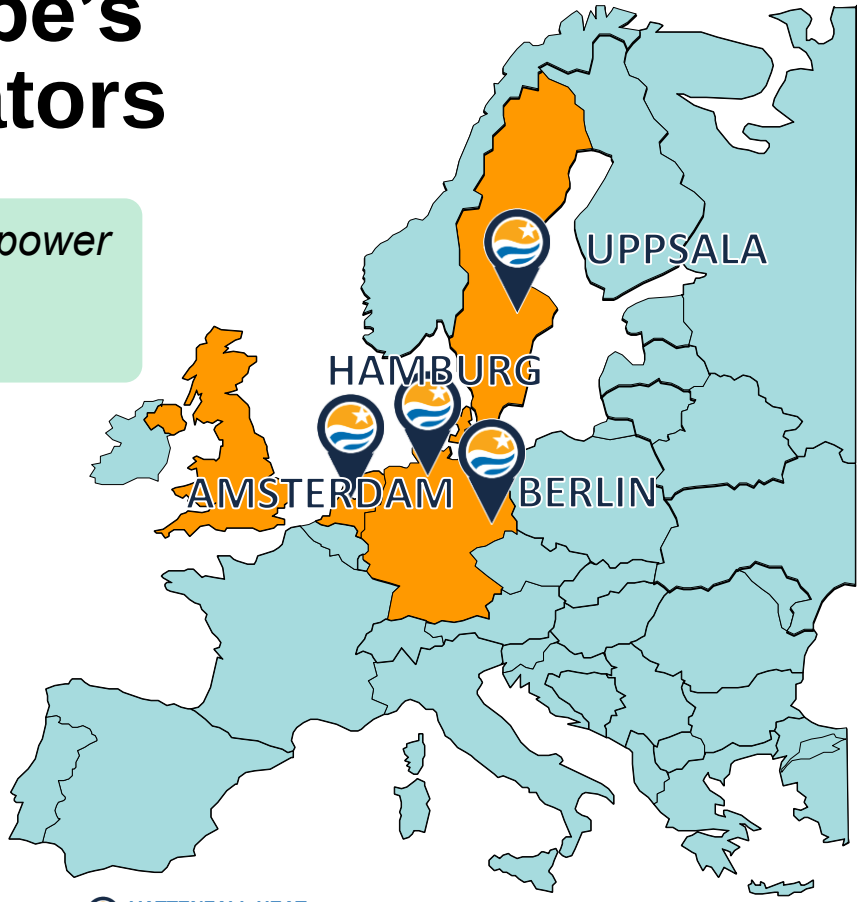
Vattenfall is One of Europe's major heat network operators

"At Vattenfall, we exist to help all of our customers power their lives in ever climate-smarter ways and ***free from fossil fuel within one generation****"*

- >2 million heat network customer base
- 25 TWh of heat sales; 4,600 employees

- Customer satisfaction is core to our business
- <1% churn rate

- Vattenfall free from CO_2, aim for 2040
- Vattenfall is 100% Swedish state owned



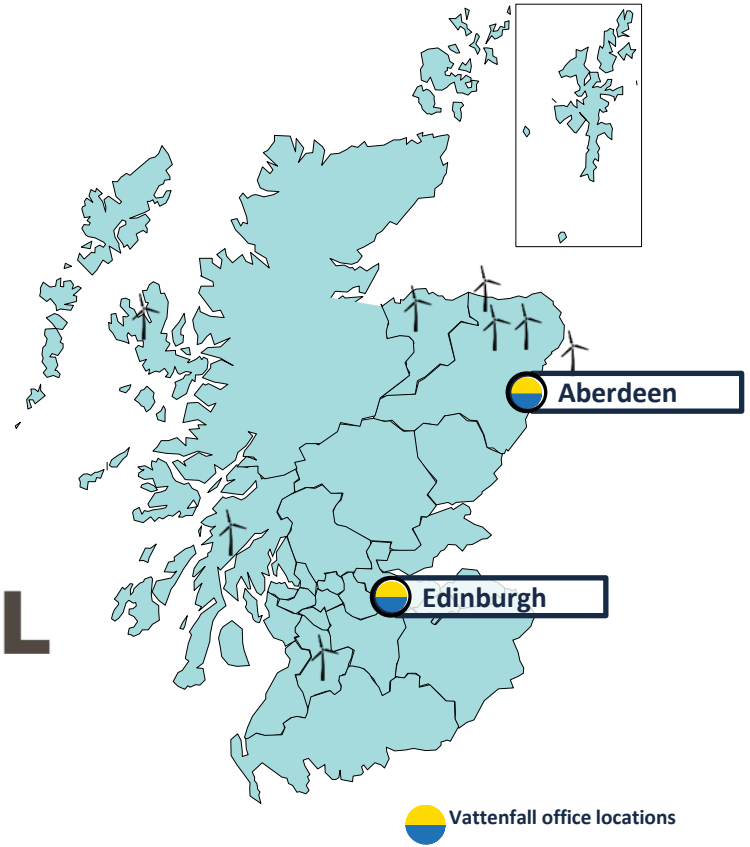
VATTENFALL

VATTENFALL HEAT
CORE PARTNER CITIES

Vattenfall looking to grow its heat network business in Scotland

- Technology
- Experience
- Commercial partnership

VATTENFALL

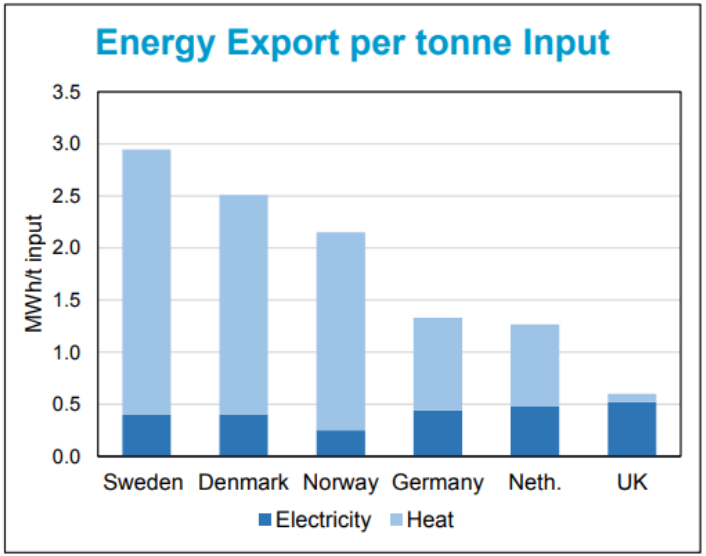


Scotland has huge potential to delver low carbon heat solutions

Natural resource

Regulatory environment

Waste Heat – EfWs not Incinerators



Source: Tolvik Consulting

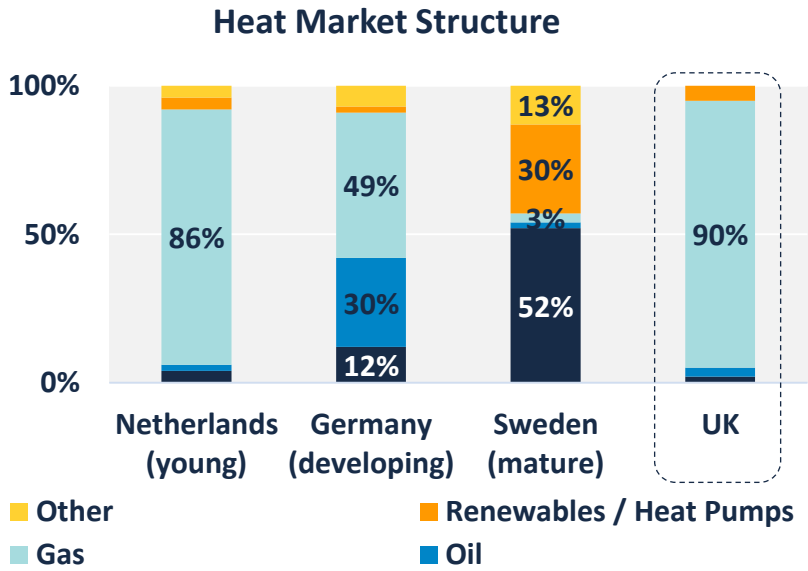
VATTENFALL

Transition to zero carbon heat: our experience in Europe transfers to Scotland

Our principles for managing the transition are applicable in Scotland

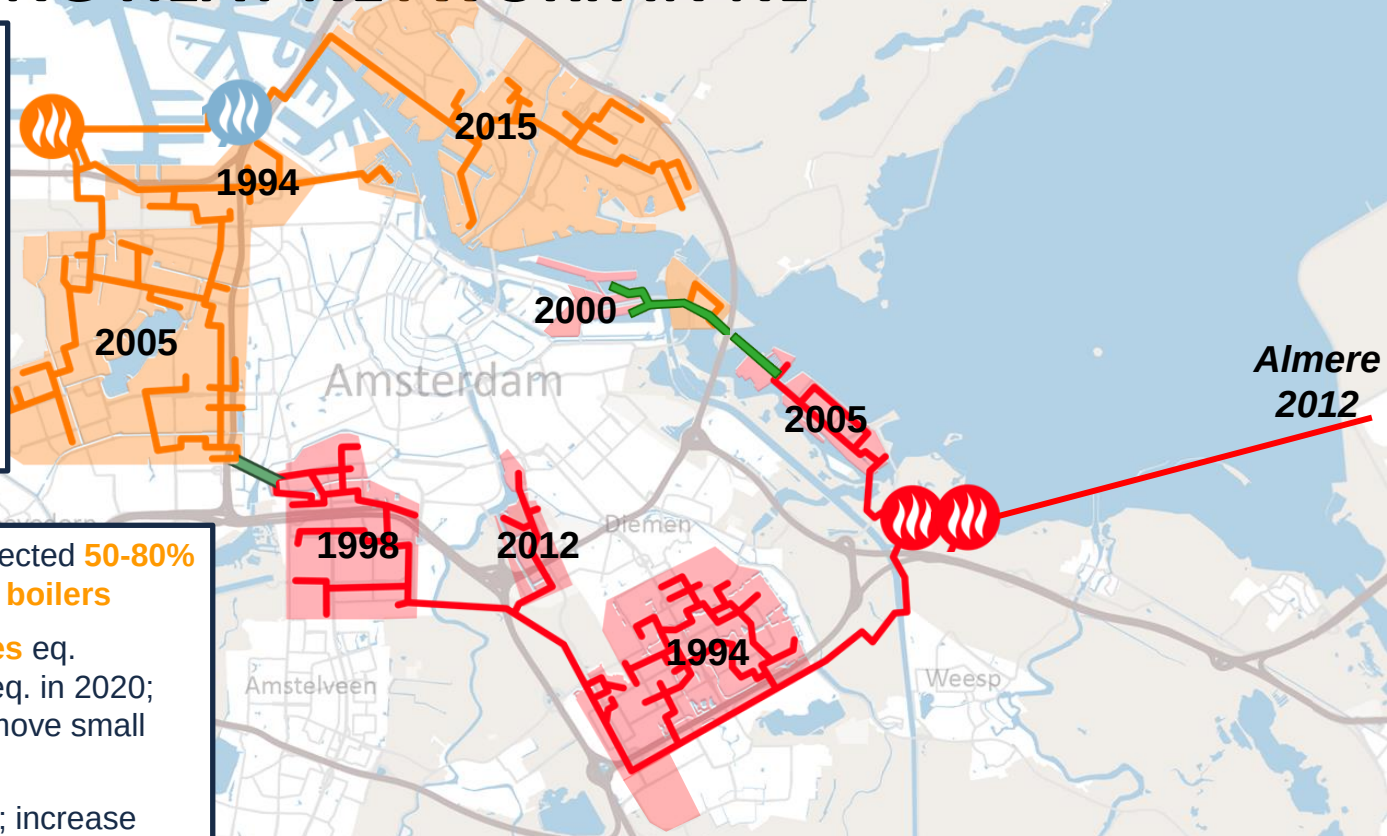
1. Decarbonisation path for networks **varies by geography**, e.g. EfW, heat pumps, geothermal, biomass, hydrogen
2. Address customer & community concerns with **responsibility as a social service**
3. Aim for **low temperature** heating together with building owners & developers
4. Integrated **long-term planning required** to follow a zero carbon heat pathway

VF's markets are at varying stages of development, UK is comparable to NL



CASE STUDY: AMSTERDAM (POP: ~800,000)
FASTEST GROWING HEAT NETWORK IN NL

- **Inception in 1994**: **co-location** of CHP / waste generation, trans-mission network and large scale city development
- **Scale-up from 2005:** '**district heating unless**' policy; **JV with city for concessions** (orange)
- **From 2012: housing market recovery**: new developments; new CHP & buffer; Almere link



- **Today**: ~140,000 homes eq. connected **50-80% CO_2 reduction compared to gas boilers**
- **2020 plan**: **connect >8,000 homes** eq. annually, reach ~170,000 homes eq. in 2020; **connect all island networks** (remove small gas CHPs);
- **2040 vision**: **~50% market share**; increase renewables share to **reach zero carbon <2050**

A lot done, more to do

- The stage is set… and the opportunity is golden

- Need to attract large volumes of cheap capital to build out infrastructure
- This is a housing stock and energy issue combined
- Need planning, foresight, and policy to get city-wide heat network, but need action today.

Claire Mack
Scottish Renewables

Richard Leyland
UK Government

Ross Loveridge
Scottish Government

Eoghan Maguire
Vattenfall

Kathleen Robertson
Scottish Government

scottish renewables

LOW-CARBON HEAT CONFERENCE

24 APRIL 2018 GLASGOW

HEADLINE SPONSOR

INVEST IN FIFE

Levelling the playing field

Andrew Yuill

Senior Renewable Heat Manager
Natural Power

Levelling The Playing Field

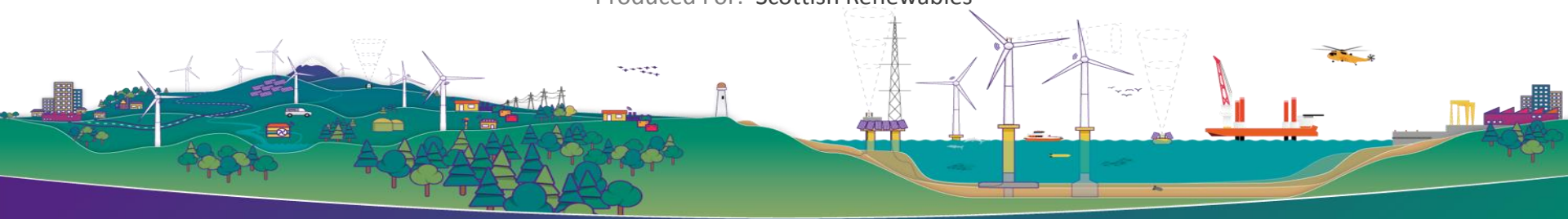
Low Carbon Heat Conference, Scottish Renewables

Andy Yuill – Senior Renewable Heat Manager

Date: 24th April 2018

Produced By: Andy Yuill – Senior Renewable Heat Manager

Produced For: Scottish Renewables



Levelling the Playing Field.

Levelling the Playing Field.

Are we playing the same game?

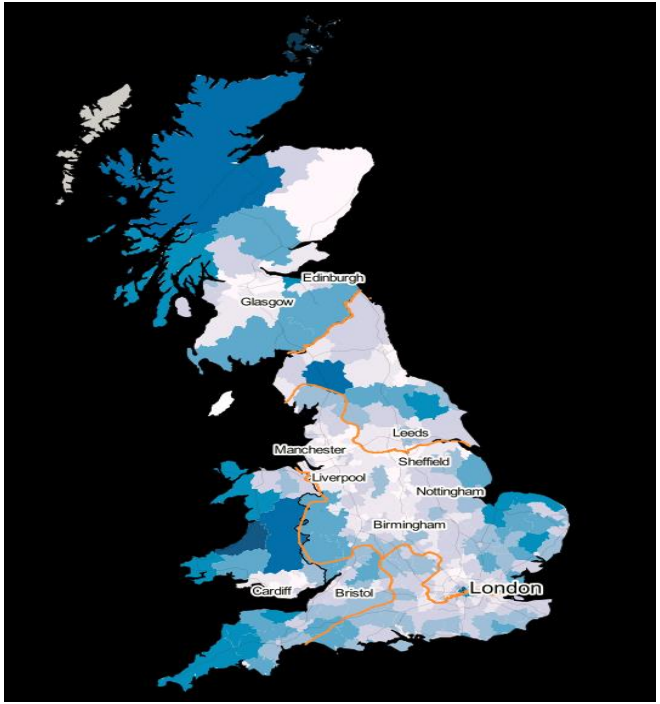
Levelling the Playing Field

Is it a fair competition?

