Low temperature heat networks and their future in the UK

CIBSE NE

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18/11/20
Contents

- Introduction
- Heat in the UK – the big challenge
- Heat networks and low temperature networks
- Case Study – Plymouth

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Buildings

- “Make the Vision Viable”
- Full building engineering from the initial ground investigations to the final bolt.
- Higher education
- Culture
- Science
- Healthcare
- Commercial/ residential
- Aviation
Cities

- Everything between the buildings
- Strategic planning
  - C40 Air quality actions plan
  - New York 80x50 plan
- Infrastructure
  - Transport planning
  - Coordination
  - Bridges
- Energy
Who are our clients
Our Service offers

- Cities Energy – energy systems at campus / large development / city / regional scale
- Buildings Energy – focus on buildings and efficiency

Energy and carbon planning  Design, delivery and performance
Campus Infrastructure Asset Strategy  Utilities Infrastructure Commercialisation
1. Energy and carbon
2. Utility infrastructure
3. Health and wellbeing
4. Climate change emergency/adaptation planning
5. Circular Economy and Waste Management
6. SMART revolution

Post COVID – utilisation?
Carbon

Natural gas + coal

- 4th industrial revolution...

Baseload is dead...

Distributed energy is here....

The Decarbonisation of British Electricity
2017 has so far been the ‘greenest’ summer on record with carbon intensity dropping to record lows.

Energy production cost in new wind farms in Poland fell much below the market price and coal-fired power plants costs

Source: National Grid

* WysokieNapiecie.pl estimates

Data: Economic Society Polish Power Plants, INEO, utilities, ELEK "November 2018
Net Zero and what does it mean?

UK becomes first major economy to pass net zero emissions law

New target will require the UK to bring all greenhouse gas emissions to net zero by 2050.

Published 27 June 2019
From: Department for Business, Energy & Industrial Strategy and The Rt Hon Chris Skidmore MP

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Net zero story

The UK today became the first major economy in the world to pass laws to end its contribution to global warming by 2050.

10 New commitments from Government to reach net-zero

- **Offshore wind**: UK will host 40GW of offshore wind by 2030, support up to 60,000 jobs.
- **Hydrogen**: £5bn to generate 5GW of “low-carbon” hydrogen production capacity by 2030.
- **Nuclear**: £525m to support up to 10,000 jobs and rollout smaller projects.
- **EVs**: Ban on petrol and diesel moved to 2030. £13bn committed to charging infrastructure.
- **Public transport**: £8bn to be funnelled into alternative cycling, walking, and low-carbon buses.
- **Aviation and shipping**: Funding to support low-carbon innovation, including £2bn for maritime.
- **Public sector**: £1bn starting next year to improve energy use in homes, schools and hospitals.
- **CCS**: £1bn has been committed to target the removal of 10MT of carbon dioxide by 2030.
- **Nature**: 30,000 hectares of trees planted annually. £8.2bn ringfenced for flood defences.
- **Finance**: The UK will make the City of London the global centre of green finance.

Heat related measures

- Heating for homes?
- 600,000 Heat pumps per year by 2028 + 1 yr additional to Green Homes Grant
- Funding for innovation
UKGBC Net Zero Carbon Buildings Framework Definition

Net Zero Carbon – Operational Energy - UKGBC
“When the amount of carbon emissions associated with the building’s operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset.”

Net Zero Carbon – Construction - UKGBC
“When the amount of carbon emissions associated with a building’s product and construction stages up to practical completion is zero or negative, through the use of offsets or the net export of on-site renewable energy.”
Design approach to net zero

- Focus first on energy saving and maximising onsite low carbon technologies. If further carbon reductions are required than can be achieved on site then these can be captured through considering offsite renewables and finally using carbon offsetting.
Heat in the UK

- 20% of emissions by our calculations
- 32% according to UK clean growth strategy
- Heat required for space heating
- Heat required for water heating
- Provided almost exclusively by the UK natural gas network serving gas boilers

Figure 2: UK emissions by sector, 2015

Source: IEA

Heating in buildings and industry creates around 32% of total UK emissions.
Heat - the plan

- UK clean growth strategy
- Phase out the installation of high carbon forms of fossil fuel heating in new and existing businesses off the gas grid during the 2020s, starting with new build

**Rolling out low carbon heating**


18. Phase out the installation of high carbon fossil fuel heating in new and existing **homes currently off the gas grid** during the 2020s, starting with new homes.

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4. Department for Business, Energy and Industrial Strategy

**Rolling out low carbon heating (continued)**

19. **Improve standards** on the 1.2 million **new boilers** installed every year in England and require installations of control devices to help people save energy.

