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Low temperature heat networks and their future in the UK

CIBSE NE

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Interreg North-West Europe HeatNet NWE

PLYMOUTH CITY COUNCIL

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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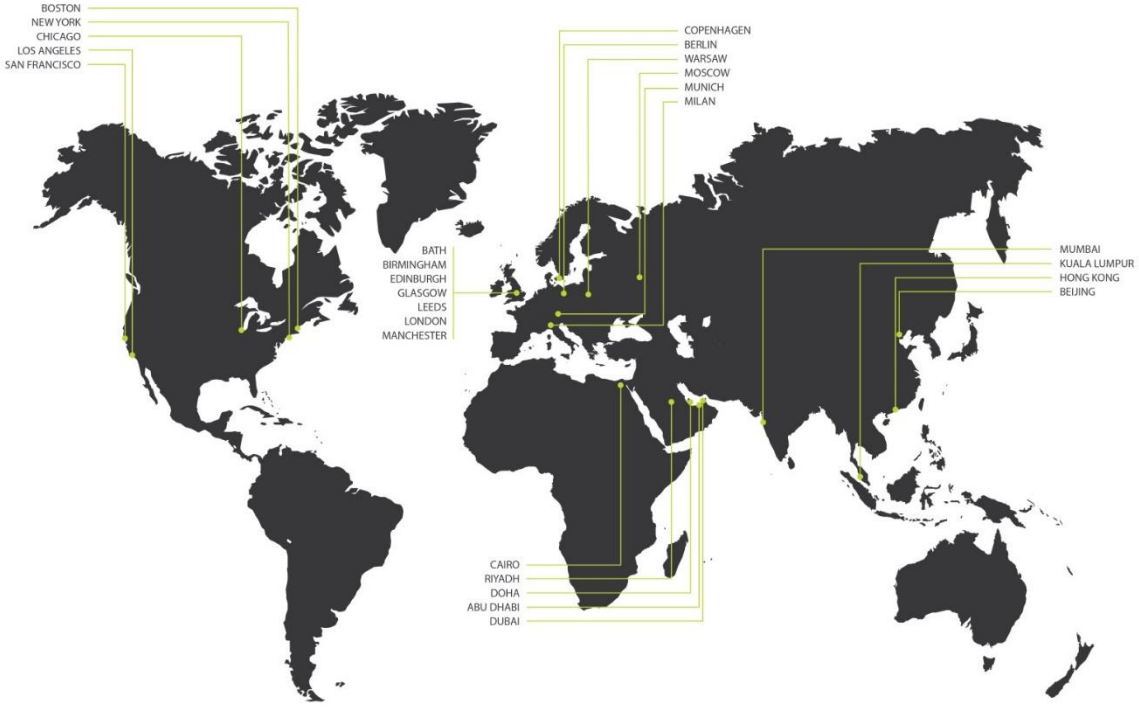
BH World Map



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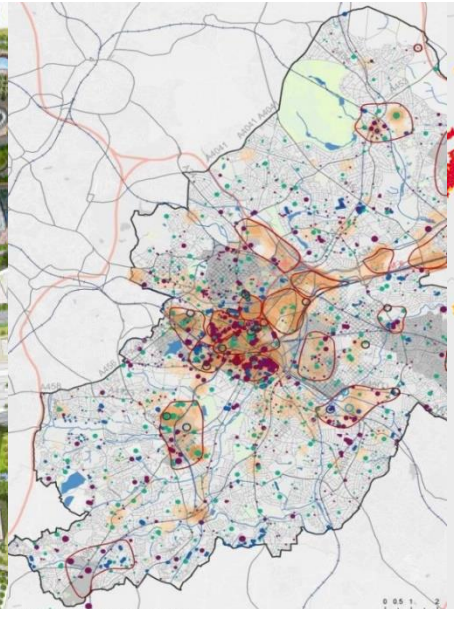
Buildings

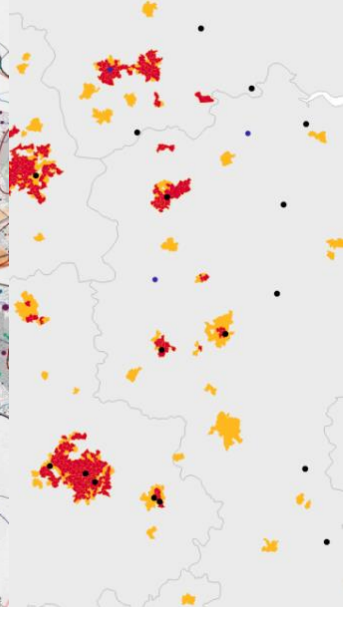
- “Make the Vision Viable”
- Full building engineering from the initial ground investigations to the final bolt.
- Higher education
- Culture
- Science
- Healthcare
- Commercial/ residential
- Aviation

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





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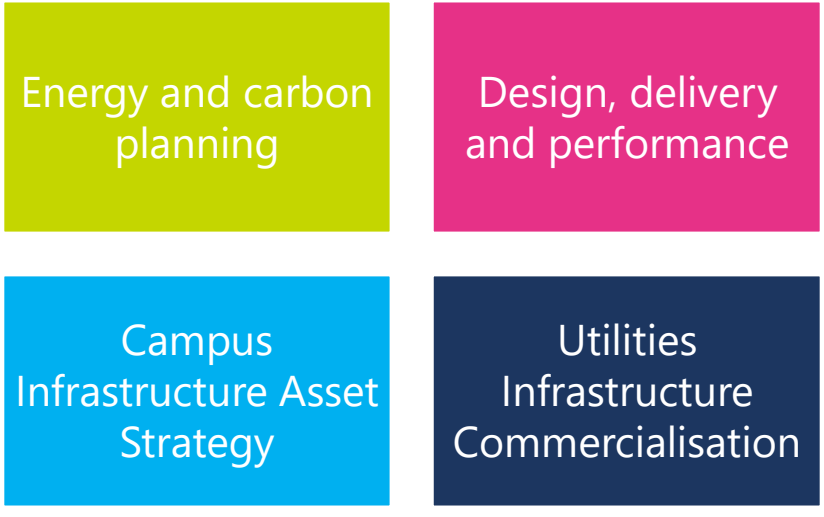
Our Service offers

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



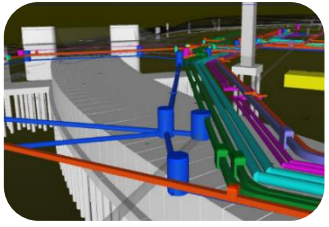
ENGINEERING FOR THE FUTURE
BIGGEST CHALLENGES FACING DEVELOPMENT AND THE BUILT ENVIRONMENT

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?