Levelling the Playing Field

3 Key Areas

Who are we playing against



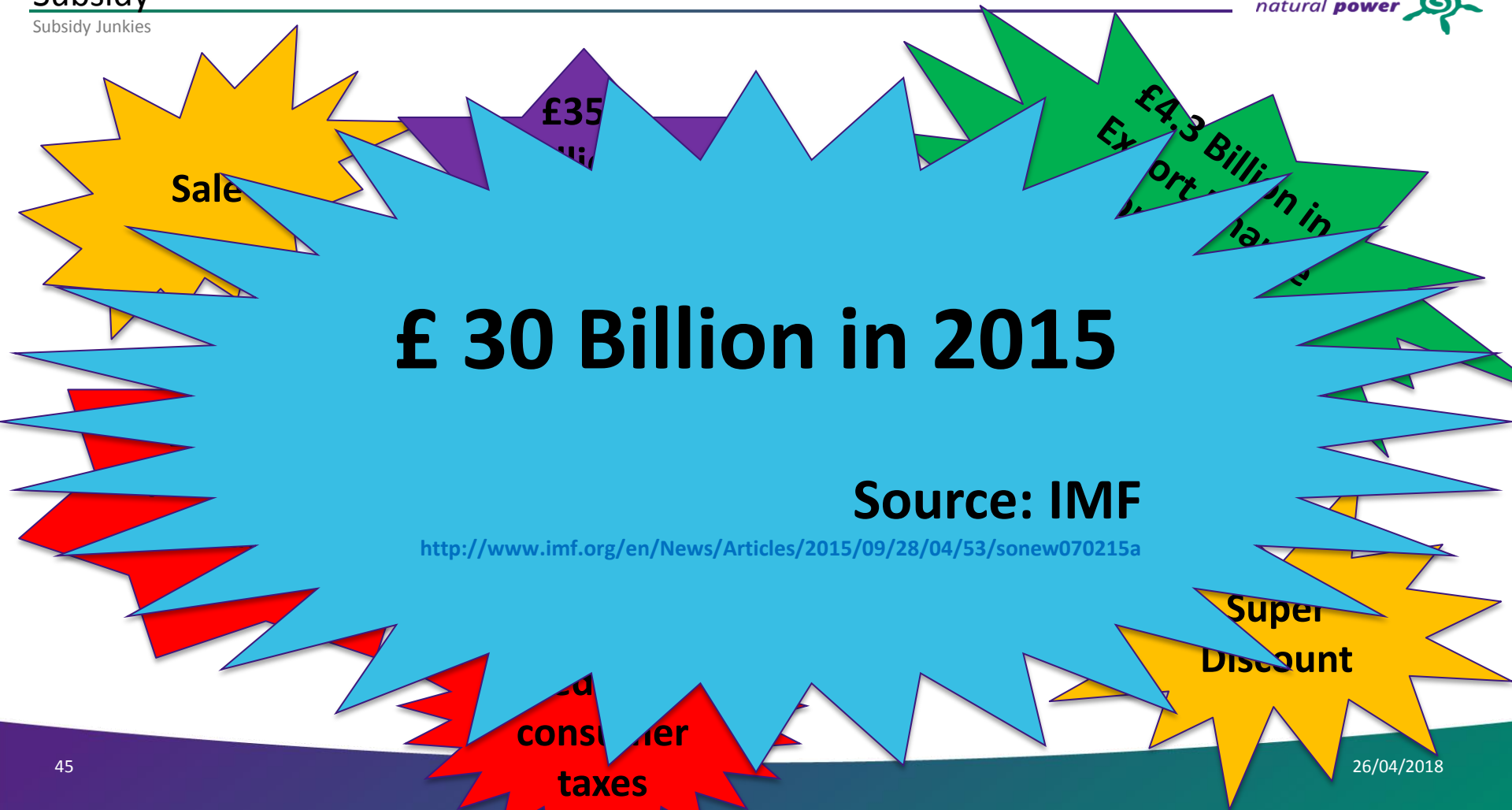
86% of UK Domestic Properties*

*Data from BEIS for 2016

"The UK defines fossil fuel subsidies as government action that lowers the pre-tax price to consumers to below international market levels. The UK has no fossil fuel subsidies"

The UK Government response to a 2015 FOI Request

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/455512/FOI_2015_15038_PUB.pdf


Sale
£35
£4.3 Billi
Ex
n in
£ 30 Billion in 2015
Source: IMF
http://www.imf.org/en/News/Articles/2015/09/28/04/53/sonew070215a
Super
Discount
taxes

Sustainability

Greener than green

Low Carbon Heat	Fossil Fuels (Gas)
RHI Sustainability	Climate Change Levy
RHI Land Use	
RO GHG Thresholds	
RHI Emissions Certificate	
Heat Networks CoP	
Biogas Energy Crop Limits	
Climate Change Levy	

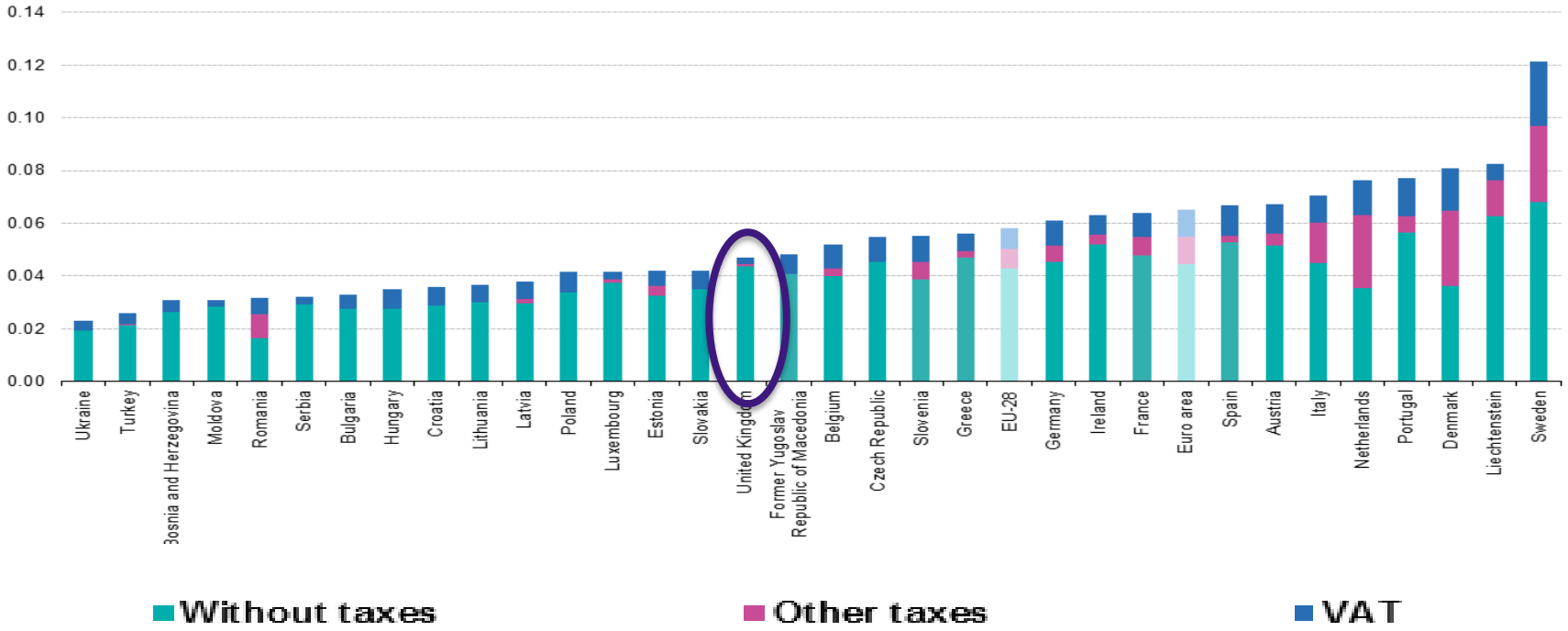
- Sustainable biofuel consumes 50% of Scottish barley production
- Sustainable biofuel company consumes 13% of the barley and 5% of milk in Ireland

DIAGEO

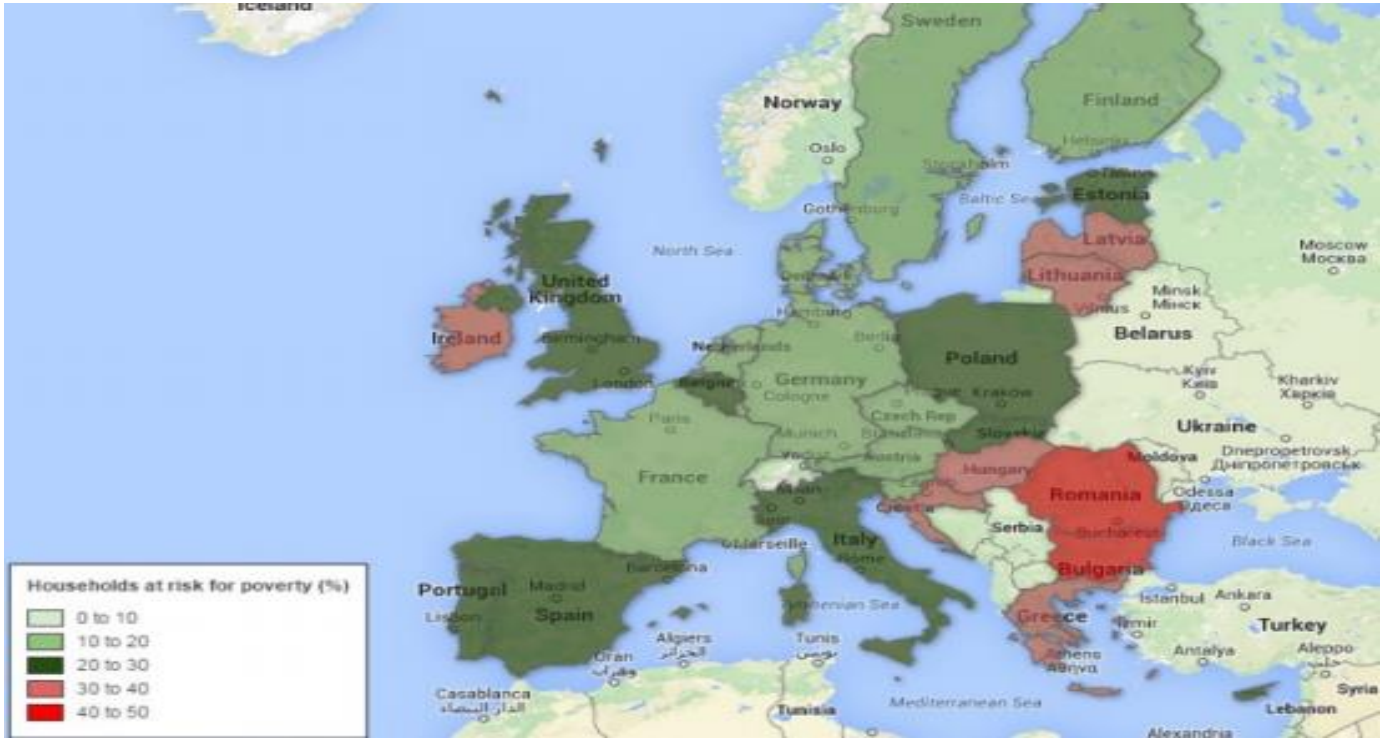
Biofuel Company Makes Number 6 in FTSE 100 Sustainability Index

Social

Fuel Poverty



Source: Eurostat (online data code: nrg_pc_202)



Source: Energy poverty and vulnerable consumers in the energy sector across the EU: analysis of policies and measures. Insight_E Policy Report 2015.

Poverty in Scotland

What are the latest figures?

1,000,000

People living in poverty

230,000 Children in poverty

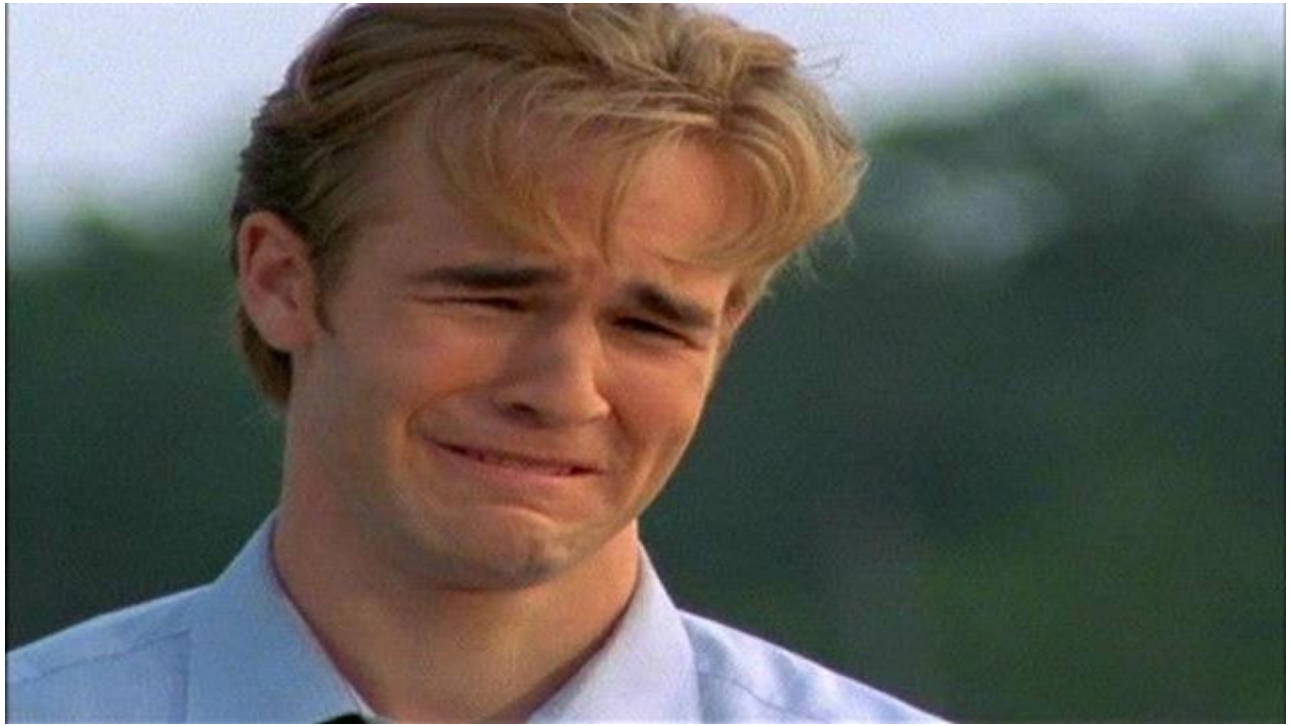
140,000 Pensioners in poverty

Scottish Government

Not that level at all

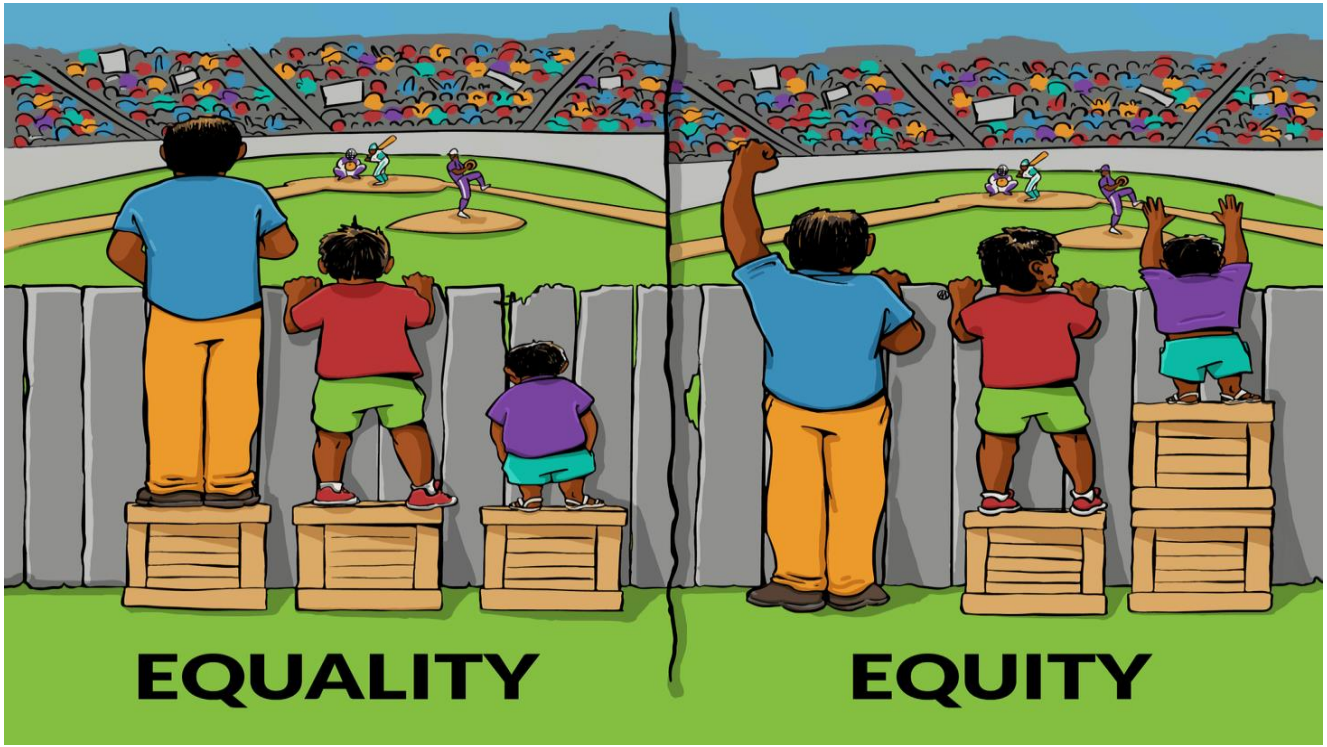
It’s all so very unfair!

Not a level playing field at all….



Levelling the Playing Field

It just needs to be equitable



Be the best that you can be

Dr Tanja Groth

Decentralised Energy Manager
Carbon Trust

Low Carbon Heat
Levelling the Playing Field

Dr Tanja Groth, Decentralised Energy Manager

24/04/2018

The UK heat market is skewed against market entry from heat networks

Scotland's ambitions are to have 10% of domestic heating met by district heating in 2050 to meet Scotland's future energy demand

The natural gas boiler market differs from the district heating market in a number of key aspects

Natural gas boilers

79% of Scottish homes use natural gas for their heating (2016 value)

District heating

1.4% of Scottish homes use district heating (2014 value)

The natural gas boiler market differs from the district heating market in a number of key aspects

Natural gas boilers

79% of Scottish homes use natural gas for their heating (2016 value)

Open to competition (or at least the illusion of competition)

District heating

1.4% of Scottish homes use district heating (2014 value)

Forms a natural monopoly to reduce demand risk

The natural gas boiler market differs from the district heating market in a number of key aspects

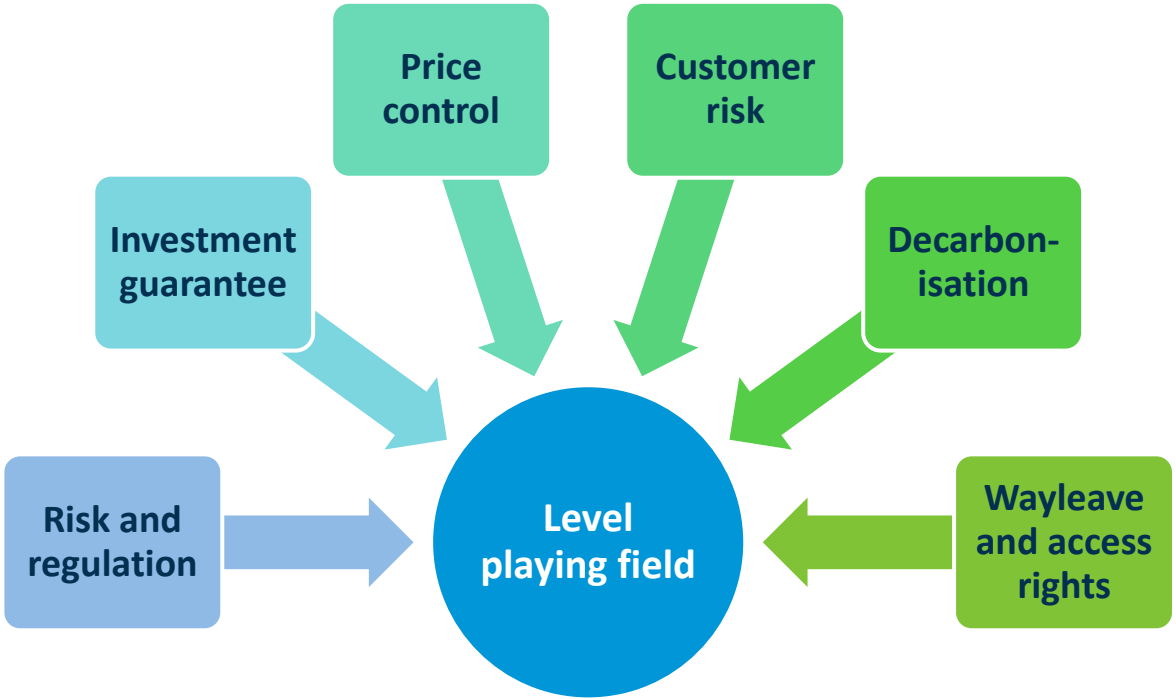
Natural gas boilers

- 79% of Scottish homes use natural gas for their heating (2016 value)
- Open to competition (or at least the illusion of competition)
- Locks you in for 10-15 years

District heating

- 1.4% of Scottish homes use district heating (2014 value)
- Forms a natural monopoly to reduce demand risk
- Locks you in for 40-60 years

ADE Task Force Report recommends action on the following topics



@tanja_groth @thecarbontrust

Thank you for listening!