20. **Invest in low carbon heating** by reforming the **Renewable Heat Incentive**, spending £4.5 billion to support innovative low carbon heat technologies in homes and businesses between 2016 and 2021.

21. **Innovation:** Invest around £184 million of public funds, including two new £10 million innovation programmes to develop new energy efficiency and heating technologies to enable lower cost low carbon homes.
Heat - the plan

- The clean growth strategy aims for 17% of heat from heat networks in the UK
- The source of the heat is envisioned as being hydrogen/electricity across all heating
- Doesn’t provide detail on achieving the goals (beyond those on the previous slide) but does say that the planning will take place in the early half of the next decade

- What are we doing now...
- What can we do now...
Where heat networks can contribute

- The adopted approach focusses **first** on **energy saving** and maximising **onsite low carbon technologies**. If further carbon reductions are required than can be achieved on site **then** these can be captured through considering **offsite** renewables and finally using **carbon offsetting**.
Heat networks - Today
Networks and temperature
Networks and temperature
Heat Networks

- Millions of pounds have been invested in traditional heat networks, both operational and planned, which are no longer providing any carbon benefit because the carbon factor of electricity has dropped

- How can we re-invent heat networks so that they provide the future they have previously promised

- Should we even be using heat networks?
  - Yes, but only where we can share energy

- Electricity, heat pumps, waste heat from cooling
Recycling energy - The 5G concept

- Combined heating and cooling...

- 5G – ‘Plug and play’ as per building requirements – use the network to share energy:
  - Within the building
  - Across the network
  - Across the seasons

- All powered by renewable energy
5g Networks – the future

- Network have moved through 4 generations, we are now at the 5th.
- Currently struggle in the face of cheap gas and expensive electricity, but technically speaking:
  - Ambient temperature pipes in the ground
  - Building connect in with heat pumps in buildings
  - Heat generated, cool rejected into pipes and vice versa
  - Rejected energy can be utilised elsewhere
  - Must have an energy storage opportunity
Plymouth – case study for 5G
The 5G network opportunity in Plymouth

• Opportunity technically investigated through the HeatNet NWE project, co-funded by the European Regional Development Fund

• Mijnwater - Operational scheme in Heerlen, The Netherlands, has proven the concept technically
The Heerlen approach to delivery

- ~60% grant funding has been secured to date (research/demonstrator project)
- The Dutch spark gap is lower (6p gas)
- The Dutch government is pushing the move from natural gas as Dutch supplies are draining
- Secure contracts by offering guaranteed savings on energy bills
- There is significant local support for the use of the mines
Bath Street cluster
Aquifer Charging - cold

- Cluster is heat dominated therefore over time it is expected that the cold wells would be permanently cooled

- Assuming everything starts at 12 °C, heat, the cold network would charge / discharge as shown.

- Free cooling should be abundant over the year once operational
Connection Detail (single connection)
Delivery in the UK
The Challenges of launching a heat network - breaking the cycle

- Business case needs customers
- Project needs a business case
- Customers need compliance and certainty
- Business case needs funding
- Funding is uncertain without customers
Business Case - Operational Viability – revenue uncertainty erodes business case

- Ground source heat pumps = high capex
- Removing CHP removes electricity revenues which can leave operational viability gaps
- These factors make RHI essential in enabling heat pump schemes with an acceptable level of returns
- **RHI makes a scheme investible, the uncertainty about replacement has created significant risk**
Pro-active Customer Capture and enforcing compliance system design

- Developer connection packs for compliance and standardisation of approach
- Heat supply prior to connection
- Temporary outdoor units
# Roadmap - stakeholder actions on a timeline