Energy and Carbon

- Carbon, pathway to zero
- Future demands
- Electric vehicles, electric heat

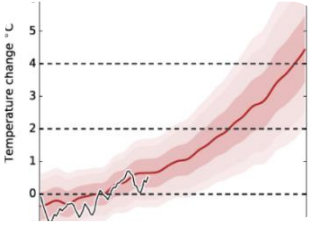


Utility infrastructure

- Improving utility and data resilience
- Reducing risk and operational reactive maintenance
- Ensuring flexibility – no regrets
- Consequential upgrades/ improvements

Health and wellbeing

- Improving campus and building design – air quality, wind, personal security, green space, community

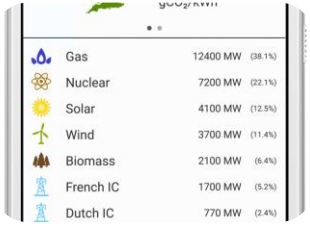


Climate change emergency

- Adapting and mitigating for a changing climate
- Scope 1, 2 and 3
- Building, infrastructure and public realm

Circular Economy & Waste

- New facilities – On site
- Adjacent development



Technology

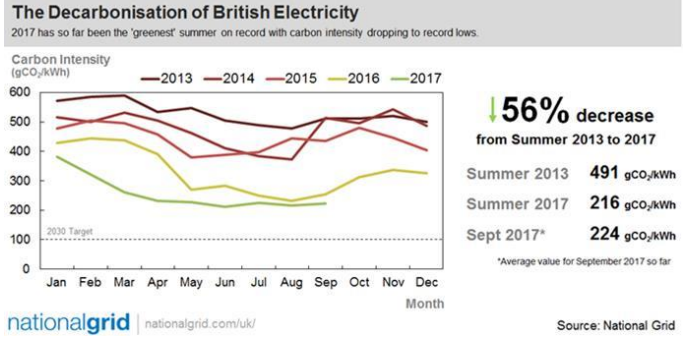
- Data revolution – SMART grid
- Controls
- Post fossil fuel heat and transport

Carbon

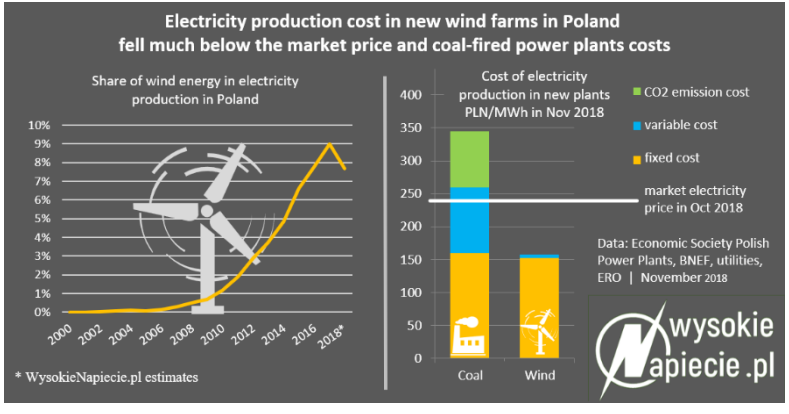
Natural gas + coal

- 4th industrial revolution…

Baseload is dead…



Distributed energy is here….



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

Chris Skidmore signs legislation to commit the UK to a legally binding target of net zero emissions by 2050

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

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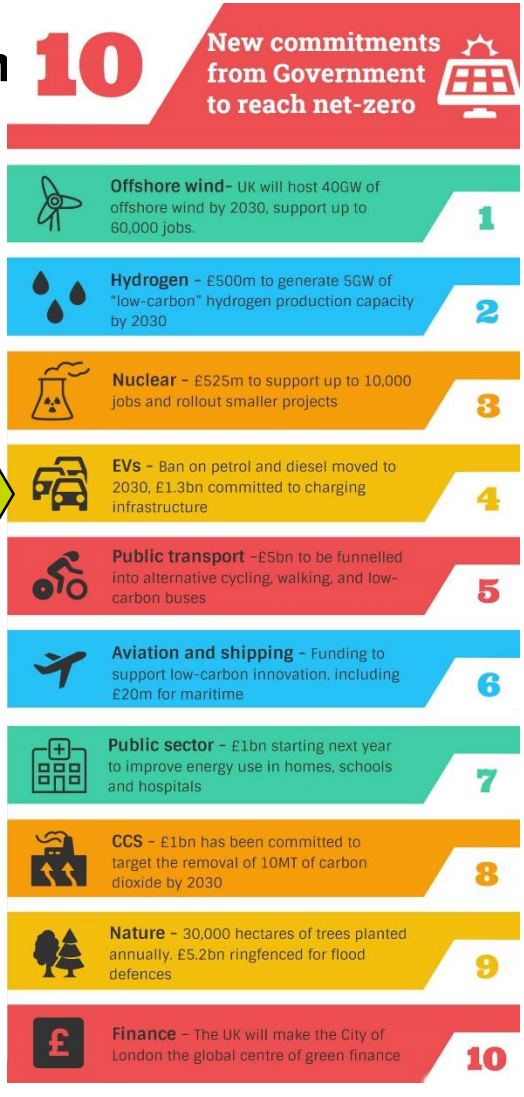

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Heat related measures

Heating for homes?

600,000 Heat pumps per year by 2028 + 1 yr additional to Green Homes Grant

Funding for innovation

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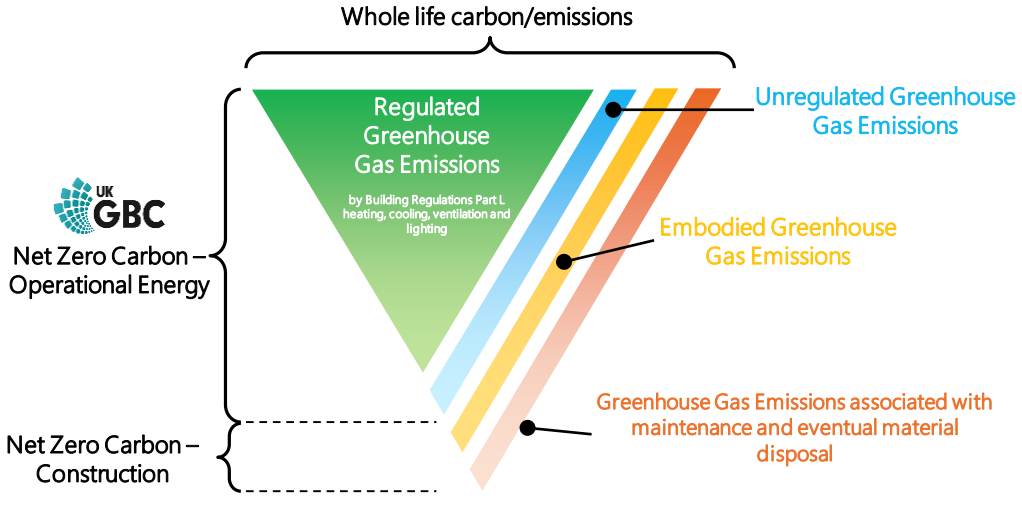
UKGBC Net Zero Carbon Buildings Framework Definition

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."



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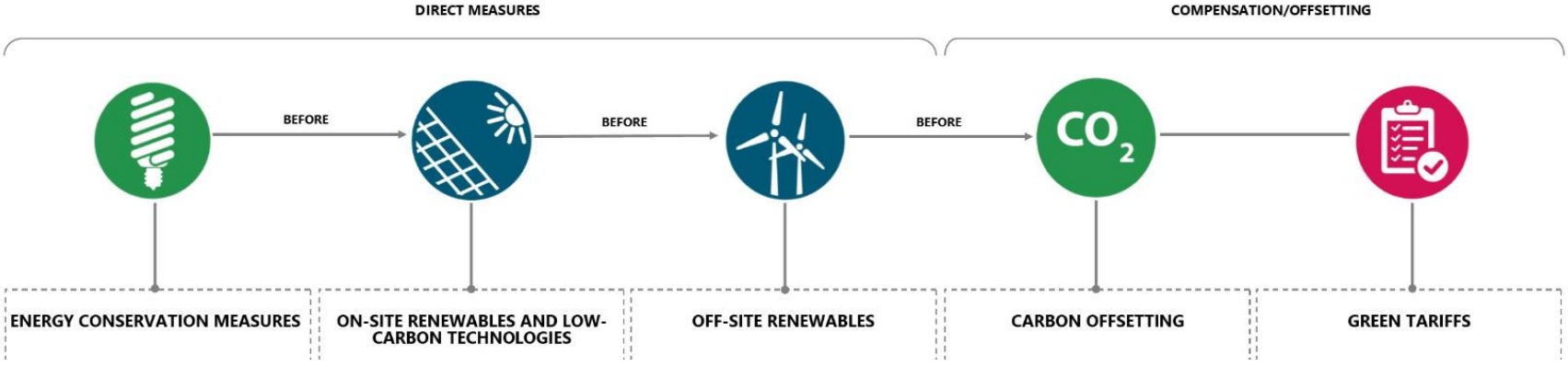
Design approach to net zero