The Carbon Trust is a company limited by guarantee and registered in England and Wales under company number 4190230 with its registered office at 4th Floor Dorset House, Stamford Street, London SE1 9NT.
Published in the UK: 2017.

Richard Lowes

Researcher

University of Exeter

The RHI:
What could you do with £23 billion?

Richard Lowes

UNIVERSITY OF EXETER Energy Policy Group

UKERC

Energy Policy Group

Recap: What were the aims of the RHI?

- 12% of all GB heat from renewables by 2020 (11% in Scotland)
  - In Scotland, the scheme operates the same but Scottish Government offers loans to households
- 'Prepare the market for mass roll out in the 2020s' (DECC, 2013)
- The scheme was split into domestic and non-domestic
  - Non-domestic opened 3 years after legislation passed
  - Domestic 5 and a half years after legislation passed

So how has the RHI performed

- According to the NAO, 65% less renewable heat delivered than it was originally expected to by now (NAO, 2018)
- Cost-effectiveness of heat delivered appears OK but is questionable (NAO, 2018)
  - I would add that the significant lean towards biomass also makes the scheme look more cost effective than it would otherwise be
- It is not clear what impact ‘gaming’ or ‘loopholes’ has had on scheme delivery (NAO, 2018)
  - But there are significant issues

Expected vs. actual delivery under the non-domestic scheme

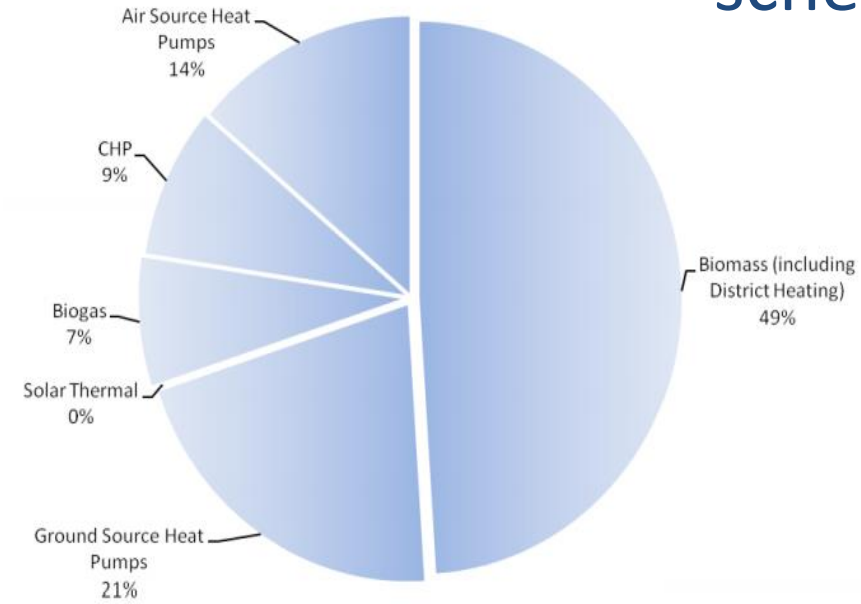


Figure 1. Modelled heat to be delivered under the non-domestic RHI scheme in the 2011 impact assessment (DECC 2011)

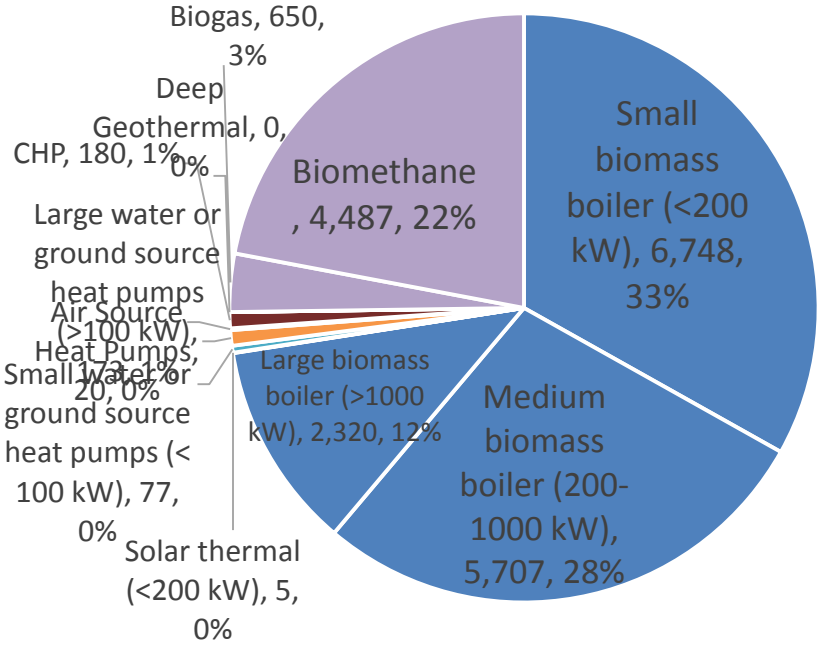


Figure 2. Heat delivered under the non-domestic RHI split by technology up to December 2017 ((BEIS 2018)

Expected vs. actual delivery under the domestic scheme

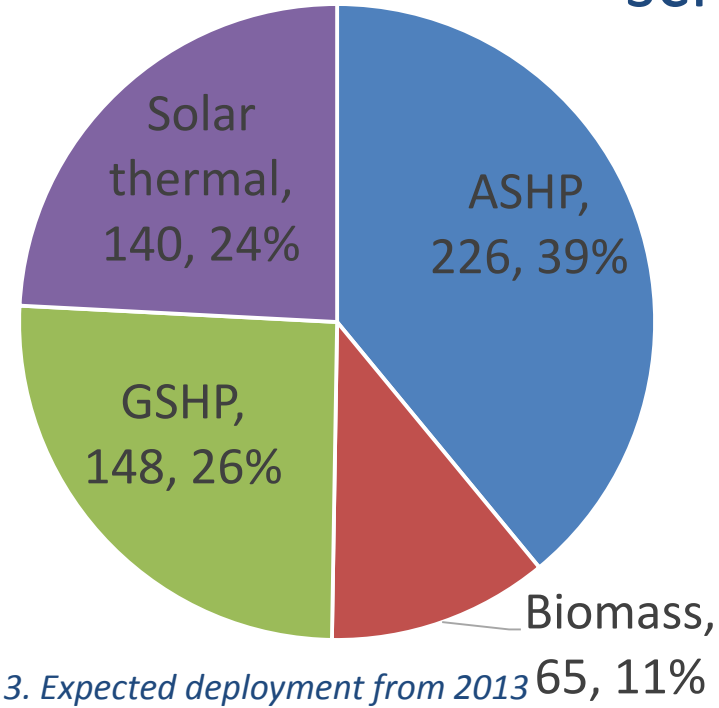


Figure 3. Expected deployment from 2013 impact assessment, (thousands of installations) (DECC, 2013)

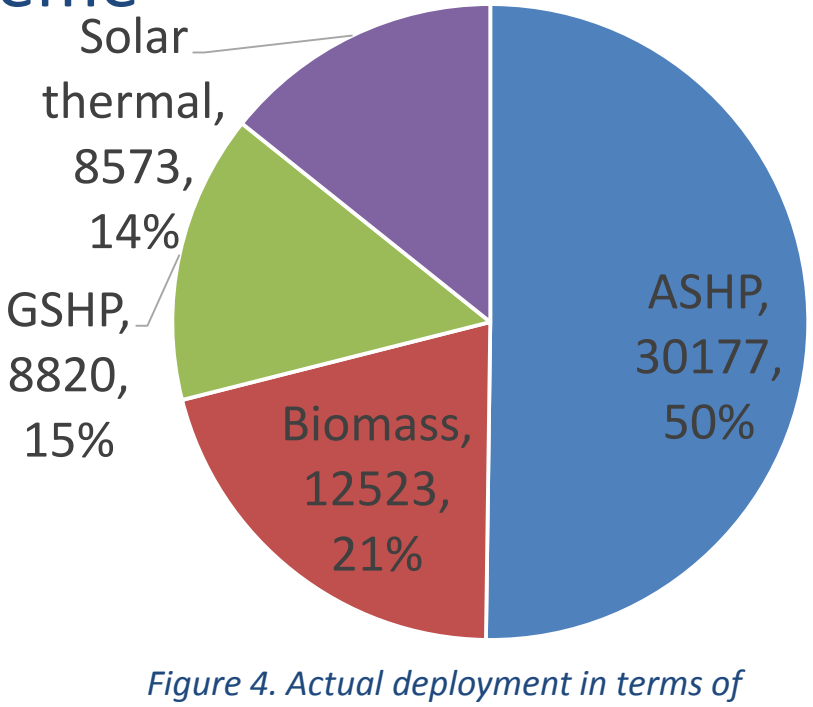


Figure 4. Actual deployment in terms of installations by December 2017 (BEIS, 2017)

But:

- The actual heat delivered by the domestic scheme has been dominated by biomass
- The domestic scheme is only likely to deliver around 15% of the heat it was originally expected to
- The domestic heat pump market has ‘flat-lined’ since the RHI was introduced, something must change (CCC, 2016)

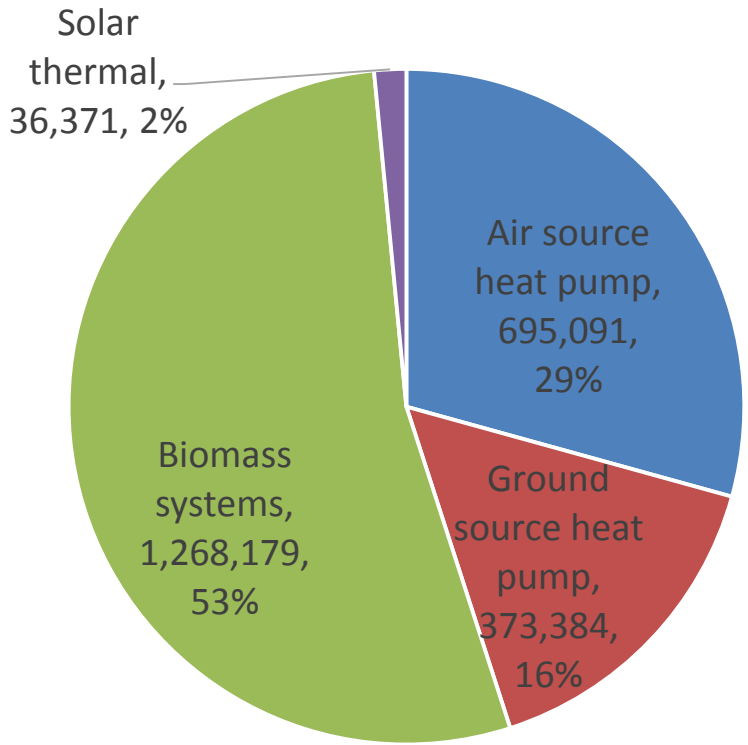


Figure 5. Total heat delivered by the domestic RHI split by technology up to December 2017 (BEIS, 2017)

So what will happen in the future?

- In the short term, tariff tweaks may shift deployment from biomass to non-biomass technologies
  - But the scheme could deliver less overall and it's unlikely there will be any significant policy changes before a new scheme comes in
- But the Government has so far said nothing, so who knows
  - Interestingly Energy UK intervened 2 weeks ago
- The scheme will not meet it's objective of 12% heat from renewable sources (7% in 2016) and a well developed low-carbon heat market

Where does this leave us?

- In an ideal world, the RHI would have deployed at originally expected levels and the market would be pump-primed for mass deployment
  - That clearly hasn't happened
- So in 2021 we will be around 10 years behind where we should be:
  - There has been limited market learning (any?)
  - We are now not ready to regulate out what should be key/easy sectors e.g. off gas grid (oil, LPG)

So what should happen post 2021?

- Some form of renewable heat subsidy is still required
  - Grants for heat pumps and solar thermal are better than payments
  - Ongoing payments for **(sustainable)** biomass
- Alongside a ban on oil and LPG heating?
- Ongoing payments may be better for non-domestic heat

- And what about the gas grid?
  - A major role for district heating
- Don't forget energy efficiency.

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Dr David Hawkey

Research Fellow, Sustainable Heat & Local Energy

University of Edinburgh

HEAT AND THE CITY

THE UNIVERSITY of EDINBURGH
School of Social and Political Science

Alignment of incentives for district heating growth

David Hawkey

University of Edinburgh

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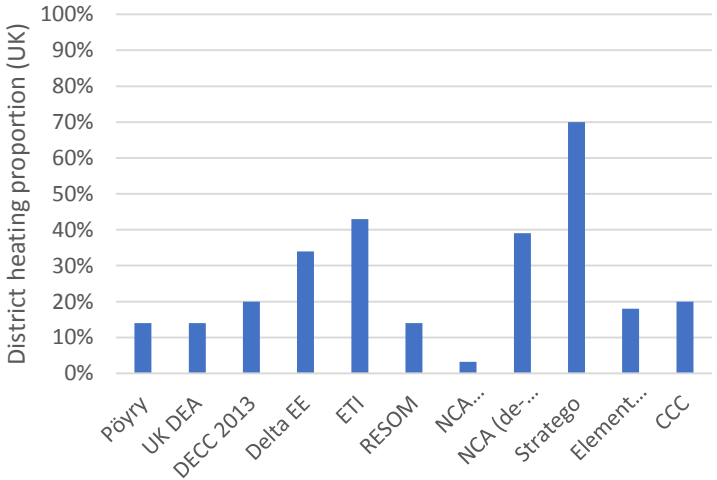
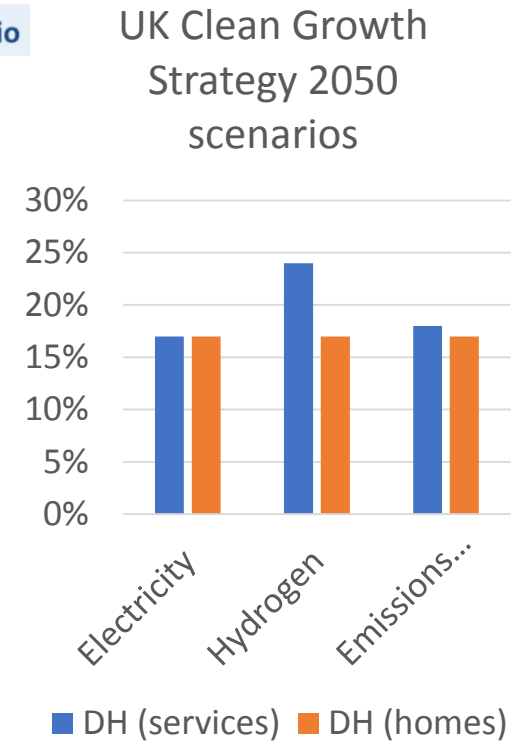
District heating across scenarios

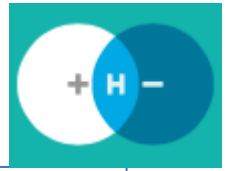
Summary of heat delivered in the Critical path scenario

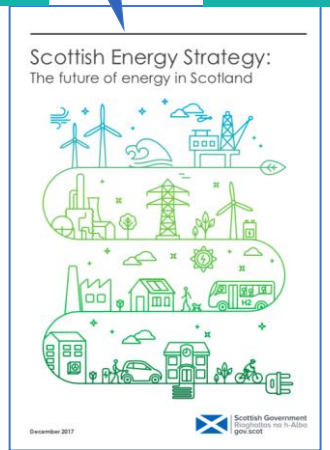
Year	Heat delivered by DH (TWh)	Fraction served by DH
2020	9.0	2%
2030	32.4	7%
2050	110.8	25%