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
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<tr>
<td><strong>GOV</strong></td>
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<tr>
<td>1. Develop R&amp;R</td>
<td>Industry</td>
<td>Test &amp; Implement</td>
<td>Industry</td>
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<tr>
<td>2. Create Local ESchool</td>
<td>Replace Project</td>
<td>Test</td>
<td>Implement</td>
<td>Continue in Project</td>
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<tr>
<td>3. B2B NMOP Access</td>
<td>Replace Group with Equivalent</td>
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<td><strong>PCC</strong></td>
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<tr>
<td>1. Special Edition Policy</td>
<td>Industry</td>
<td>Test &amp; Implement</td>
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<tr>
<td>2. Impact Area Policy</td>
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<tr>
<td>3. Develop &amp; Sustain Policy</td>
<td>Test Policy</td>
<td>Implement Policy</td>
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<td><strong>DHN</strong></td>
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<tr>
<td>1. Product Development</td>
<td>Develop Policy on Restrictions</td>
<td>Test Policy</td>
<td>Implement Policy</td>
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<tr>
<td>2. Engage in Continual Development</td>
<td>Engage in Continual Development</td>
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<td><strong>PROMOTER</strong></td>
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<tr>
<td>1. Engage with DHND</td>
<td>Engage Existing Building Stakeholders</td>
<td>Engage Existing Building Stakeholders</td>
<td>Engage Existing Building Stakeholders</td>
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<tr>
<td>2. Develop Contracts with Developers</td>
<td>Continuously Engage Developers as they come forward</td>
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<tr>
<td><strong>DEVELOPER</strong></td>
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<tr>
<td>1. Engage with PCC &amp; Consultants</td>
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<td>2. ASB by Secondary Developers</td>
<td>Industry</td>
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<td><strong>EXISTING BUILDING</strong></td>
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<td>1. Be Aware of ESchool Policy</td>
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<tr>
<td>2. Install Light Touch Heating-Energy Efficiency Measures</td>
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</table>
Summary roadmap

- Replace RHI with an equivalent level of support for electrification
- Establish a body to deliver heat
- Implement a policy which requires connections in zones
- Accept heat supply for developments without network in place
- Enforce use of compliant systems
- Connect sites
Delivery in Practice
Moxy Hotel - when It’s easy

- Hotel and some residential units
- Potential mix of cooling and heating loads
- Single owner
- Agreed to install a fully future proofed system with little to no persuasion needed
- Can be connected upon completion to either a 4G or 5G scheme

- A full scheme of Moxy hotels would be ideal
Multiple use – When it’s difficult

- Large site in Plymouth City Centre
- Potentially significant cooling load – excellent for a 5G scheme
- Identified as a key connection in the 5G study
- Single ownership, multiple retail and commercial tenants
- Site is being parcellled up for re-development
- Pre-planning negotiations underway for highlighted green area
Multiple use - issues

- Won’t comply with PCC request for a centralised heating and/or cooling system with single point of connection
- Won’t place any requirements on potential future tenants due to high street retail market:
  - Tenants have supply chains, national agreements, and generally will install VRF
  - Master developer won’t ask that tenants install all VRF outdoor units in a single compound which would offer a single connection location
outcome

- Distributed outdoor VRF units
  - Connectable but at significant cost and with significant coordination
- Un-meterable heat and cooling
  - We would need to adopt the power supply to the outdoor units and bill tenants for power
- Tenants with 0 incentive to connect unless we can offer a significant commercial benefit
  - Could be possible, however 11 individual negotiations to make it happen
Lucky in Plymouth that we have had civils costs with drainage works

However still ~£300k for ~200m of DN300 buried pipework and ancillaries (contract variation so likely high cost)

- MDPE pipe
- Uninsulated

Had valve supply and cost problems due to saline ground conditions
Bath Street Infrastructure

- Borehole drilling is very challenging:
  - Yield issues
  - Operational challenges
  - Original contract was for 2 wells total

- An optimum 5G network requires multiple boreholes, all performing perfectly
  - Very unlikely and can’t guarantee
  - Probably need a back up energy input opportunity if boreholes are the foundation of the scheme
Comparison with Heerlen (Easy Delivery)

<table>
<thead>
<tr>
<th>Heerlen</th>
<th>U.K.</th>
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<tbody>
<tr>
<td>~60% grant funding</td>
<td>Cannot be done due to state aid. However 5G schemes can be viable without this level of funding.</td>
</tr>
<tr>
<td>Dutch spark gap is lower</td>
<td>We need to be comparing against an electrified counterfactual which will only be a feasible comparison with significant policy shift.</td>
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<tr>
<td>Dutch government desperate to move from natural gas</td>
<td>Not seen to be the case in the U.K.</td>
</tr>
<tr>
<td>Secure contracts by offering guaranteed savings</td>
<td>5G schemes can offer this, difficult commercial sector tenants might not want to/ might not be able to listen.</td>
</tr>
<tr>
<td>There is significant local support for the use of the mines</td>
<td>Needs clearer and coherent messaging to the public about the direction of travel needed for decarbonisation.</td>
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</tbody>
</table>
What are the next steps

- Design systems for the demands and not the trends in technology
- Consider alternative heat sources
- Keep building confidence through regulation
  - Design standards
  - Consumer protection – Ofgem
- Move quickly
- Keep lobbying for support