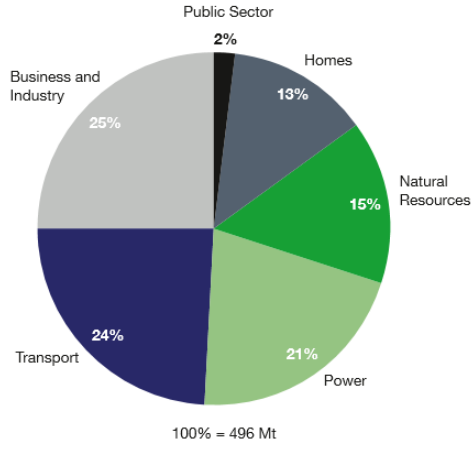
- Focus **first** on **energy saving** and maximising **onsite low carbon technologies**. If further carbon reductions are required than can be achieved on site **then** these can be captured through considering **offsite** renewables and finally using **carbon offsetting**



Heat in the UK

- 20% of emissions by our calculations
- 32% according to UK clean growth str
- Heat required for space heating
- Heat required for water heating
- Provided almost exclusively by the UK

Figure 2: UK emissions by sector, 2015[27]



Heating in buildings and industry creates around 32% of total UK emissions

Source: BEIS

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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

17. Build and extend **heat networks** across the country, underpinned with public funding (allocated in the Spending Review 2015) out to 2021
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

Building our Industrial Strategy

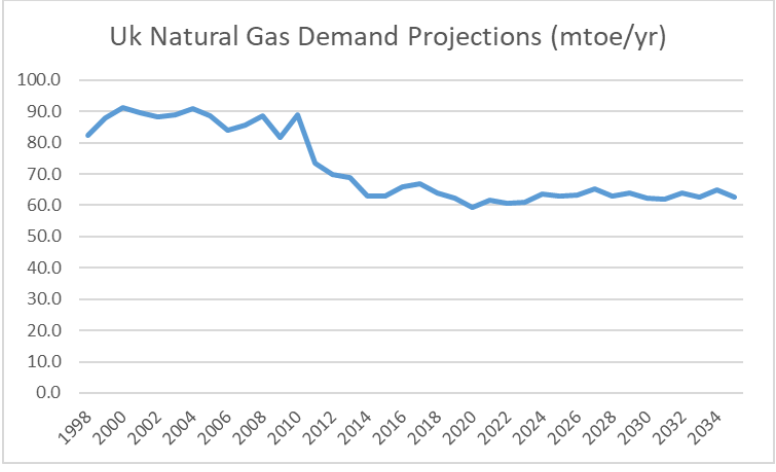
4 Department for Business, Energy and Industrial Strategy

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…

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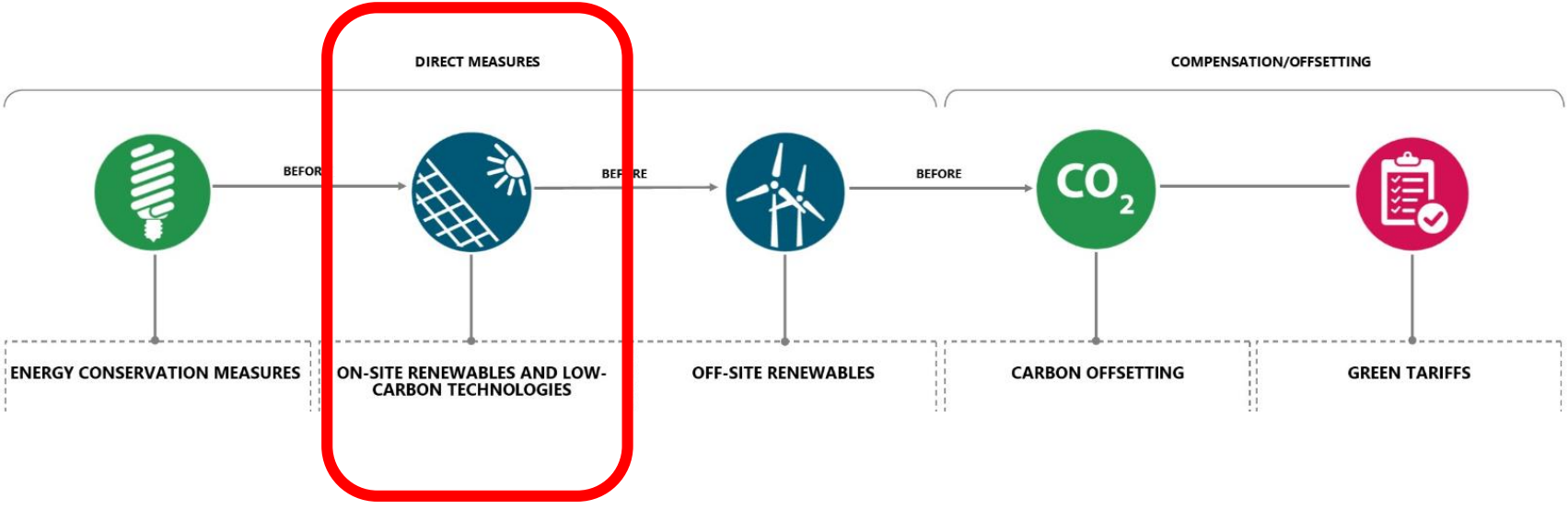
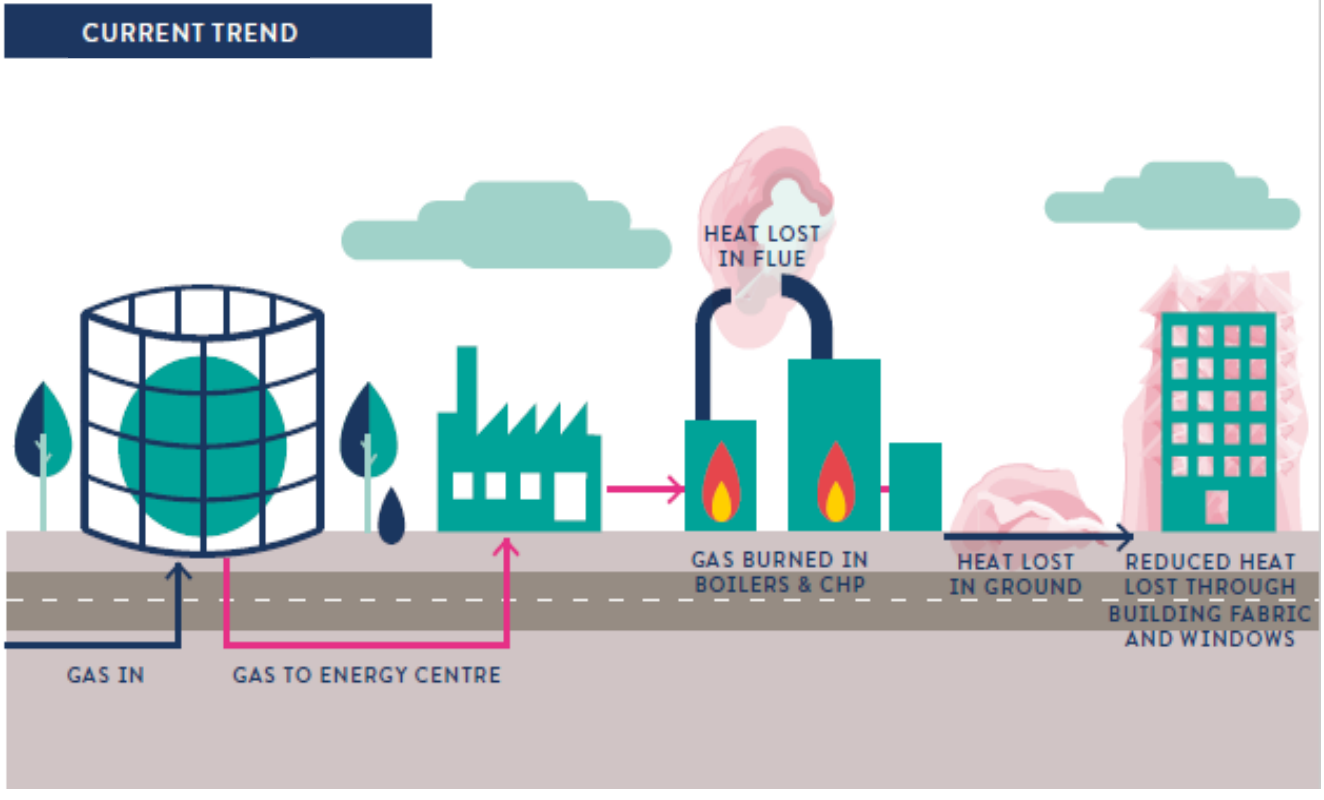
Where heat networks can contribute