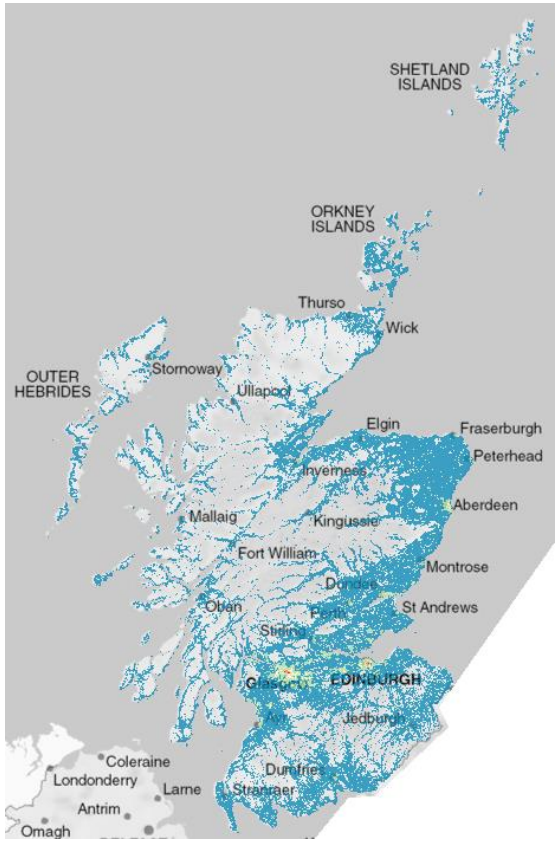


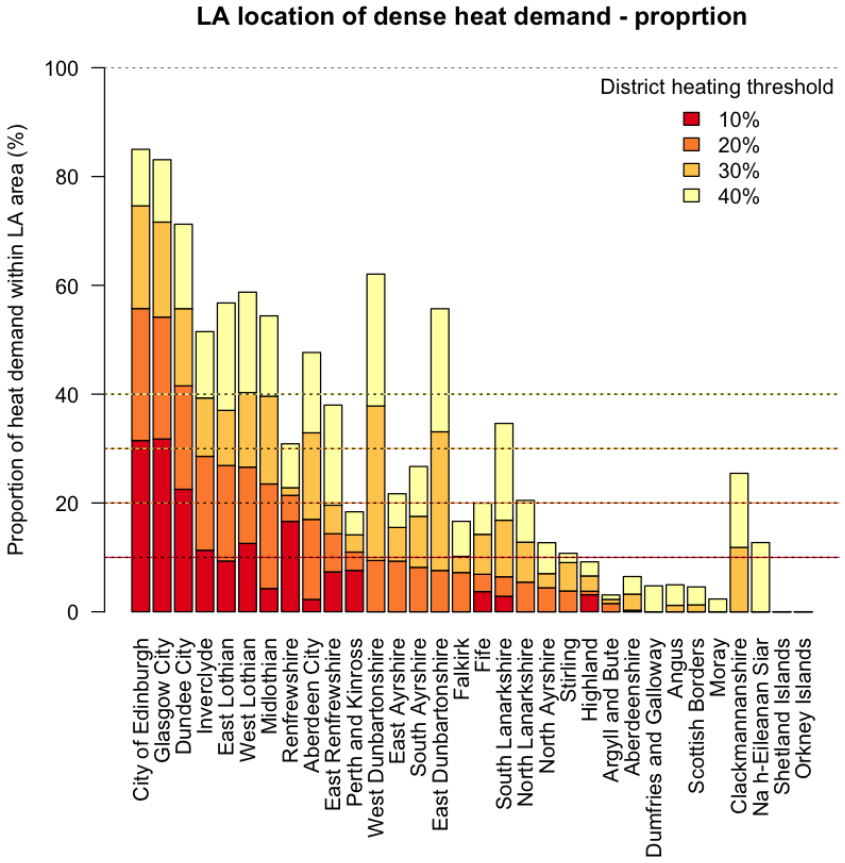
DH meets over 10% of heat demand

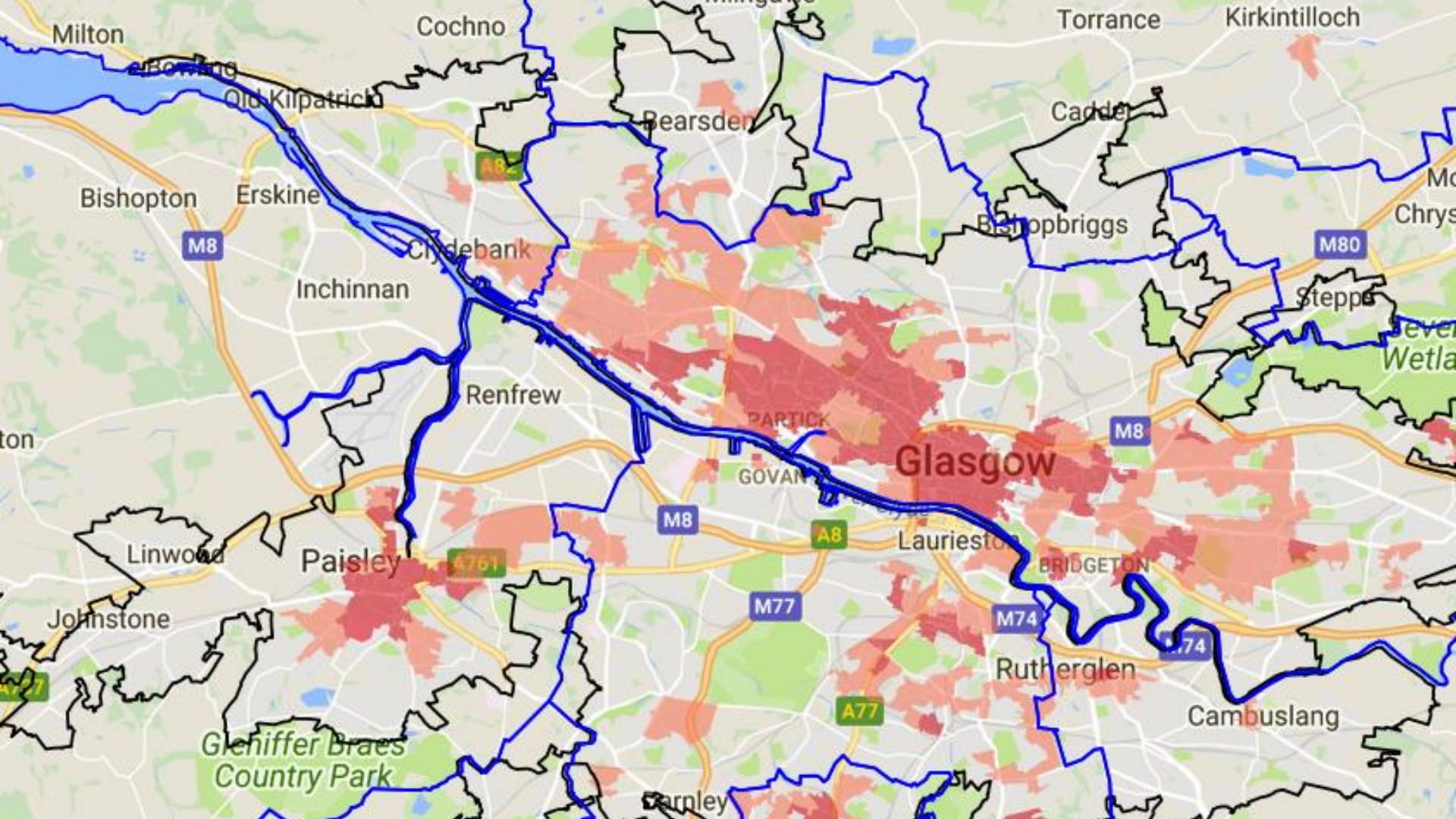




Concentration of DH areas in Scotland



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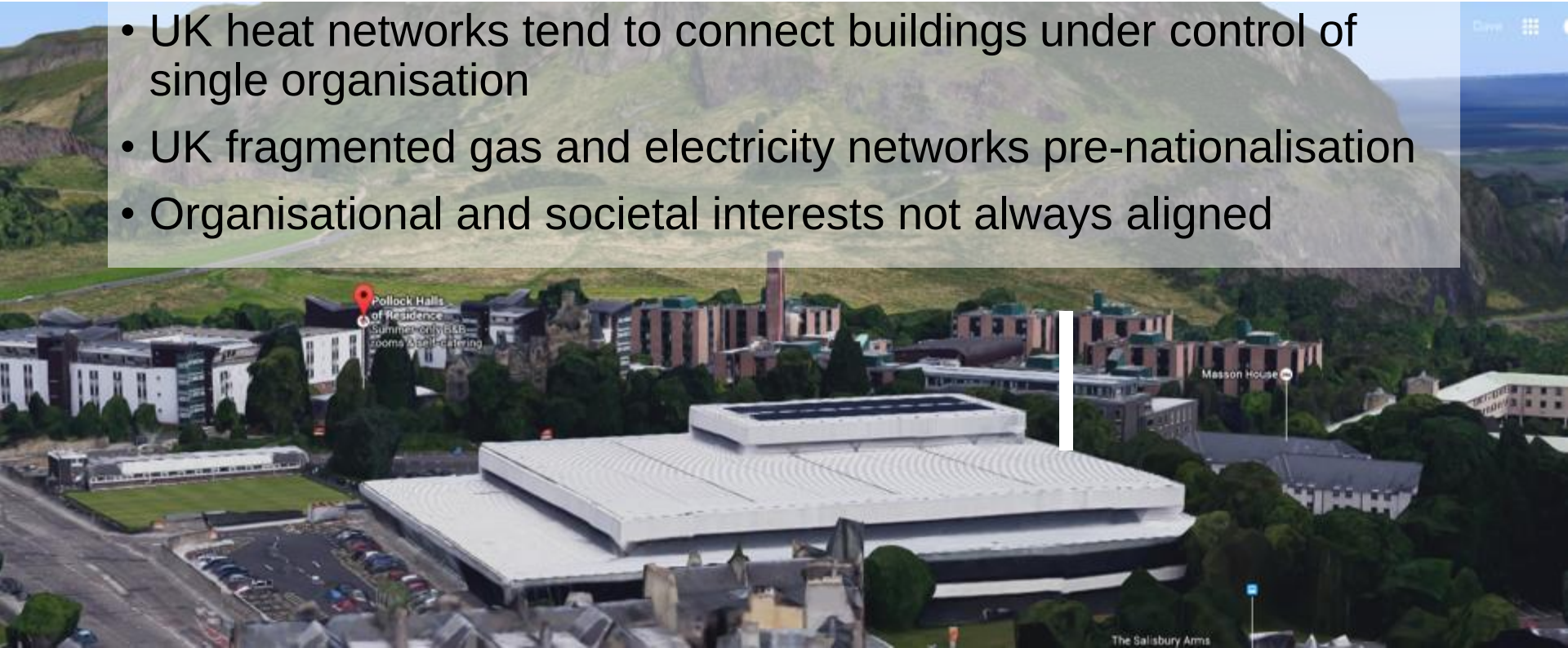
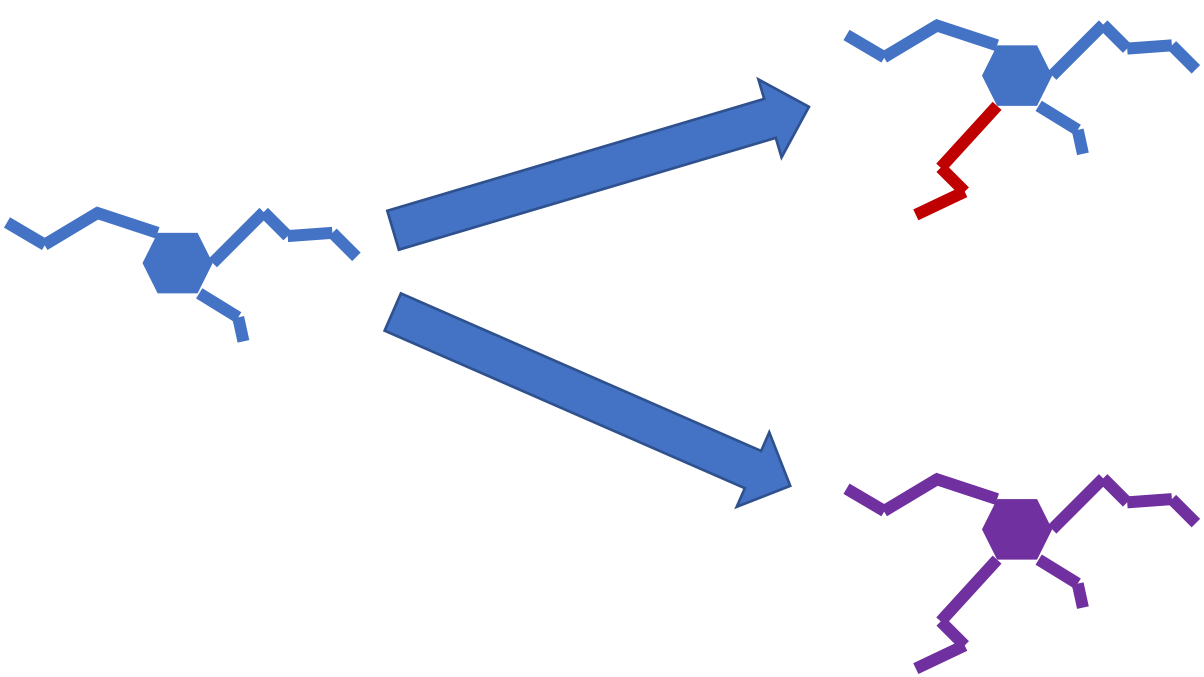
Cochno
Torrance
Kirkintilloch
Old Kilpatrick
Bearsden
Bishopton
Erskine
M8
Clydebank
Inchinnan
Bishopbriggs
M80
Renfrew
PARTICK
Glasgow
M8
GOVAN
M8
A8
Linwood
Paisley
A761
Johnstone
M77
M74
Rutherglen
A77
Cambuslang
Gleniffer Braes
Country Park

Piecemeal and fragmented DH development

- UK heat networks tend to connect buildings under control of single organisation
- UK fragmented gas and electricity networks pre-nationalisation
- Organisational and societal interests not always aligned



Misaligned objectives: cherry picking

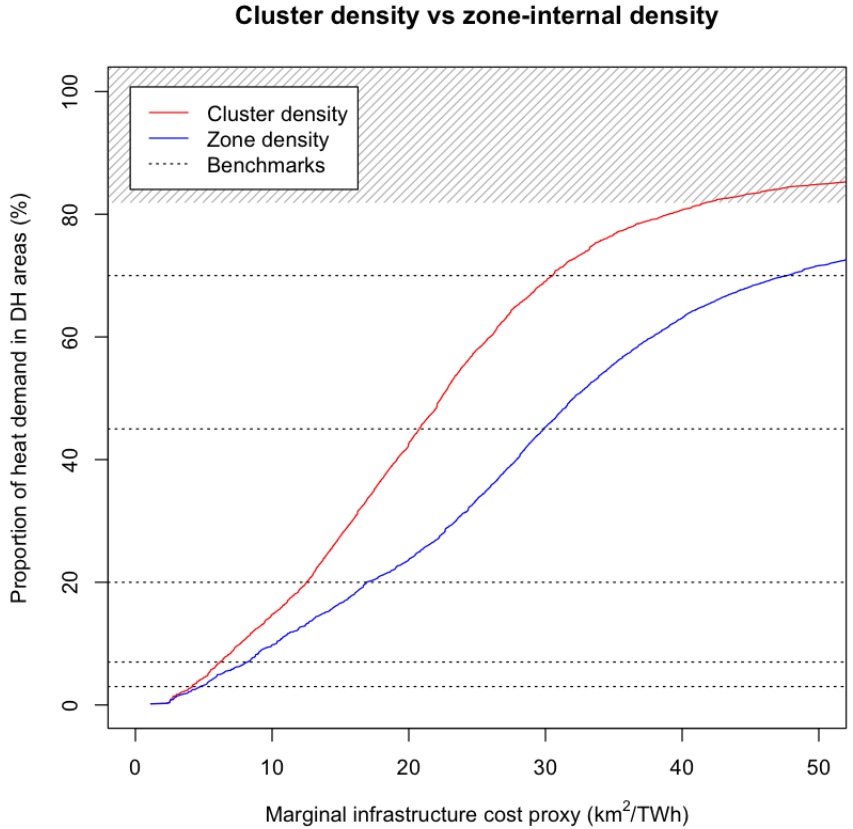


Cherry picking model
Does *incremental* revenue support *incremental* investment?

Cross-subsidy model
Does *aggregate* revenue support *aggregate* investment?

Impact of cherry picking

- Scottish Heat Map datazone level
- High-level modelling across a range of heat prices
  - Cherry-picking
  - Cross subsidy
- Difference around 50% higher penetration



Future proofing

- Opportunity to avoid mistakes of past network creation
- Local strategies articulate area-based transition to low carbon heat
  - Capacity building, socioeconomic assessment, evidence base
- Delivery and governance models that anticipate potential growth and interconnection
- Dynamic governance to maintain alignment
  - Economic regulation of heat networks
  - Area-based consent/concession

Fabrice Leveque
Scottish Renewables

Tanja Groth
Carbon Trust

Andrew Yuill
Natural Power

Richard Lowes
University of Exeter

Dr David Hawkey
University of Edinburgh

scottish renewables

LOW-CARBON HEAT CONFERENCE

24 APRIL 2018 GLASGOW

HEADLINE SPONSOR

INVEST IN FIFE

Breaking down the barriers

Dave Pearson

Director

Star Renewable Energy

HEATPUMPS - Barriers to adoption - Prezi

Peter Bense

Director, Heat & Power

SWECO UK Ltd

SCOTTISH LOW CARBON HEAT CONFERENCE

CASE STUDY – UNIVERSITY OF GLASGOW HEAT NETWORK

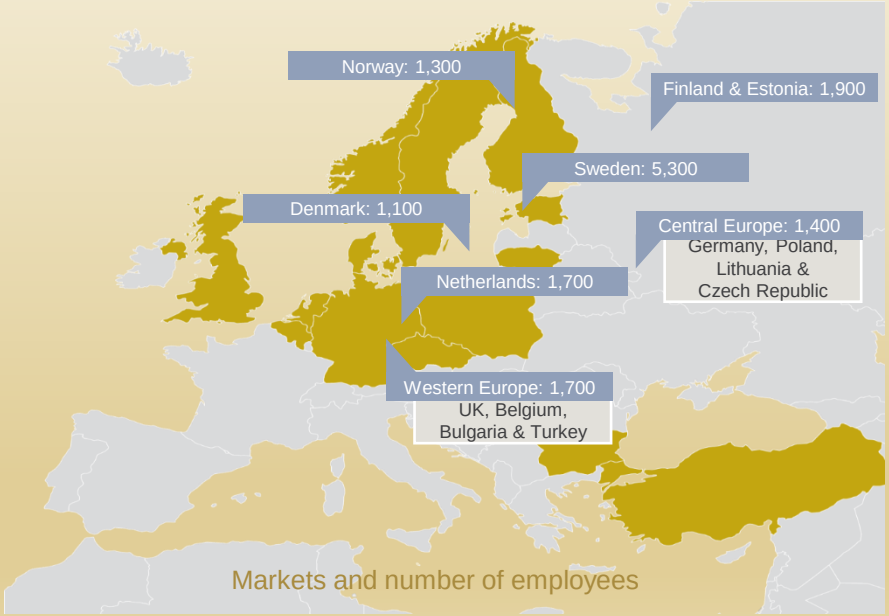
PETER BENSE
DIRECTOR, HEAT & POWER SWECO UK LTD

Who are Sweco – Sweco Group

- **Europe's No.1** Engineering Consultancy
- **14,500** Employees
- **€1.7 bn** Annual Turnover

We have the capability to provide a full service offering for international projects utilising the extensive experience of expertise of specialists from all Sweco countries

Our vision is to become Europe's most respected knowledge company in the fields of consulting engineering, environmental technology and architecture.