- 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



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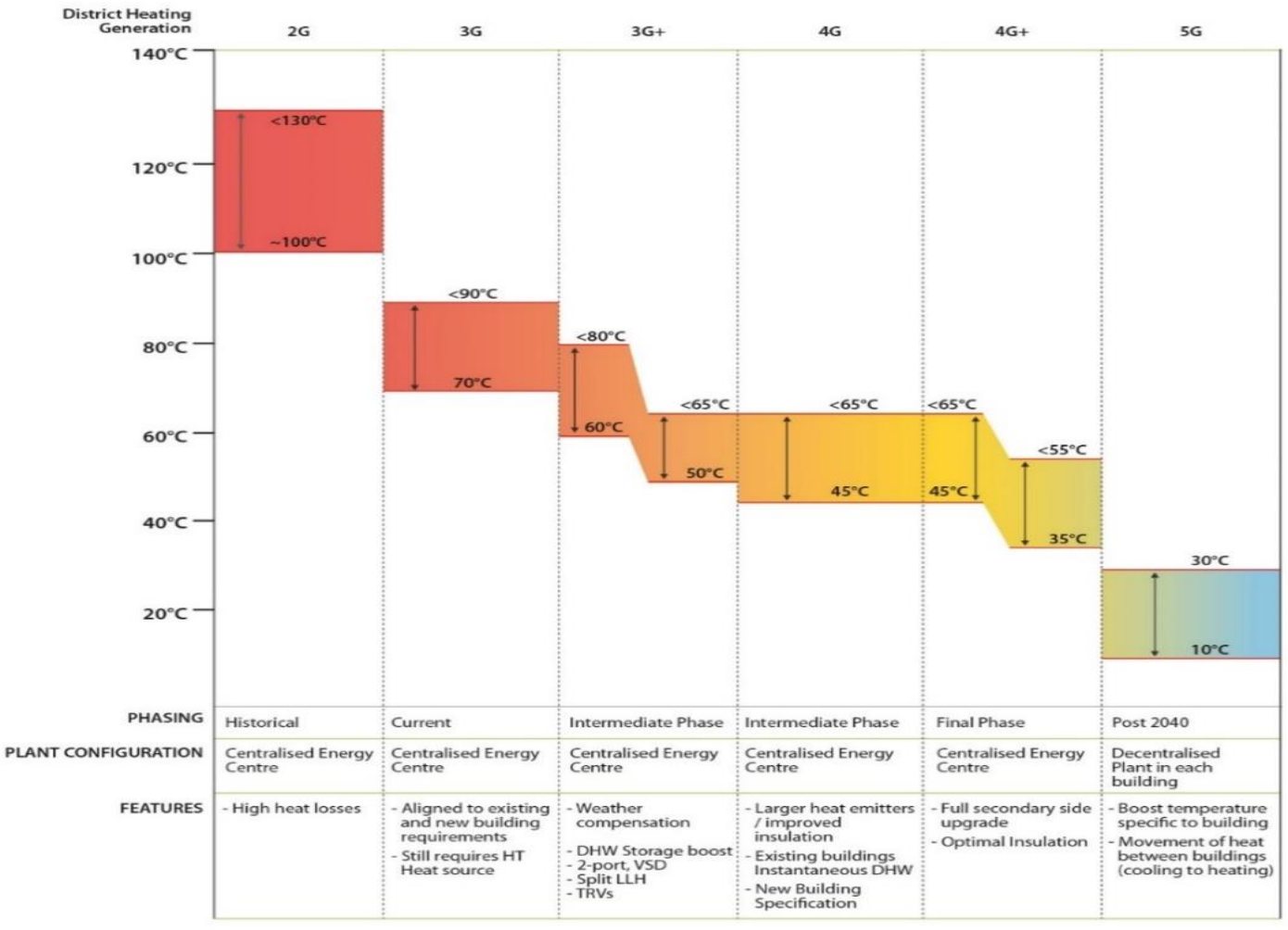
Networks and temperature



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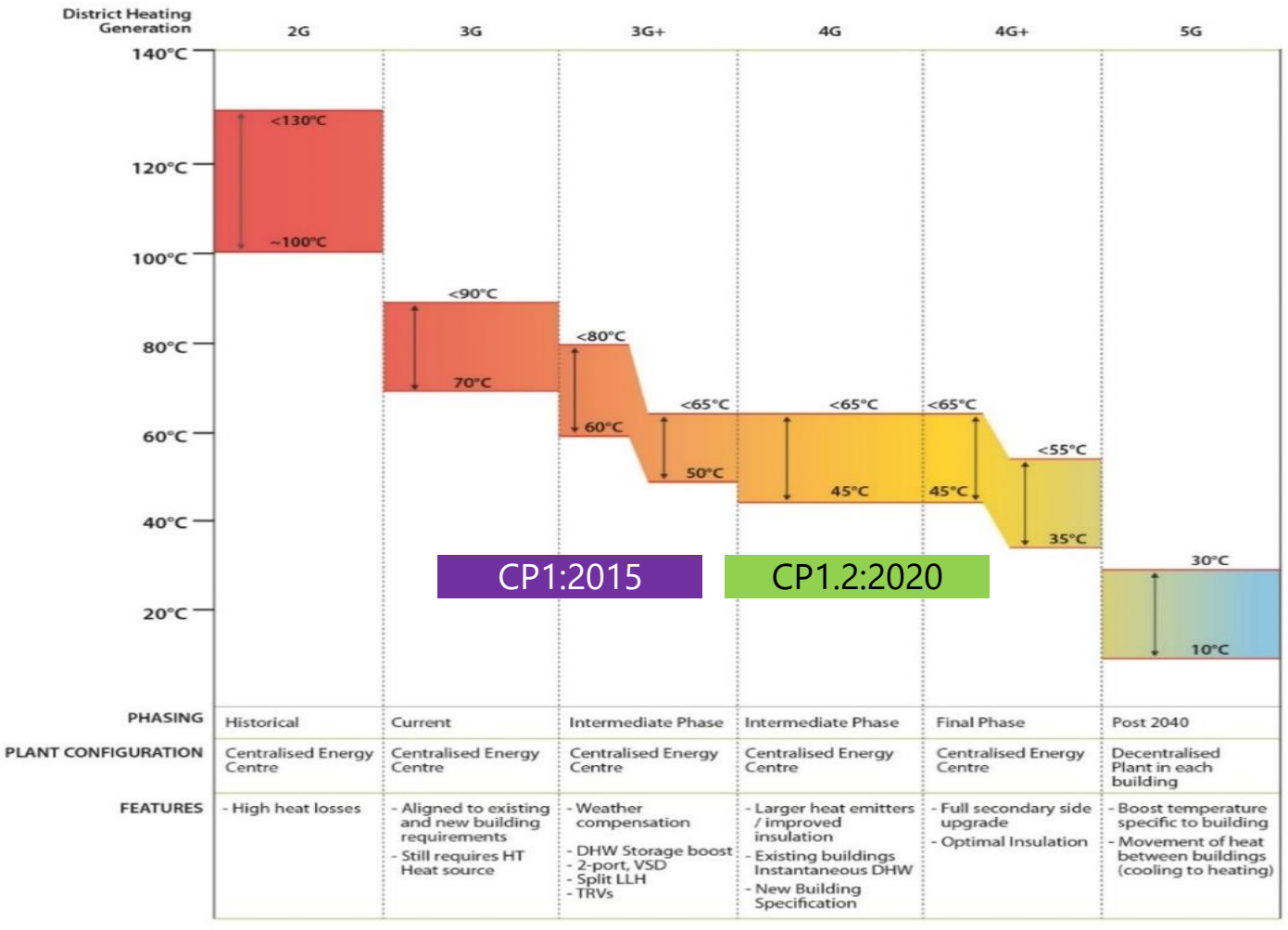

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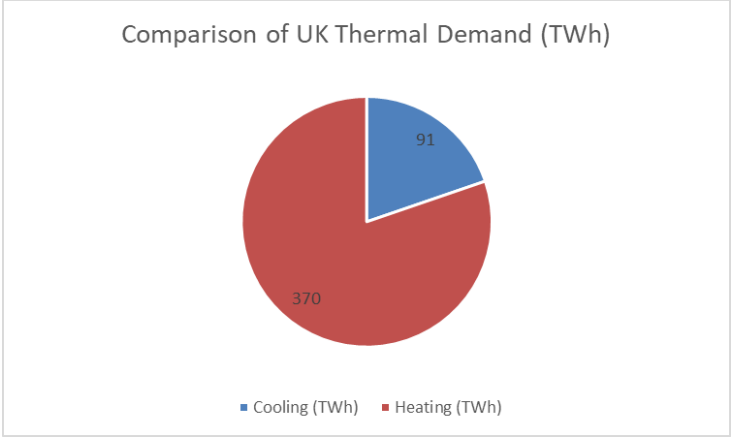
Heat Networks

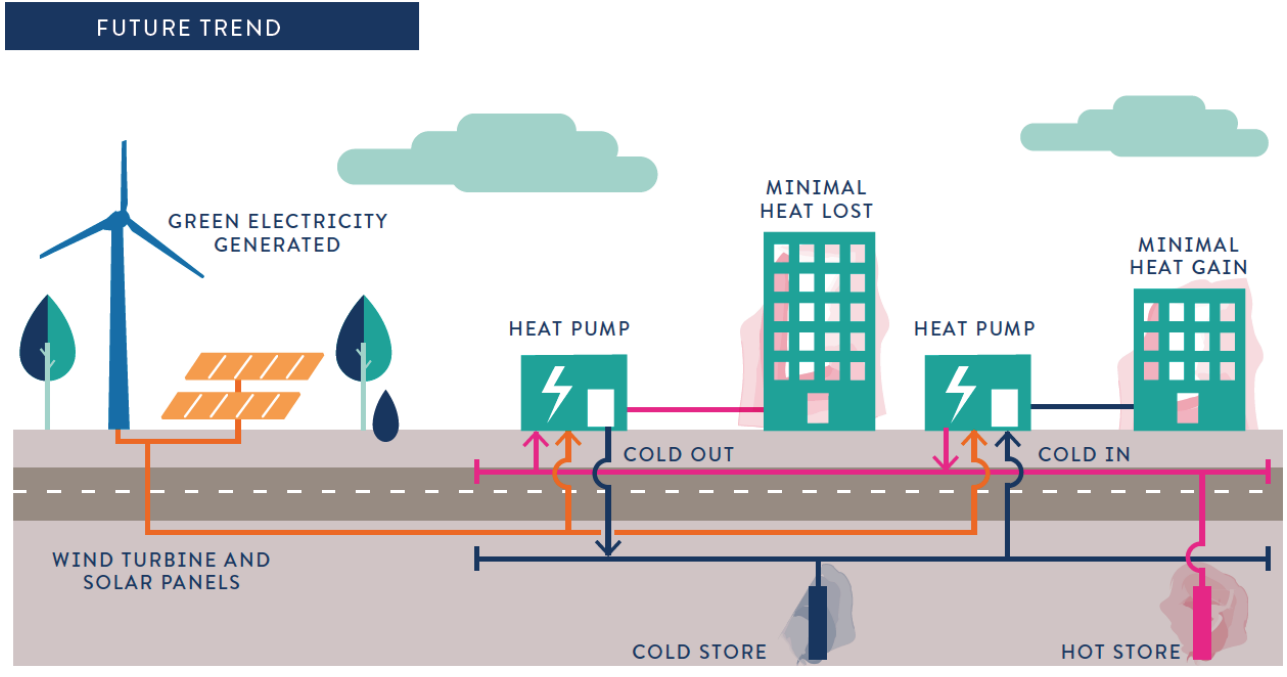
- Millions of pounds have been invested in traditional heat networks, both operational and planned, which are no longer providing any carbon benefit because the carbon factor of electricity has dropped
- How can we re-invent heat networks so that they provide the future they have previously promised
- 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