Sweco UK

- Network of **14** regional offices
- **850** employees
- **£60 million** annual revenue

University of Glasgow Heat Network Project

Buro Happold
Employer's Requirements

University of Glasgow
Client

Crown House Technologies
EPC Contractor

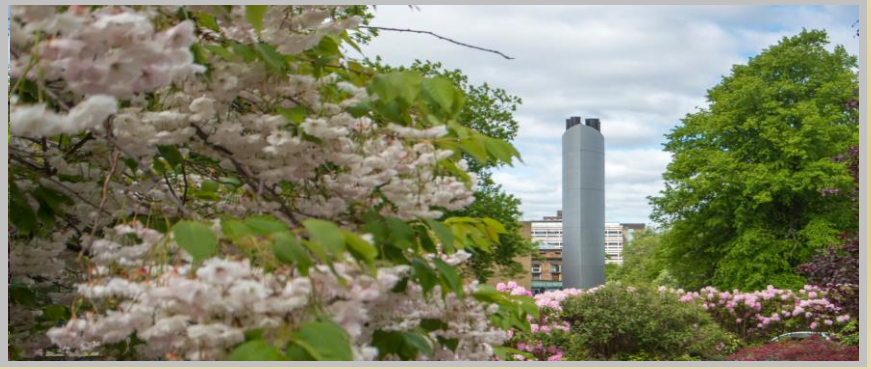
Sweco
Design Partner

Planning
Environmental
Permitting

Specialist Construction
Subcontractors

Specialist Design
Sub Consultants

- Air Quality
- Acoustic



UoG Scheme Outline

- Upgrade of Energy Centre
- Installation of new chimney
- Connection of 53 buildings of varying ages and condition
- Replacement of HV Electrical infrastructure

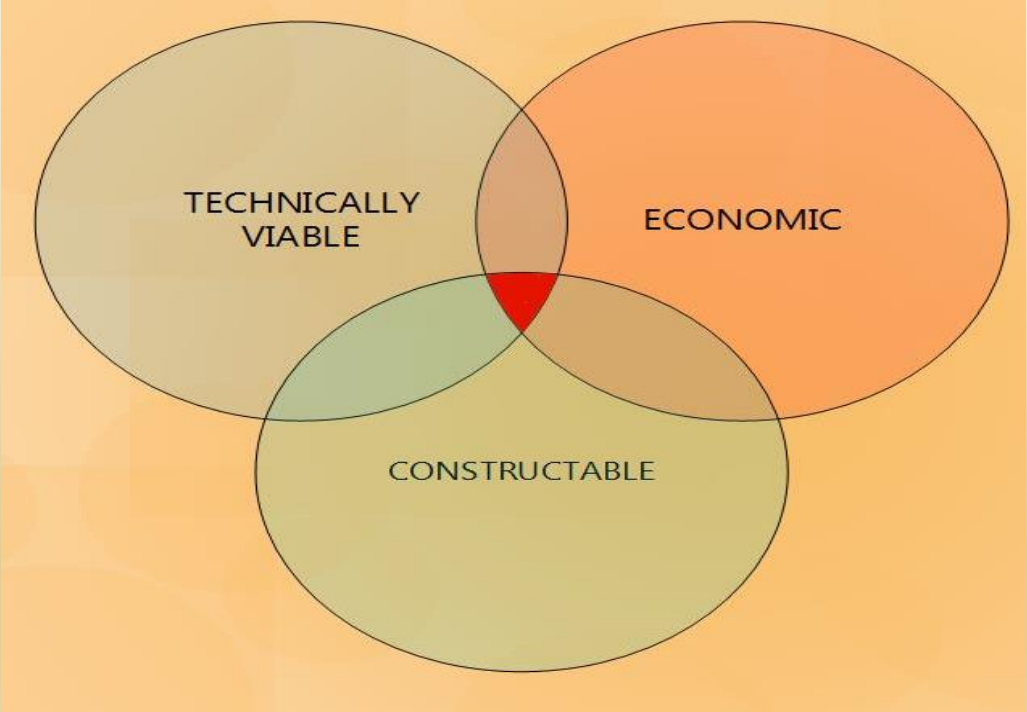
While maintaining the University fully operational throughout the construction.

Requirements for a successful installation

Any viable network must be technically and commercially robust

The challenge for a designer is to balance performance, cost and buildability.

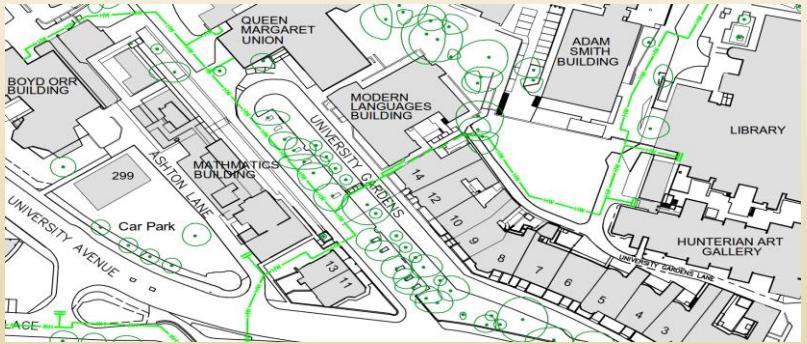
Most schemes require compromises in some areas and flexibility on the part of planners, users and contractors.



UoG Scheme Challenges - Planning & Environmental

Challenge: Strict Planning Regulations

- Protected tree orders
- Connection to listed buildings
- Consideration of future site development



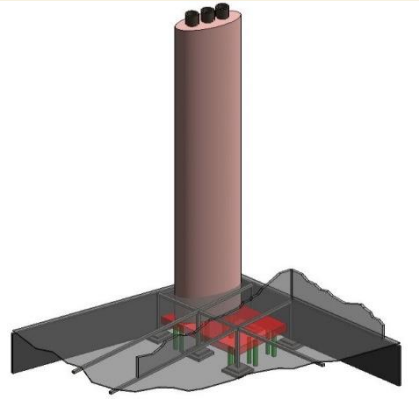
Solution:

- Proactive engagement with Planners to ensure compliance with regulations
- Use of existing ducts and building penetrations to reduce the visual impact of installed systems
- Engagement with the University to understand future requirements and reduce future service clashes

UoG Scheme Challenges - Chimney

Challenges

- Working within confines of existing historic buildings
- New chimney foundations within building basement
- Conflicts with existing building structure and foundations



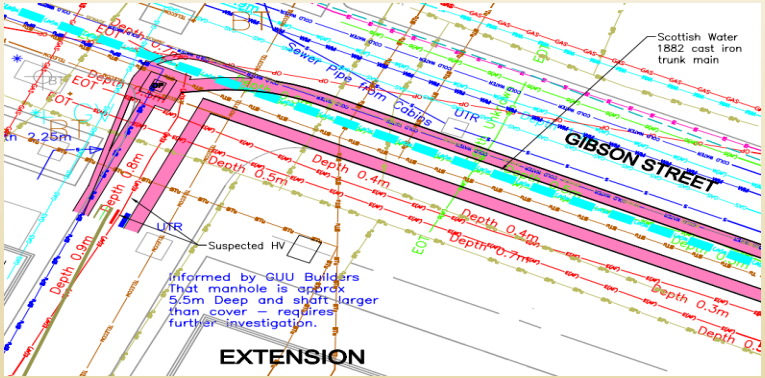
Solution:

- Piled solution allowed foundation to span over existing foundations
- Use of mini piles and reduced headroom rig within basement area
- Extensive demolition within basement area to accommodate new energy centre equipment

UoG Scheme Challenges – Network Design

Challenges

- Heavily Congested Urban Environment
- Multiple service crossings
- Interface with Third Party Utility Providers



Solution:

- Non-invasive utility detection survey
- Selected use of trial trenches in particularly congested areas
- Bespoke tools to maximise pipe properties
- Modelling of thermal expansion of pipework

UoG Scheme Challenges – Energy Centre

Challenges

- Increasing plant capacity within existing space
- Lack of metered data and existing plant schematics
- Client specified return temperatures.

Solution:

- Working together with the contractor to produce a 3D model of the Energy Centre
- Extensive work was done to process what little data was available with heat loads determined through benchmarks, calculation and surveys
- The network is controlled on return temperature, where possible, to ensure a low return temperature and extended run time of the CHP engine

UoG Scheme Challenges – Impact of SEEP Consultation

Proposals to give developers similar rights to other statutory undertakers for permitted development and wayleaves.

- Negotiation for the routing of DH mains within adopted roads would have been easier.

Requirement for the public sector to assess potential connection to district heating in collaboration with local authorities preparing their LHEES.

Proposed system of mediation to support discussions between non-domestic sectors with usable surplus heat and relevant third parties seeking to develop or extend district heating.

- Both of these measures would have given greater certainty for future expansion, specifically the “wider Glasgow network”


Thank You
Any Questions?
SWECO

Jackie Sayer

Engineer (Energy & Sustainability)

The Highland Council

Low Carbon Heat Projects:
Local Authority Challenges

Jackie Sayer | Engineer (Energy & Sustainability) | The Highland Council

Energy Transition Challenges

Highland Council Context

Regional Statistics
High Level of Fuel Poverty
Lack of fuel choices (limited mains gas)
Largest local authority in UK
Low population density
20% larger than Wales
Long lead times
Grid constraints
Challenging climatic conditions

Low Carbon Heat Installations

Highland Council Statistics

Biomass	Air Source Heat Pumps	Ground Source Heat Pumps	Solar Thermal
90 sites	**30** sites	**6** sites	**17** sites
21MW	900kW	300kW	48kW

Project Influences

Key Factors

1. Ambition - to identify and develop projects
2. Resources - to deliver the project
3. Money - to procure resources
4. Determination - bureaucracy must be embraced

Communication *must be effective and accurate*

Confidence *in technologies and performance*

Commitment *to strategic aims and objectives*

Influencing Low Carbon Agenda

Financial

- **Internal (organisational structures)**
  - Competing priorities among services
    - e.g. economic development vs sustainable solutions
  - Operational pressures vs strategic thinking
  - Short term budget allocation vs whole life costing
- **External (incentives/funding assistance)**
  - Resource intensive (to apply and deliver)
  - Extremely challenging timescales/deadlines
  - Often requiring innovation
  - Type of funding varies – grants/repayable assistance

Recent Progress in Highland

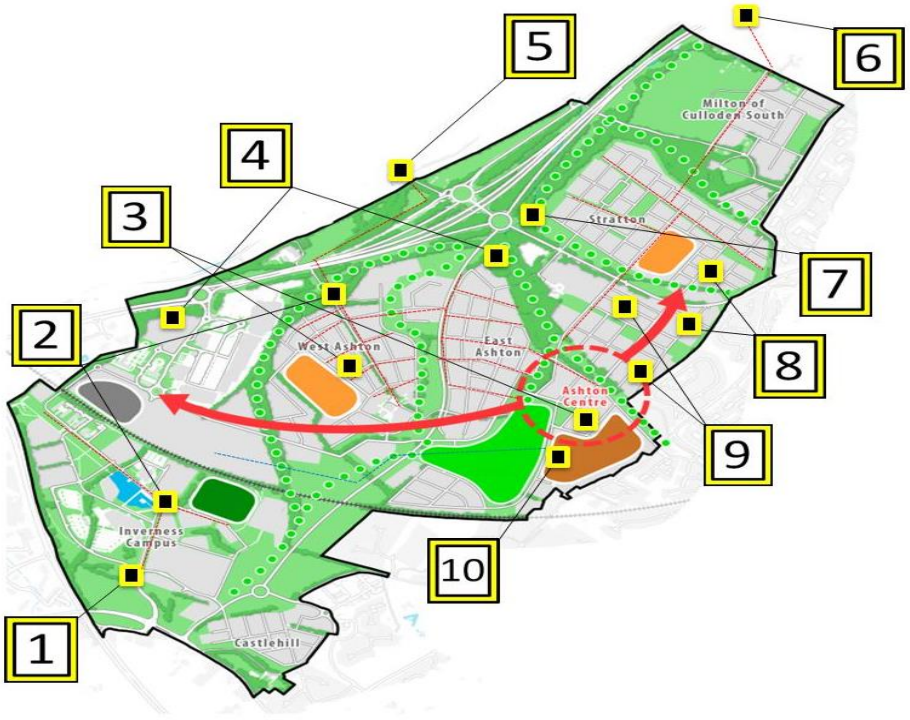
Energy & Low Carbon Planning

- Strategic Energy Planning Meetings
- Major Development Pre-application Meetings
- Community Consultation Support
- District Heating Opportunities Assessments
- Energy Statement Template Development
- Alignment of Heat & Energy Strategy with Highland-wide Plan

Recent Progress – Industry Focus

Opportunity to Influence

Inverness East Development – Consultation Support



Example Heat Solutions:

1 - Community ASHP

2 - Power/Heat Storage Stations

5 - Community WSHP

6 - Wastewater Heat Recovery

Engagement Opportunities

✓ Respond to planning consultations

✓ Enabling developers & communities

✓ Industry showcase events

Low Carbon Agenda

Masterplanning for the Highlands

Community Heat & Power Solutions	Energy Storage Solutions	Solar PV and Thermal	Low Carbon Transport Infrastructure
Influence New Developments	Planning Alignment	District Heating	Efficiency & Behaviour
Commercial Added Value	Renewable Scoping	Delivery Partners	Carbon Management Plan

Low Carbon Heat Project Challenges

Wish List

Get Commitment

i.e. highly influential advocate to champion low carbon duties

Improved Communication

effective decision making

Increased Confidence

more (and better!) projects

Thank You

Get involved with Highland

energy.engineering@highland.gov.uk

The Highland Council
Comhairle na Gàidhealtachd

Jackie Sayer | Engineer (Energy & Sustainability) | The Highland Council

Grant Feasey

Senior Design Engineer

AES Solar

Breaking down the barriers Solar Thermal

Grant Feasey CEng MEng MIMechE
Senior Design Engineer
AES Solar

Crucial Markets

Solar Thermal
- Self-build new build
- Developer New build

Solar PV
- Developer new build
- Self-build new build
- Commercial New build
- Retrofit

Trends

Solar Thermal	⬇	Solar PV	⬆	New build domestic	⬆
Retrofit	⬇	Battery Storage	⬆	New build commercial	⬆
Self-build	➡	EV Chargers	⬆		

Is Policy Helping?

	2010		2017
AES Solar PV	100% Solar Thermal manufacture, design and installation		20% Solar Thermal / 80% Solar
Solar Thermal (UK)	70MW		7MW
Solar PV (UK)	45MW		902MW

Is Policy Helping?

Incentives: Non-domestic RHI, Domestic RHI, FIT

Regulation: SAP requirements

Planning: Permitted Development

Support: Home Energy Scotland Loans, some larger scale funding mechanisms / one-off pots of money, innovation funding, KTP's, enterprise focus on energy and manufacture.

Opportunities to do Better

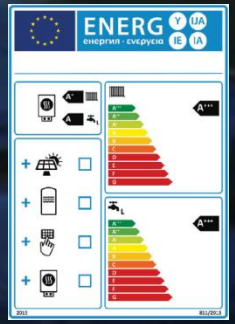
- Coherent policy approach across technologies
  - ST disadvantaged by delays to RHI and whilst other technologies received strong support
- Proper 'realism test' of policies before being rolled out and/or greater flexibility to modify as lessons learnt
  - RHI / Space heating issue
  - FIT runaway
- Improvement to how energy measures are credited
  - EPC recommendations out of date
  - SAP credit for CO_2 savings from Solar Thermal underestimated / PV overestimated?
    - The refinement and update process is slow
- Current regulation enforces greater uptake of renewables but results in poor design
- Front loaded incentive payments?

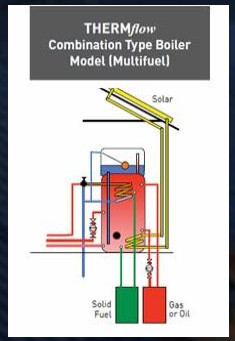
Opportunities to do Better

Combination with other technologies

- Heating system often thought of as an either/or decision
- Improve public awareness of benefits of combinations
- Collaboration between manufacturers and suppliers
- Use of tools such as Labelpack+
- Refinement of control systems (smart controllers) for multi source heat set-ups
- Development of specification tools for designers & specifiers

- Electrification of heating?
  - ST + PV supporting heat pumps/Biomass/other





Opportunities to do Better

Solar Thermal District Heating

- Proven over 30 years in countries with similar demographic's, building stock, economies, geography and latitude.
- Growing market in Europe
- 347MWth new installs in Denmark during 2016
- Can learn lessons from others
  - technology, how to establish industry, what incentives work
- Relatively well refined technology
- Plenty of transferable skills and manufacturing expertise in the UK

How to go about it?

- Funds for feasibility studies and pilot sites? Already made a start
- Encourage installation of heat networks for new developments through planning regulation or incentives?

AES Solar
EST. 1979

Thank You

www.aessolar.co.uk

John Barclay

ITPEnergised

Dave Pearson

Star Renewable Energy

Peter Bense

SWECO UK Ltd

Jackie Sayer

The Highland Council

Grant Feasey

AES Solar

scottish renewables

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INVEST IN FIFE

Time to innovate

Mark Wheeldon

Innovation Project Manager

SGN

Hydrogen 100 feasibility study & Safety case

Mark Wheeldon

April 2018

SGN

Your gas. Our network.

Overview

- **First Hydrogen distribution Network**
  - work program consists of 18 projects
- **5 phases project set to run for 12 years**
  - Small sale demonstration to city gate conversion
- **Will demonstrate safe, secure & reliable distribution of Hydrogen.**
  - Safety case, Feasibility & FEED
- **Road to social proof**
- **Progress to date**
- **Infrastructure Policy / Barrier's**

Phase 1 - feasibility, FEED & Safety case

Scope

The objectives being;

- To determine the viability from both a technical and economic viewpoint of constructing the first 100% Hydrogen network.
- To develop the safety case, compliance framework and safe systems of work necessary to design, construct and operate the first H2 distribution network.

Method – **Three feasibility studies that will run concurrently**

All three studies will have the same scope but will be conducted in different locations with very different existing and potential network features.