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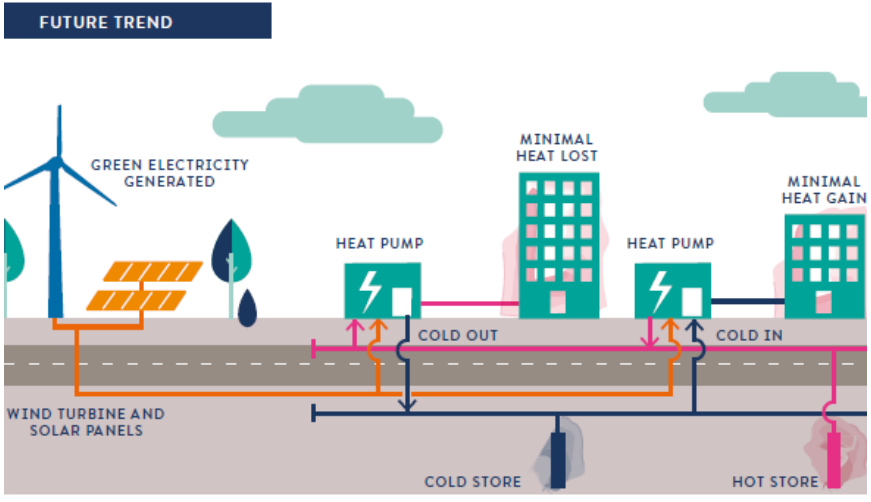
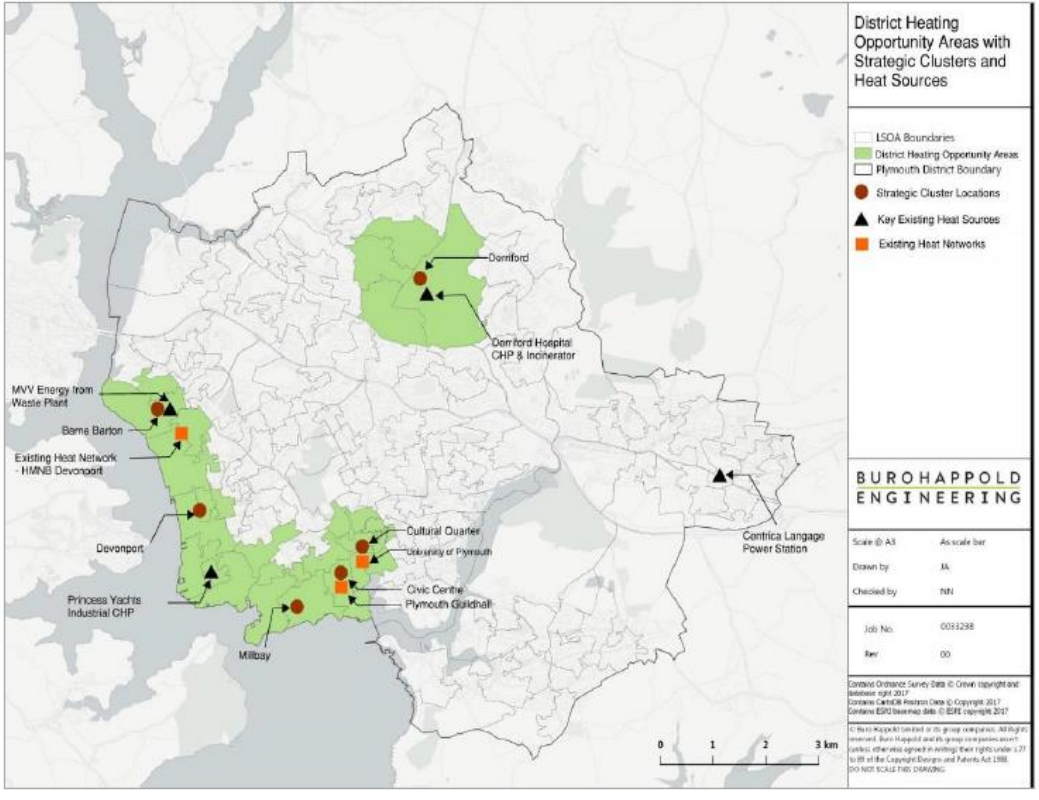
5g Networks – the future

- 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



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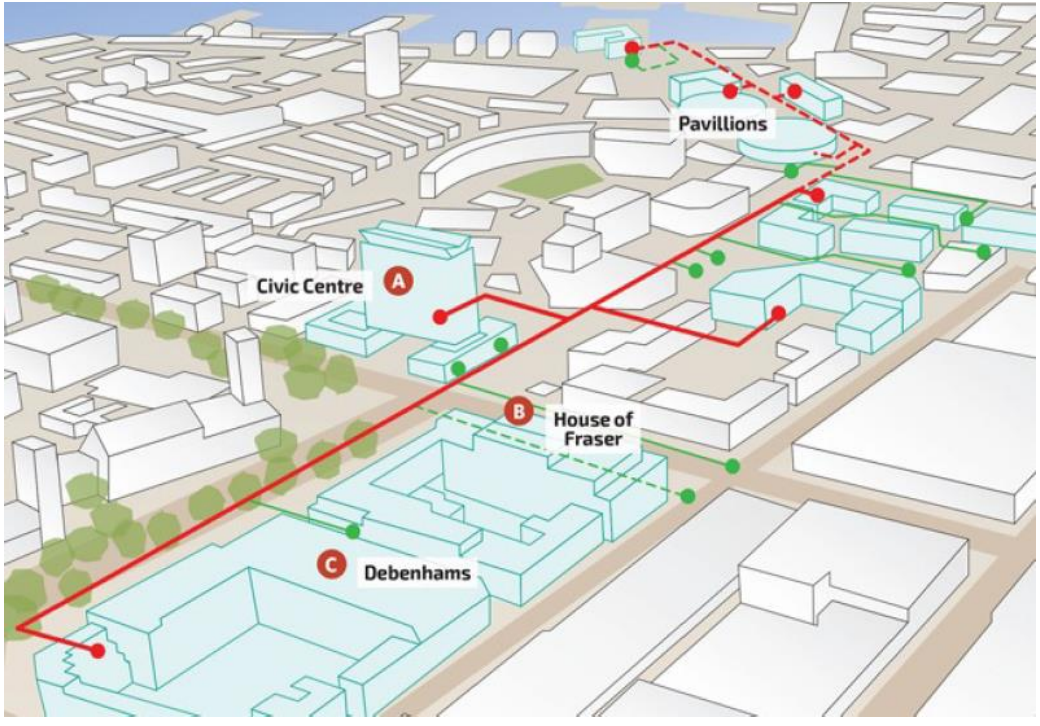
The 5G network opportunity in Plymouth