Study one - Levenmouth, Fife
Study two –MACC Developments Ltd, Machrihanish Airbase
Study 3 – Aberdeen conference Centre, Aberdeen

Feasibility FEED Study
(Site Specific

1-2 Years

NIA

Demonstration Network

- Wind, Solar & SMR
- Production & Processing
- Storage
- PE Distribution Network)

Design & Construction
2 Years

NIC, Private Sector, SGN, BEIS? & Scottish Government

Feasibility Study

Conversion of existing Public Network

1 Year

NIA

Small Scale Conversion Demonstration
(Expansion of demo site or new site)

Significant customer interaction
3-4 Years

NIC, Private Sector, SGN, BEIS? & Scottish Government

Medium Scale Conversion

Small city

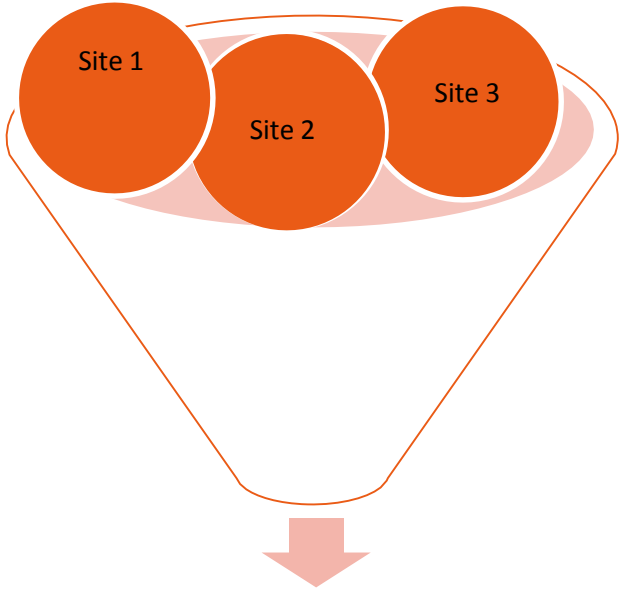
With Carbon Capture and Storage

PCR
Government ?

WALES&WEST UTILITIES
nationalgrid
Northern Gas Networks
Scottish Government gov.scot
Department for Business, Energy & Industrial Strategy

SGN

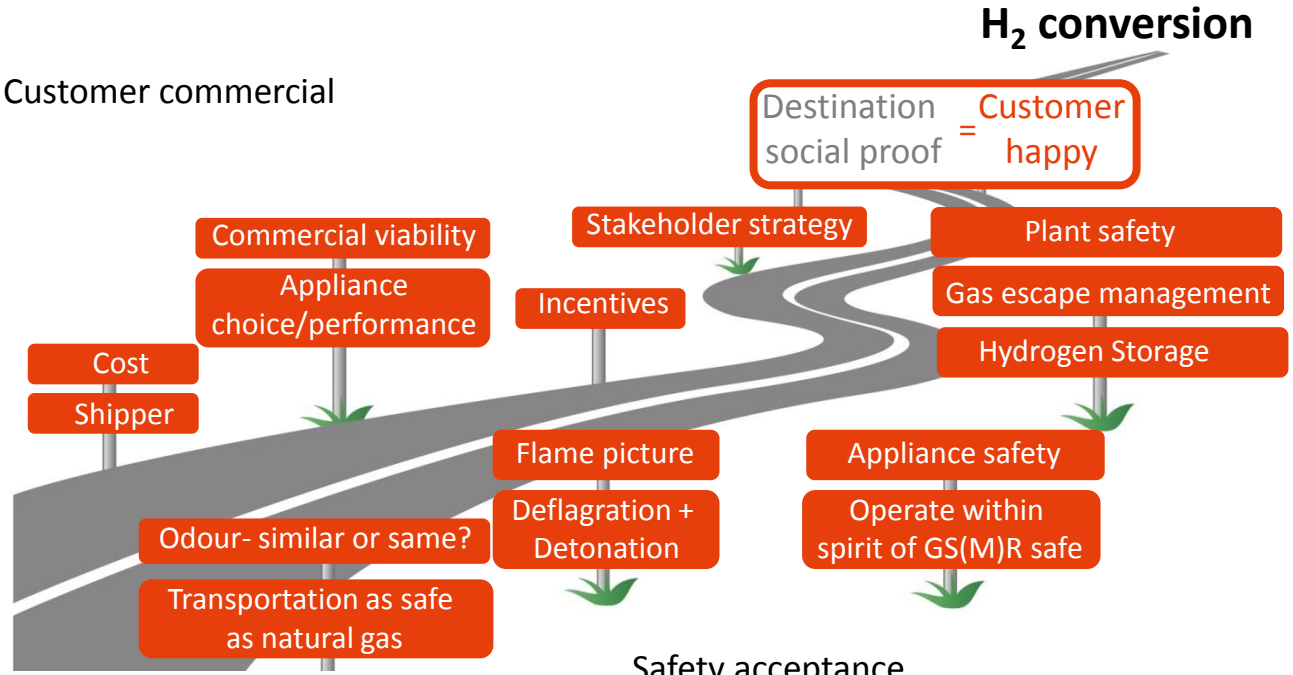
SGN H_2 Project – Safe, secure, reliable Distribution



Construction Demonstration

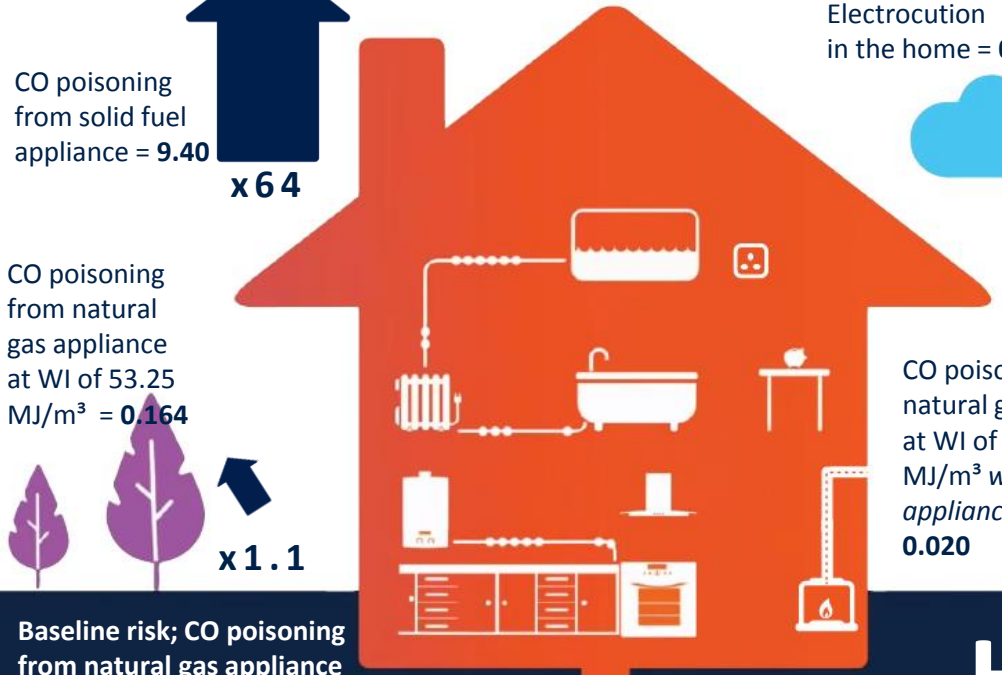
100% H_2

H_2 Road to social proof



Relative risks to the home

Risk = number of fatalities per million people per year



CO poisoning from solid fuel appliance = **9.40**

x 6 4

Electrocution in the home = **0.364**

x 2

CO poisoning from natural gas appliance at WI of 53.25 MJ/m³ = **0.164**

x 1 . 1

CO poisoning from natural gas appliance at WI of 53.25 MJ/m³ *with appliance servicing* = **0.020**

x 7

Baseline risk; CO poisoning from natural gas appliance at Wobbe Index (WI) of 51.4 MJ/m³ = 0.147

H_2?

H100 Feasibility study (Work program)

Compliance framework

1. Technical assurance and program overview
2. Stakeholder and customer strategy
3. Safety case & Operational procedures
4. PE materials and jointing techniques
5. Characteristics of hydrogen
6. Consequence testing (NDT & DT)
7. Hydrogen logistics (Production & Supply)
8. Metering & Appliance validation program
9. Odorant & Gas Detection
10. Commercial arrangements
11. Academic partnership

Technical & Commercial viability

A. **Site agreements**
Levenmouth, Campbeltown & Aberdeen

B. **Site feasibility study's**
Technical and Commercial Viability, recommendations and options for each site

C. **FEED**
Technical requirements, Cost of execution, Risk.

H100 final report
Options and recommendations)

Infrastructure Policy / Barriers

Network Operators - Barriers to Construction, Conversion and Operation

- Need to evidence transition to more expensive low carbon networks.
- De-risking of demonstration networks to enable proof of concept (CAPEX & OPEX)
- Initially loss making – Would need a change in Policy (Government & Regulator)

Customers – Cost & Appliances

- Road to social proof
- Cost of hydrogen – Under current government policy will always be more expensive to produce and distribute than Natural Gas.
- With incentives could compete with electricity on price and be truly green.

SGN

Thanks

SGN
Your gas. Our network.

Mark.wheeldon@sgn.co.uk

Dr Daniel Friedrich

Chancellor's Fellow

University of Edinburgh

Seasonal thermal energy storage for Scotland

Daniel Friedrich

School of Engineering
Institute for Energy Systems
University of Edinburgh

SR Low-Carbon Heat Conference 2018

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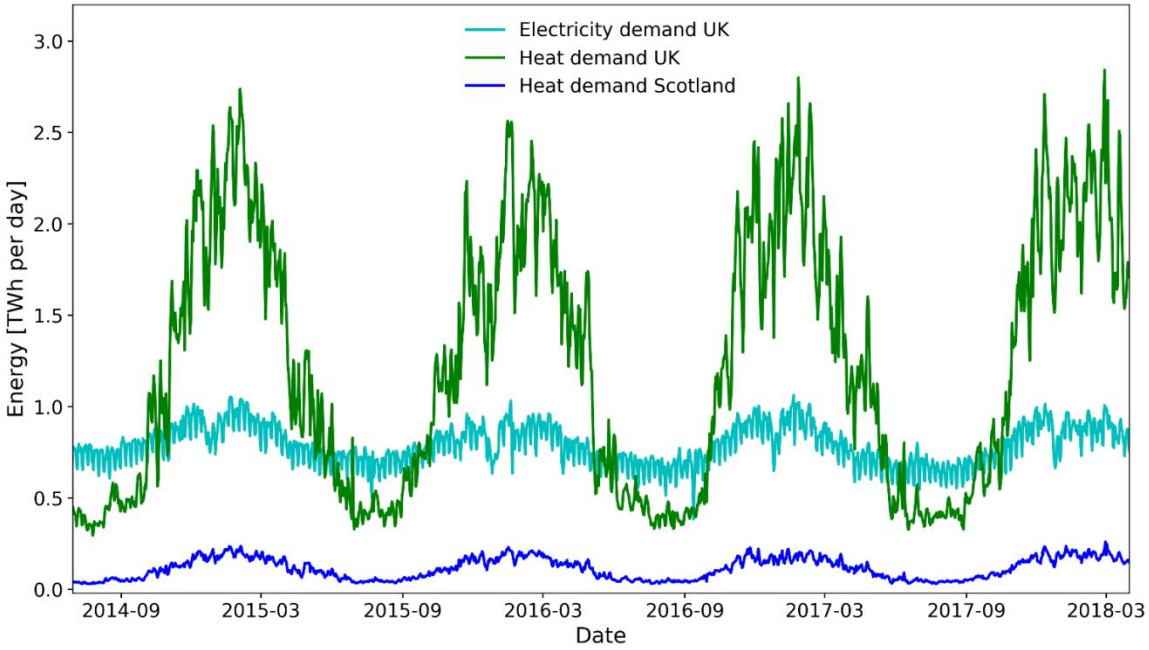
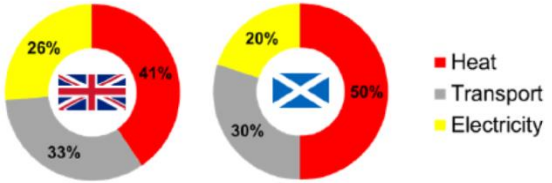
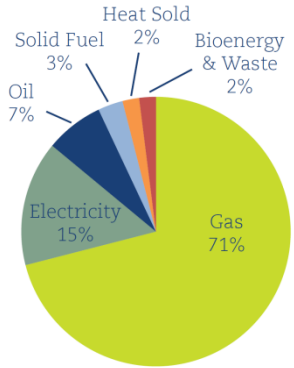
UK electricity and heat demand







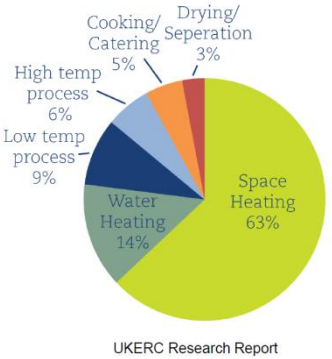
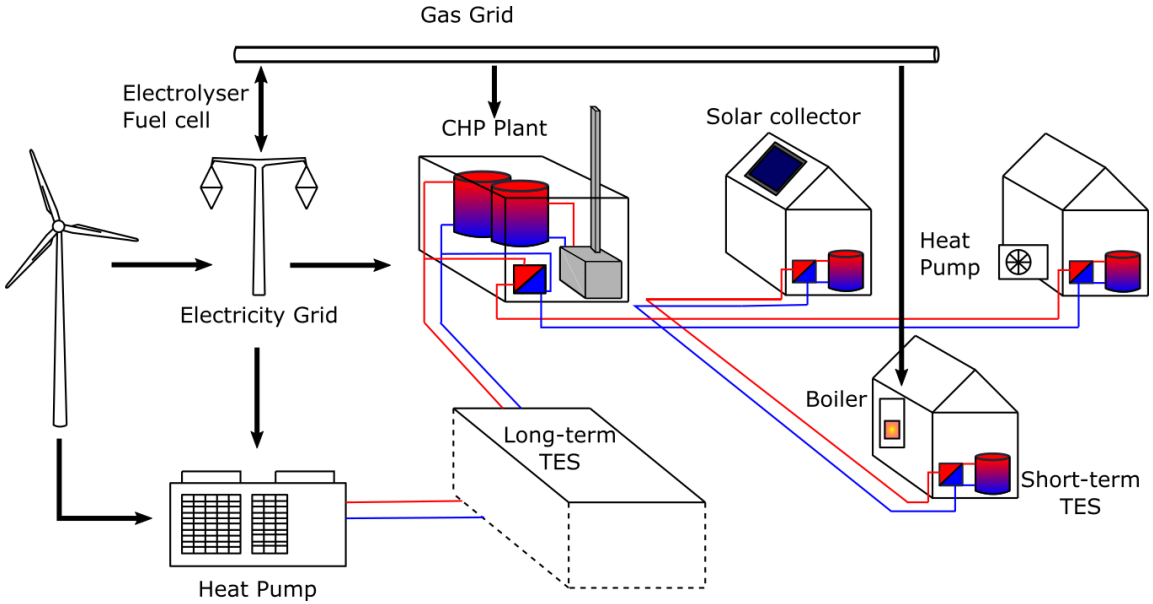


Figure inspired by Wilson et al. Historical daily gas and electrical energy flows through Great Britain's transmission networks and the decarbonisation of domestic heat, 2013.

Decarbonisation options and opportunities



- Large scale and distributed nature of the heat demand
- Potential for integration with renewables
- Efficient and affordable thermal energy storage (TES)

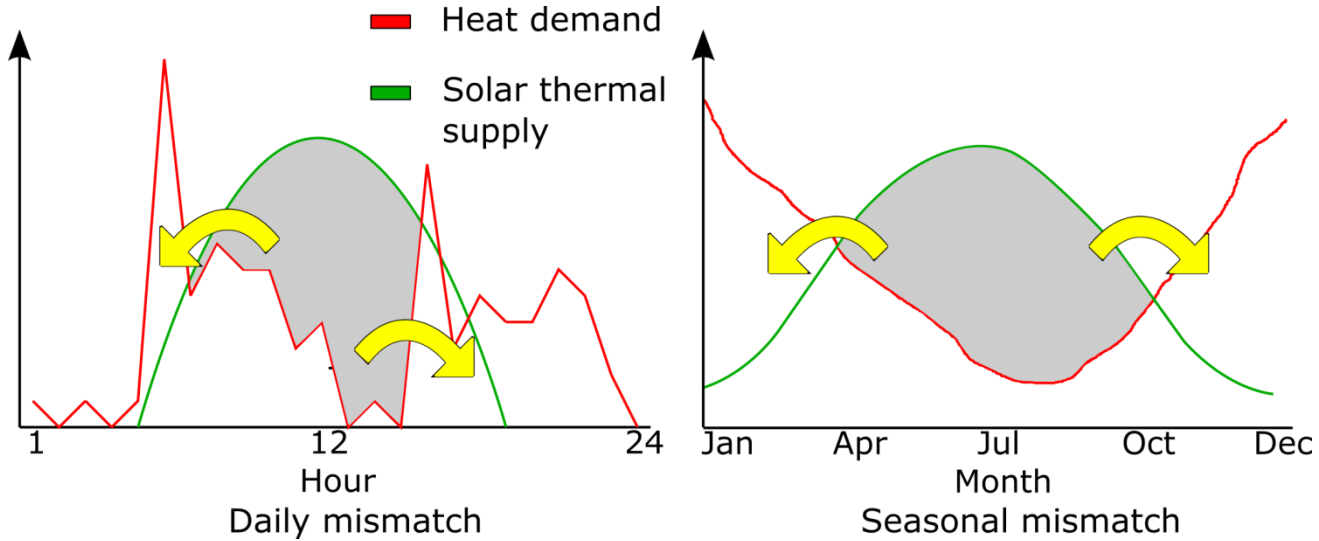
Current domestic heating

- User control and on-demand
- Gas is relatively cheap
- Gas boilers are robust, flexible and familiar
- Hot water tanks are removed
- Poor insulation

Challenges

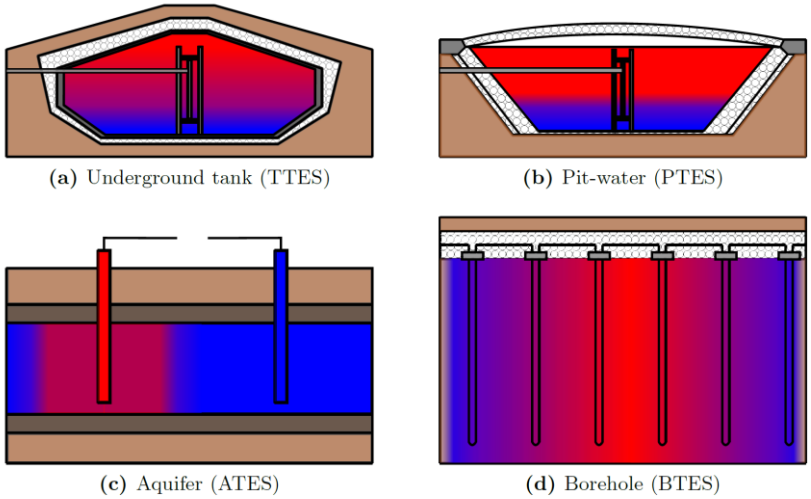
- Complete decarbonisation
- Affects all customers