- 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



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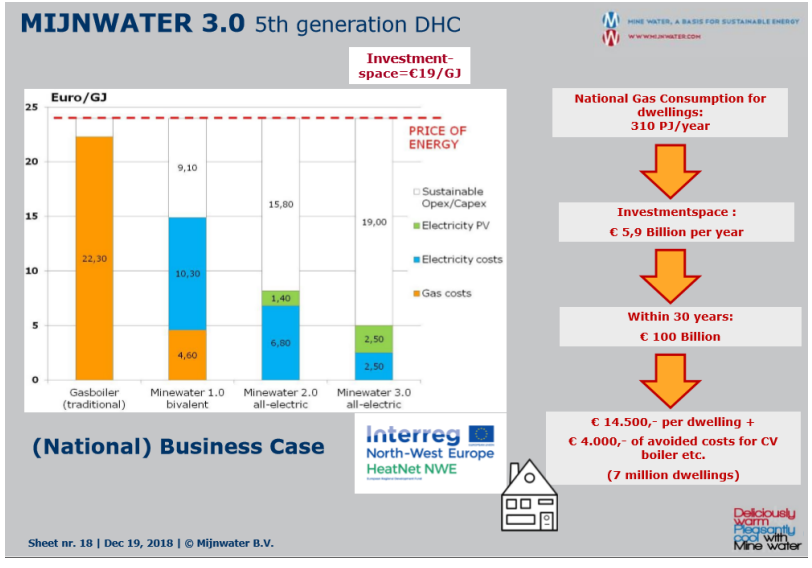
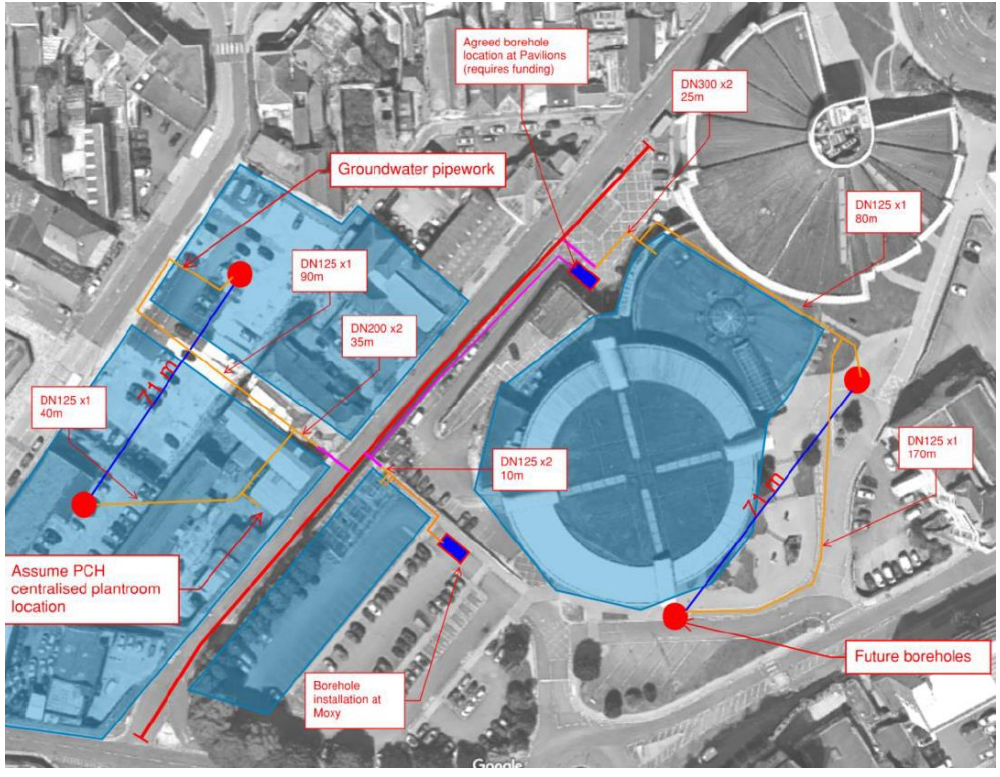
The Heerlen approach to delivery

- ~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



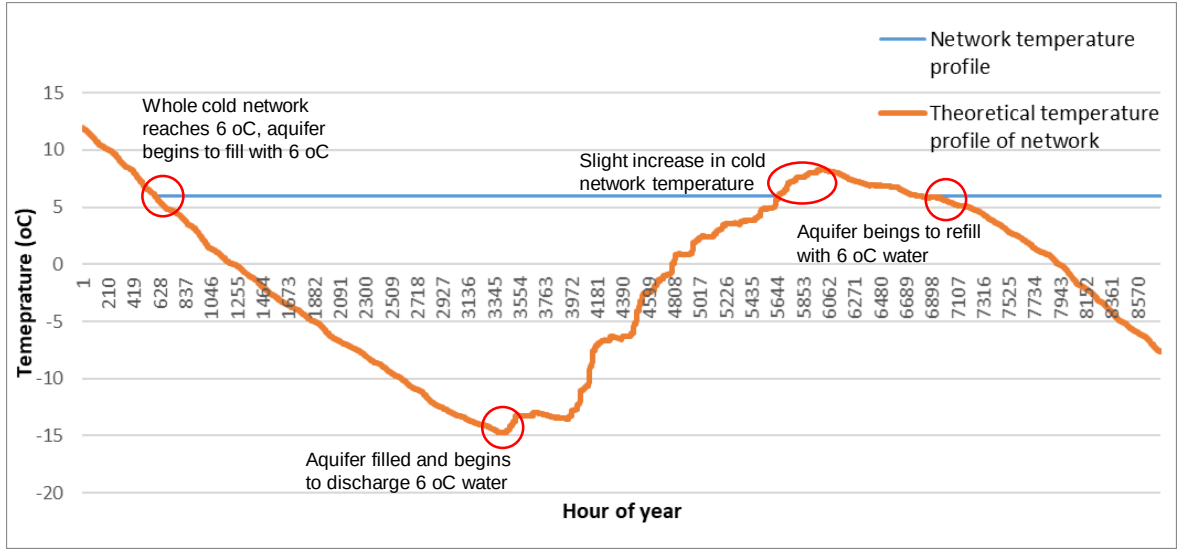
Technical Detail

Bath Street cluster

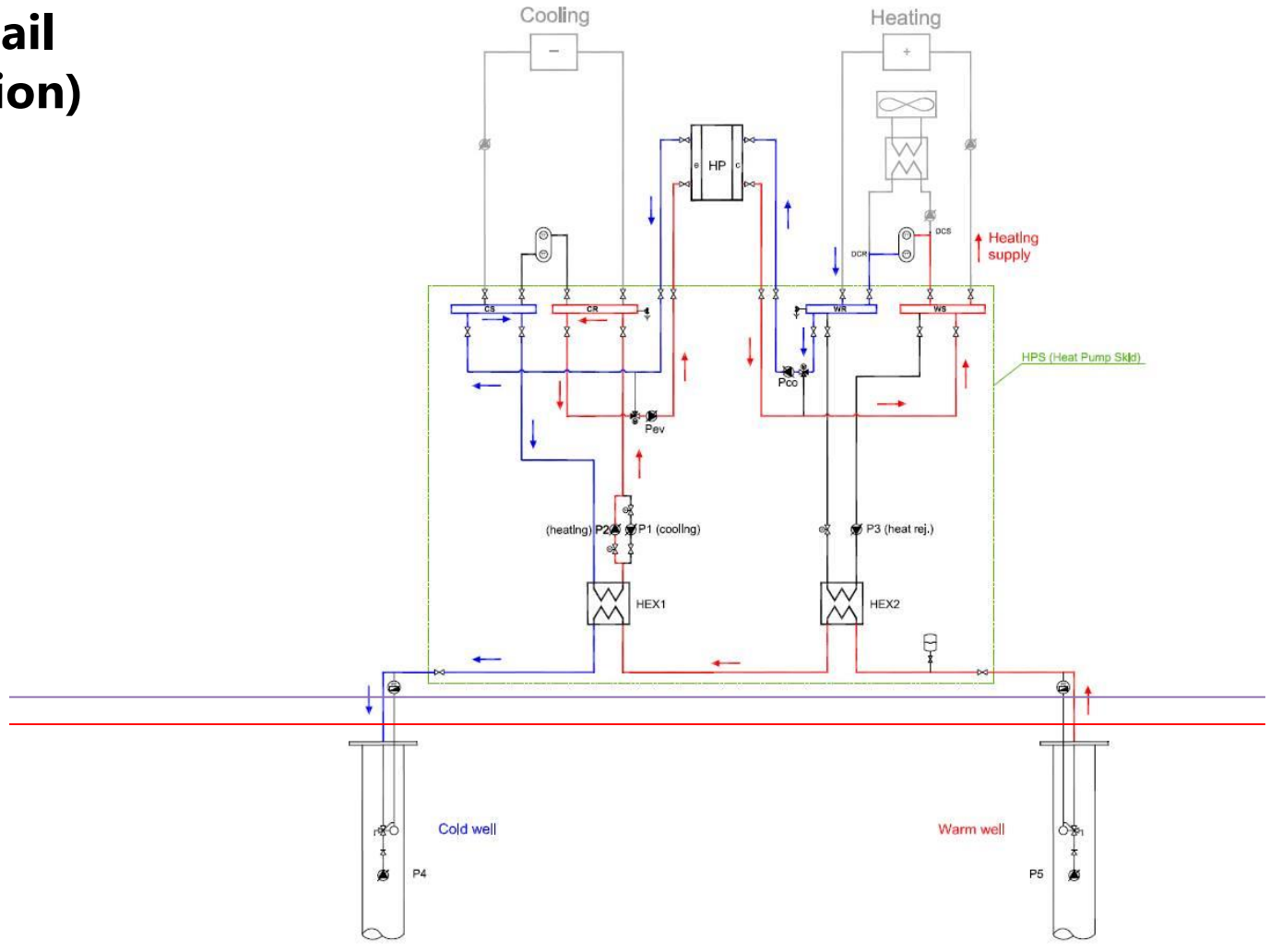


Aquifer Charging - cold

- Cluster is heat dominated therefore over time it is expected that the cold wells would be permanently cooled
- Assuming everything starts at 12 oC, heat, the cold network would charge / discharge as shown.
- Free cooling should be abundant over the year once operational