Seasonal energy balancing



- Daily mismatch can be balanced by short term storage
  - About 350 cycles per year with less than 24 h storage duration
- Seasonal mismatch requires large storage capacity with low self-discharge
  - Only one cycle per year with up to 7 month storage duration

Seasonal thermal storage options

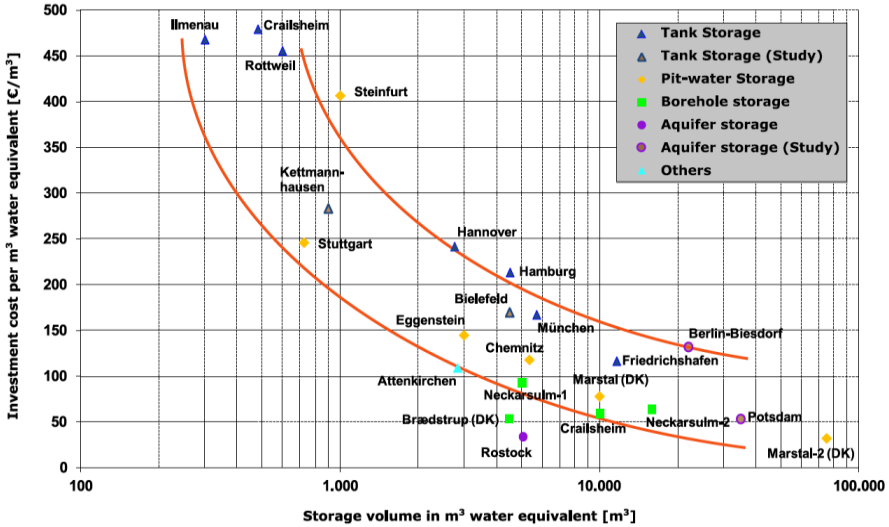


(a) Underground tank (TTES)

(b) Pit-water (PTES)

(c) Aquifer (ATES)

(d) Borehole (BTES)



- Roundtrip efficiency around 50%
- Usually larger than 1,000 m^3
- Require suitable space or sub-surface

Renaldi, Modelling and Optimisation of Energy Systems with Thermal Energy Storage, 2018

Marstal-2

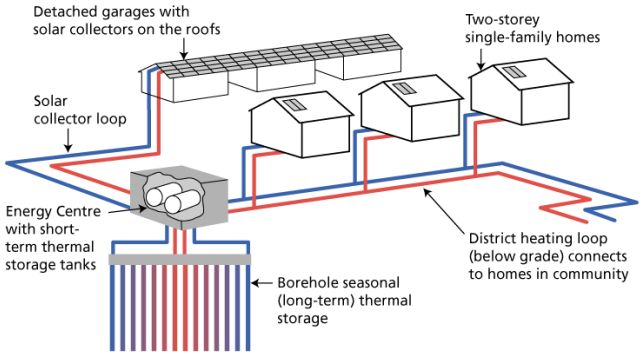
- 200,000 m^3 at 41 €/m^3
- With ΔT=70 °C it cost 0.6 €/kWh

Cost of STES from Solites: Saisonalspeicher.de - das Wissensportal für die saisonale Wärmespeicherung, 2014.

Denmark: Vojens district heating pit storage

- Vojens district heating scheme in Denmark opened in 2014
- 200,000 m^3 pit storage
- 70,000 m^2 solar thermal collectors
- Provides around 50% of the annual heat demand
- Remainder from 3 gas engines, a 10 MW electric boiler, an absorption heat pump and gas boilers
- District heating scheme has around 2,000 customers

Drake Landing Solar Community

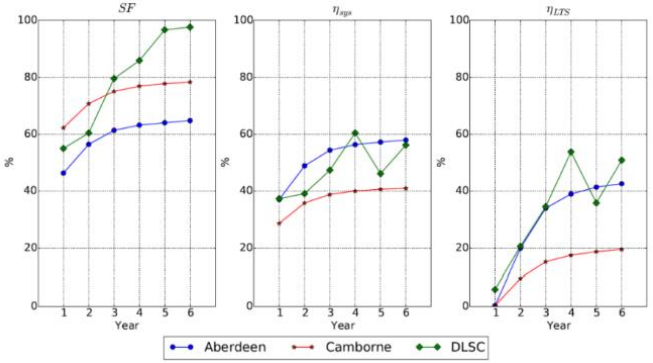


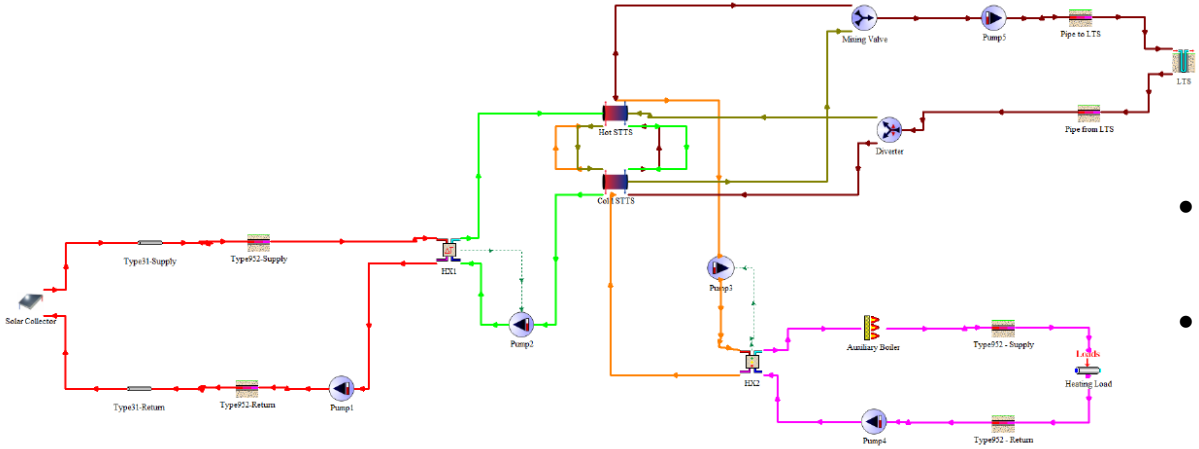
- 52 energy efficient houses: each has a yearly space heating demand of around 12MWh for 5200 degree-days
- 2293m^2 of solar collectors: about 40m^2 per dwelling
- 240m^3 buffer hot water storage tank
- Borehole storage of around 35000m^3 of earth with 144 boreholes of 35m depth

The Drake Landing Solar Community project - Early Results, Sibbitt et al., 32nd Annual Conference of the Solar Energy Society of Canada, 2007

Solar district heating in Scotland

- Trnsys model validated with Drake Landing data
- Run with data from Camborne in Cornwall and Aberdeen

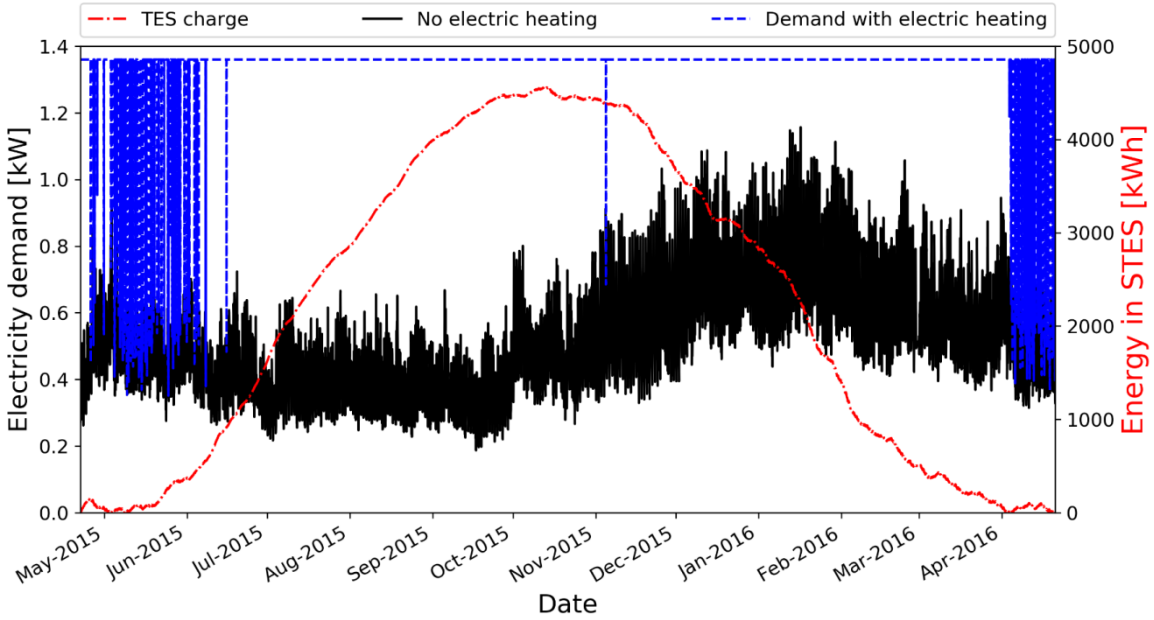




- Lower solar fraction (SF) due to lower solar irradiance
- Camborne has lower efficiency due to worse ground conditions

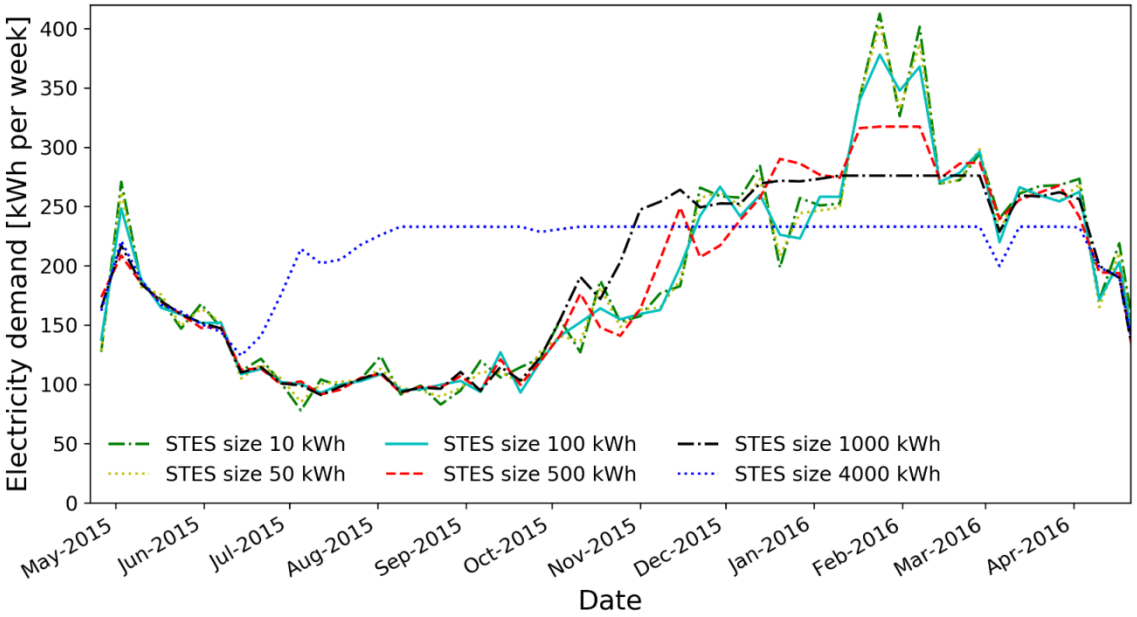
Renaldi, Friedrich: Techno-economic analysis of a solar district heating system in the UK, in preparation

Use heat pumps instead of solar thermal



- A typical UK property requires around 4.5 MWh or 60 m^3 of hot water storage
- Mostly flat electricity demand

Weekly electricity demand



- Large storage size required to flatten seasonal demand profile
- Smaller storage can only reduce the winter peak demand

Questions?

- Seasonal thermal energy storage has low capital costs compared to other energy storage technologies
- Low cost heat is required to charge the system
- In combination with heat pumps seasonal storage could be used to balance seasonal demand fluctuations

Thank you for your attention!

John Mackintosh

Business Development Director

GI Energy

In Partnership with

John Mackintosh

Business Development Director

GI Energy – Scotland

V&A @ Dundee

The Journey to GI Energy

gi energy

In Partnership with

ESB

Largest Lake Loop in Europe

1st prize winner 2009 The Ashden Awards for sustainable energy

Oxford Earth Sciences

First Supermarket

NATIONAL RAIL AWARDS 2016 WINNER SUSTAINABILITY AWARD

Multi Renewable Energy Centre Old Oak Common Depot

GREEN APPLE AWARD WINNER

First Large Scale GSHP in UK

First Energy Pile Installation

One New Change

THE GREEN APPLE AWARDS 2011

GI Energy Expands in US

V&A Dundee all Electric Energy Centre

2000 02 03 04 05 06 07 08 10 12 14 16 2018

WaterFurnace

geothermal heating international

geothermal international

SSE

GREENCOAT ESB NOVUSMODUS

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Heating & Renewables AWARDS 2015 WINNER

HOMES AWARDS 2016 WINNER

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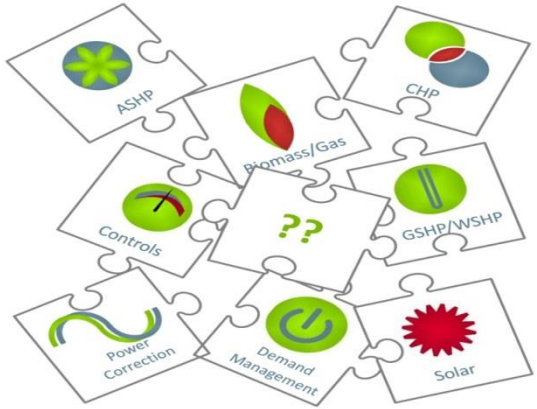
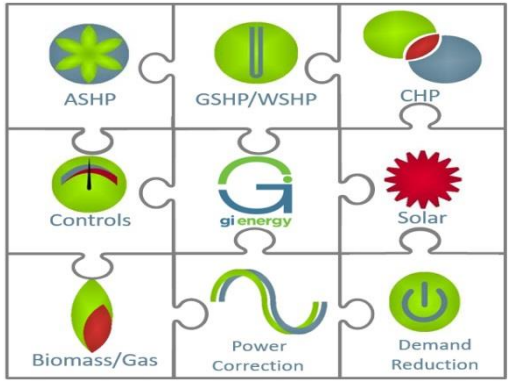


The Traditional Approach

- Multiple “specialists”
- Too many interfaces
- Communication nightmare
- No specialist responsible for all
- Problem solving almost impossible



The GI Energy Approach

- In-house specialists design, deliver, control and optimise the full system
- Simplifying the interfaces
- Mitigates risk to main contractor and client
- Fully exploits natural synergies between technologies
- Clean demarcation of responsibilities
- One point of contact

gi energy

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ESB

A Selection of Past and Present GI Energy Projects:

V&A @ Dundee
1 MW all electric energy centre with high and low temperature Ground Source heating and cooling heatpumps, including free cooling and seasonal thermal energy storage.

Robert Gordon University
2 MW Ground Source heating and cooling system providing all the cooling for the new Sir Ian Wood campus building along with base load heating and seasonal thermal energy storage in the granite below.

Dumfries and Galloway Royal Infirmary
1MW of integrated GSHP and CHP providing heating, cooling, free cooling and electricity to the new hospital. Heat rejection from the CHP recharges the bore hole array in the summer months.

Old Oak Common
3 MW of multi award winning fully integrated open and closed loop Ground Source, CHP, PV and Solar thermal energy centre with fully optimised controls and energy monitoring facilities.

gi energy

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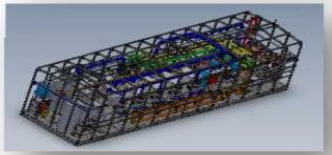
ESB

Kingsmill Hospital, Mansfield
10 MW Water Source Heat Pump system providing all the cooling and base load heating for the whole hospital campus. All the energy is taken from Europe's largest closed loop lake collector including source pipes directionally drilled below existing dual carriageway.

Forth Valley College
2.6MW fully integrated hybrid heatpump and boiler energy centre providing exceptional savings for the new campus development. Simultaneous heating and cooling and free cooling provided from the driven energy piles integrated into the buildings foundations.

Sainsbury's East Kilbride
1MW of high and low temperature heat recovery heatpumps utilising the fridge pack waste heat rejection to provide all the heating to the supermarket. One of nine that GI energy have completed for SSL throughout the UK.

Food Processing, Lincoln
5 MW of Water Source Heat Pumps providing low carbon and low run costs for the processing facilities with future cooling and low-grade heat recovery to be incorporated.



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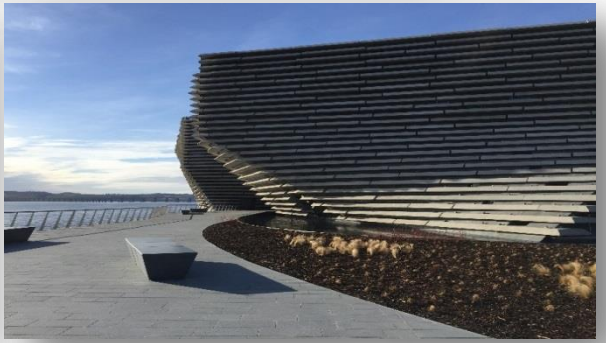
ESB

V&A

ARUP

bam

- All electric heating and cooling using heat pumps
- 1MW
- High and low temp heat pumps
- 200m deep borehole array
- Thermal energy storage within the rock below
- Free Cooling



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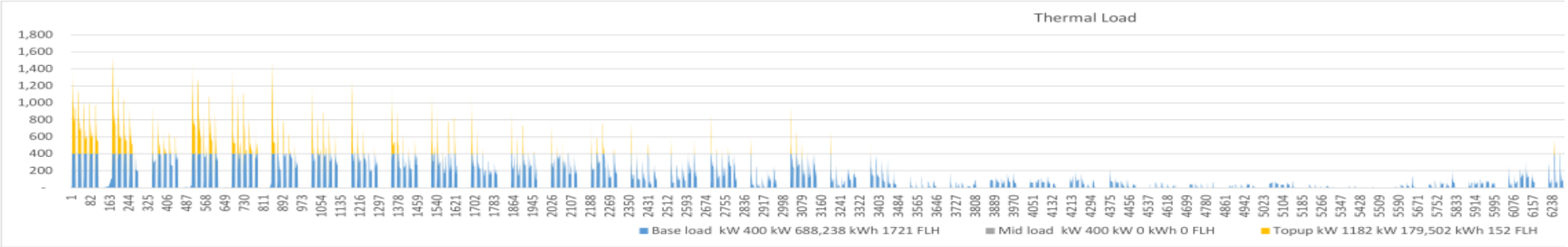
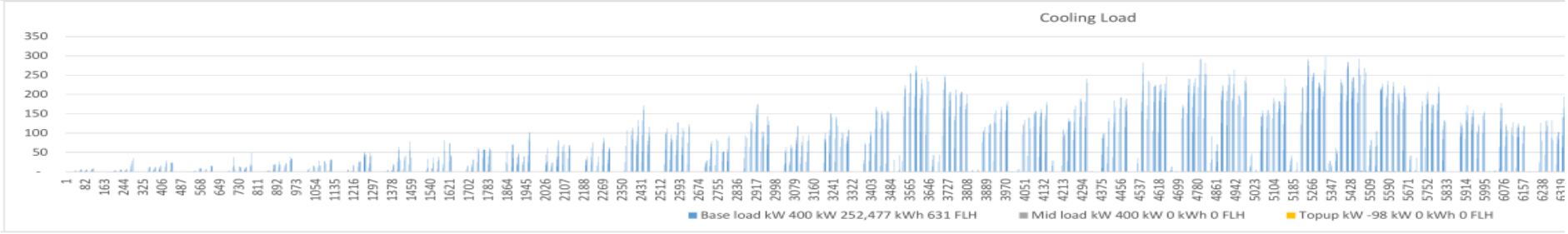
Example Load Profile

	HEATING / DHW						COOLING			
	Heating load (kW)	VENT load (kW)	Combined heating and VENT	Base load kW	Mid load kW	Topup kW	Cooling (kW)	Base load kW	Mid load kW	Topup kW
				400 kW	400 kW	1182 kW		400 kW	400 kW	-98 kW
MAX (kW)	1,539	336	1,582	688,238 kWh	0 kWh	179,502 kWh	302	252,477 kWh	0 kWh	0 kWh
SUM (kWh)	526,736	341,004	867,740	1721 FLH	0 FLH	152 FLH	252,477	631 FLH	0 FLH	0 FLH
				79.3139%	0%	21%		100%	0%	0%





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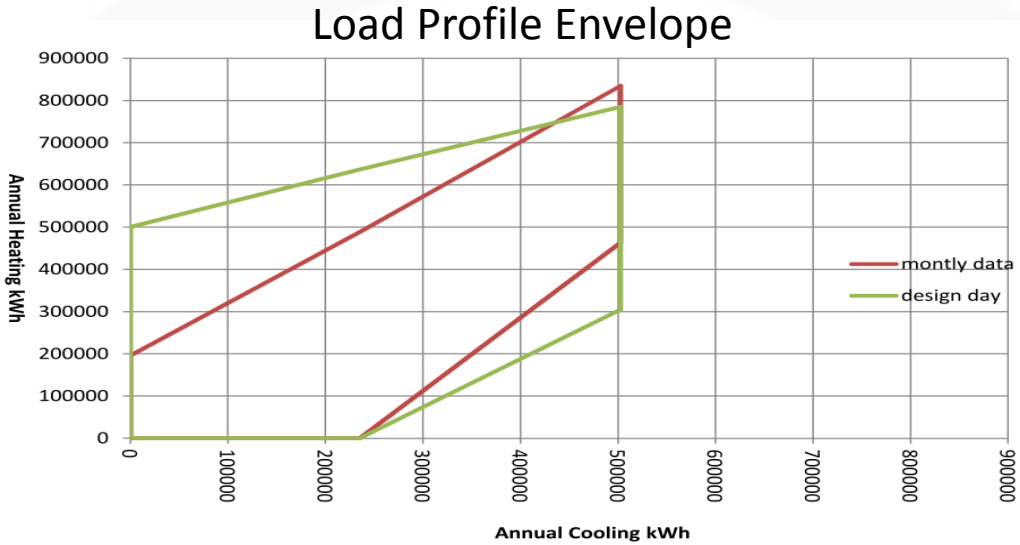

- GSHP Heating and Cooling
- ASHP Heating and Cooling
- Simultaneous Mode
- Free Cooling

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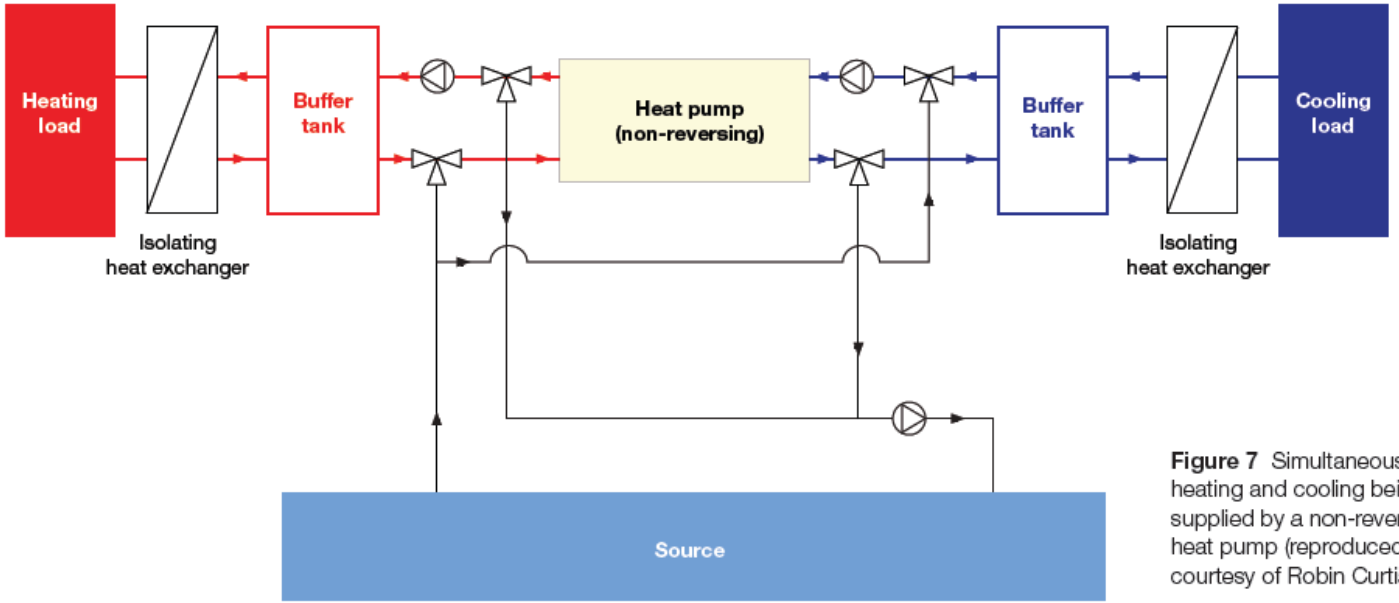

Figure 7 Simultaneous heating and cooling being supplied by a non-reversing heat pump (reproduced courtesy of Robin Curtis)

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ESB

In Partnership with

- Saves 43% in Carbon Emissions
- Saves 105% in running costs inc. O&M
- 100% Electrical heating and cooling
- Decarbonises with the national grid

In Partnership with

"We would like to thank GI Energy for their incredible efforts over the period and for delivering what must be one of the most complex, complicated and stunning buildings built in recent years, a tremendous effort and a magnificent achievement" *Malcolm Boyd, Construction Manager, BAM*

"We are very pleased with GI Energy's sustainable design and performance on the V&A and very excited to have such a high tech, low energy, low carbon solution for all the building's heating and cooling requirements. This really reflects the ethos of the building being a centre of excellence for art and design" *Mike Galloway, Director of City Development, Dundee City Council*

Thank you

www.gienergy.net

John Mackintosh

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Mark Neller

Associate Director - Programme & Project Management

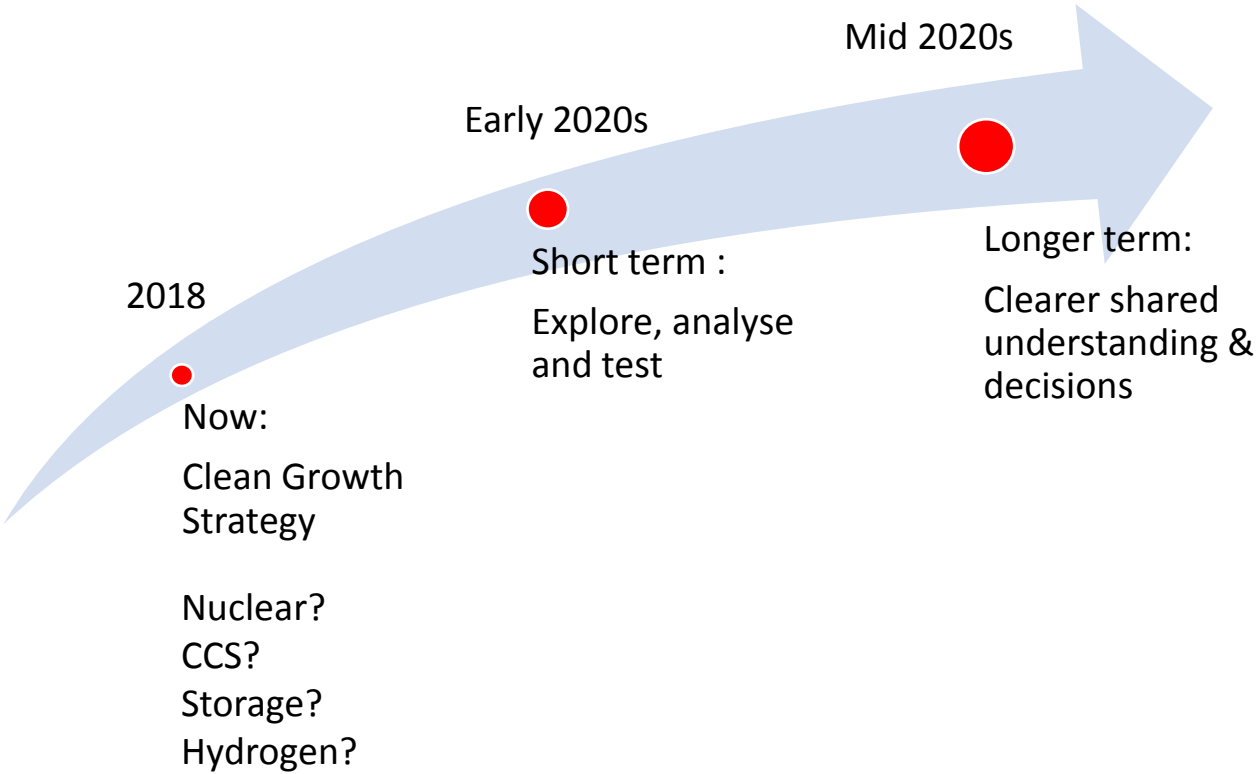
Arup

BEIS Hy4Heat Programme

Mark Neller
Arup+ Programme Director.

April 2018

Heat Strategic context

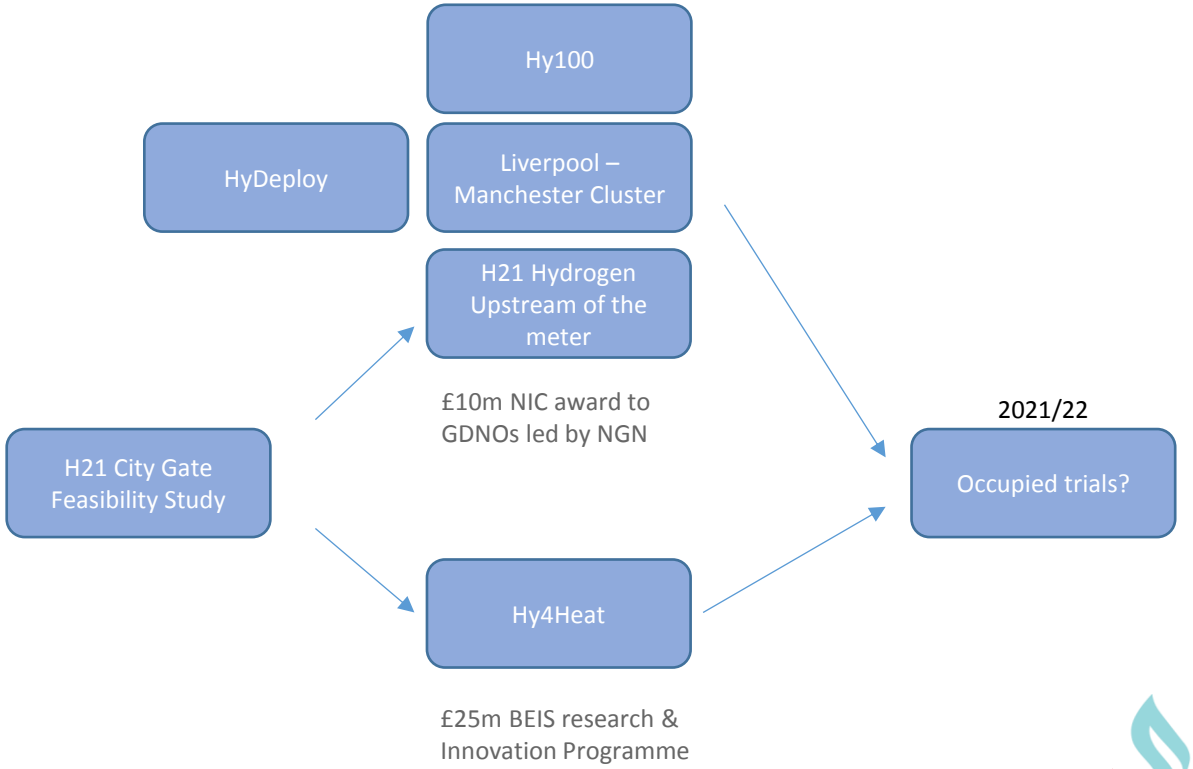


Hy4Heat Mission

To establish if it is technically possible, safe and convenient to replace methane with hydrogen in residential and commercial buildings and gas appliances. This will enable the government to determine whether to proceed to a community trial.

Hy4Heat

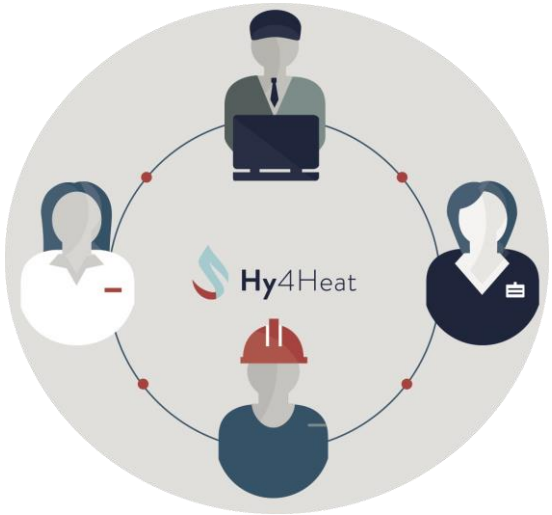
Relationship with GDNO projects



Hy4Heat

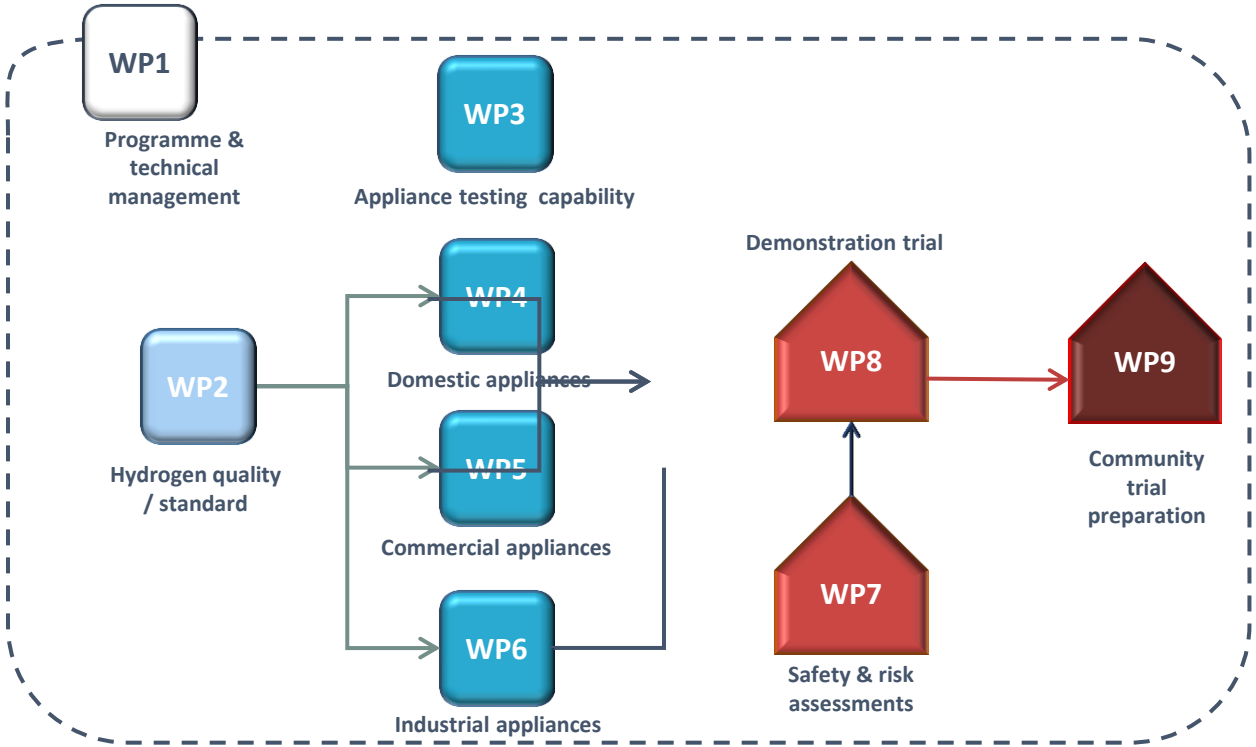
Our approach

- Collaborative
- Impartial
- Evidence based
- Stakeholder focused



Hy4Heat

Programme Work Packages



Hy4Heat

Stakeholder focused programme

- Advisory panel
- Work package stakeholder engagement groups
- Use network of energy expertise
- Consumer and public perception

Hy4Heat


Hy4Heat

Ragne Low
University of Strathclyde

Mark Wheeldon
SGN

Dr Daniel Friedrich
University of Edinburgh

John Mackintosh
GI Energy

Mark Neller
Arup

scottish renewables

LOW-CARBON HEAT CONFERENCE

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INVEST IN FIFE