Connection Detail (single connection)



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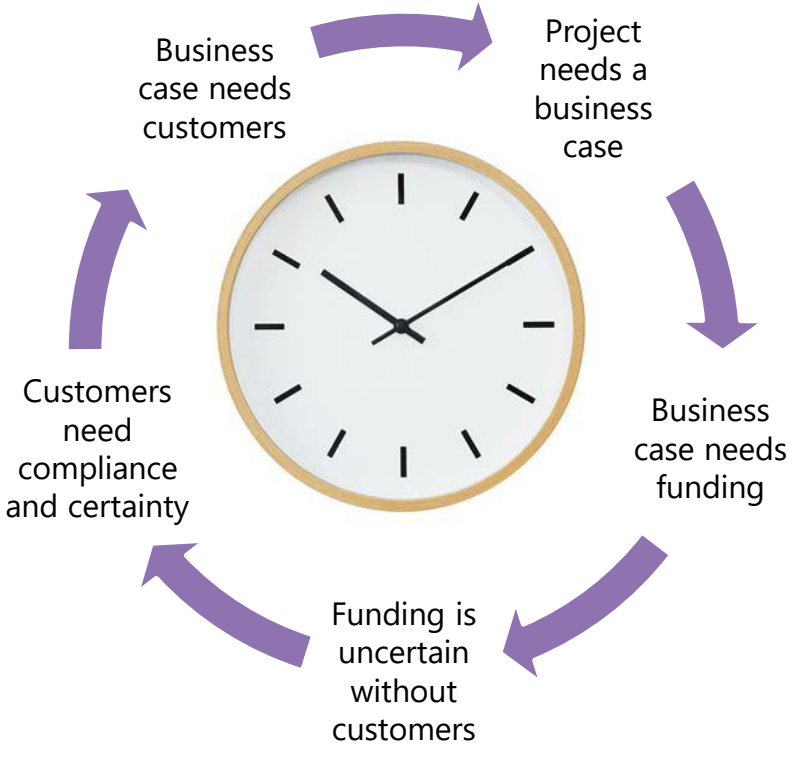
Delivery in the UK

The Challenges of launching a heat network - breaking the cycle



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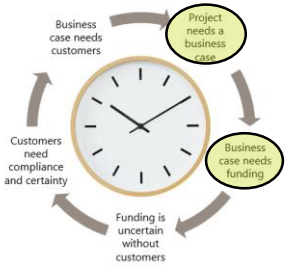
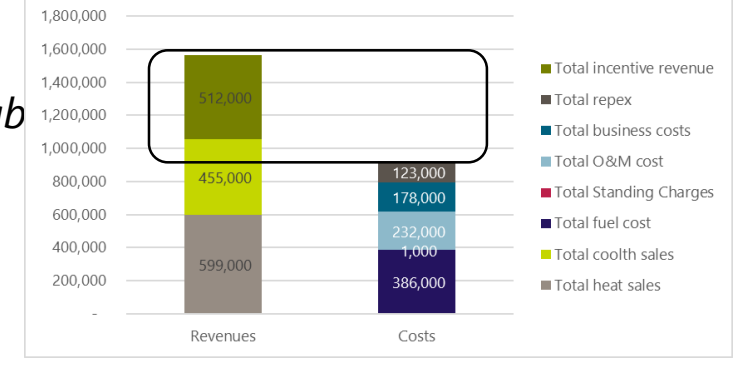
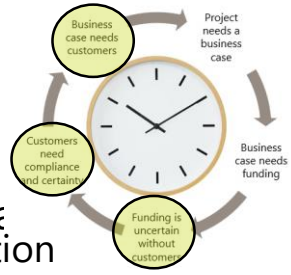
Business Case - Operational Viability – revenue uncertainty erodes business case



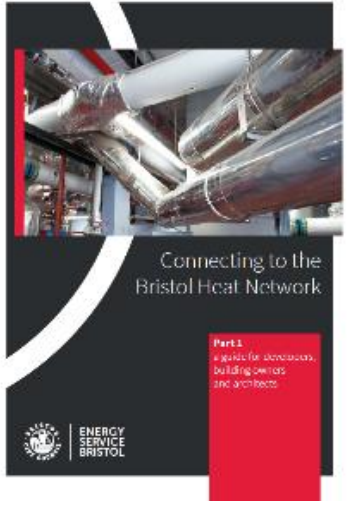
- Ground source heat pumps = high capex
- Removing CHP removes electricity revenues which can leave operational viability gaps
- These factors make RHI essential in enabling heat pump schemes with an acceptable level of returns
- *RHI makes a scheme investible, the uncertainty ab significant risk*

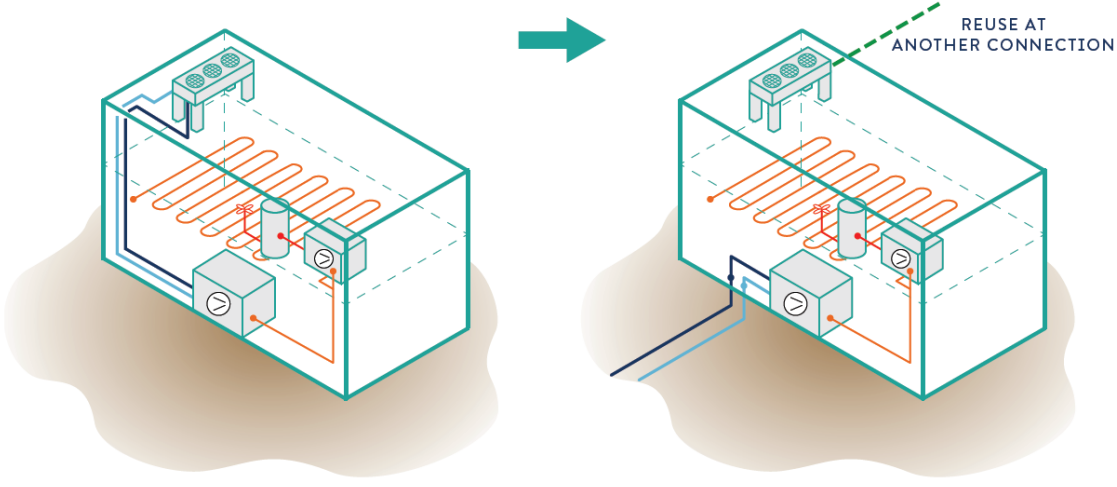


Pro-active Customer Capture and enforcing compliance system design



- Developer connection packs for compliance and standardisation of approa
  - Heat supply prior to connection
  - Temporary outdoor units





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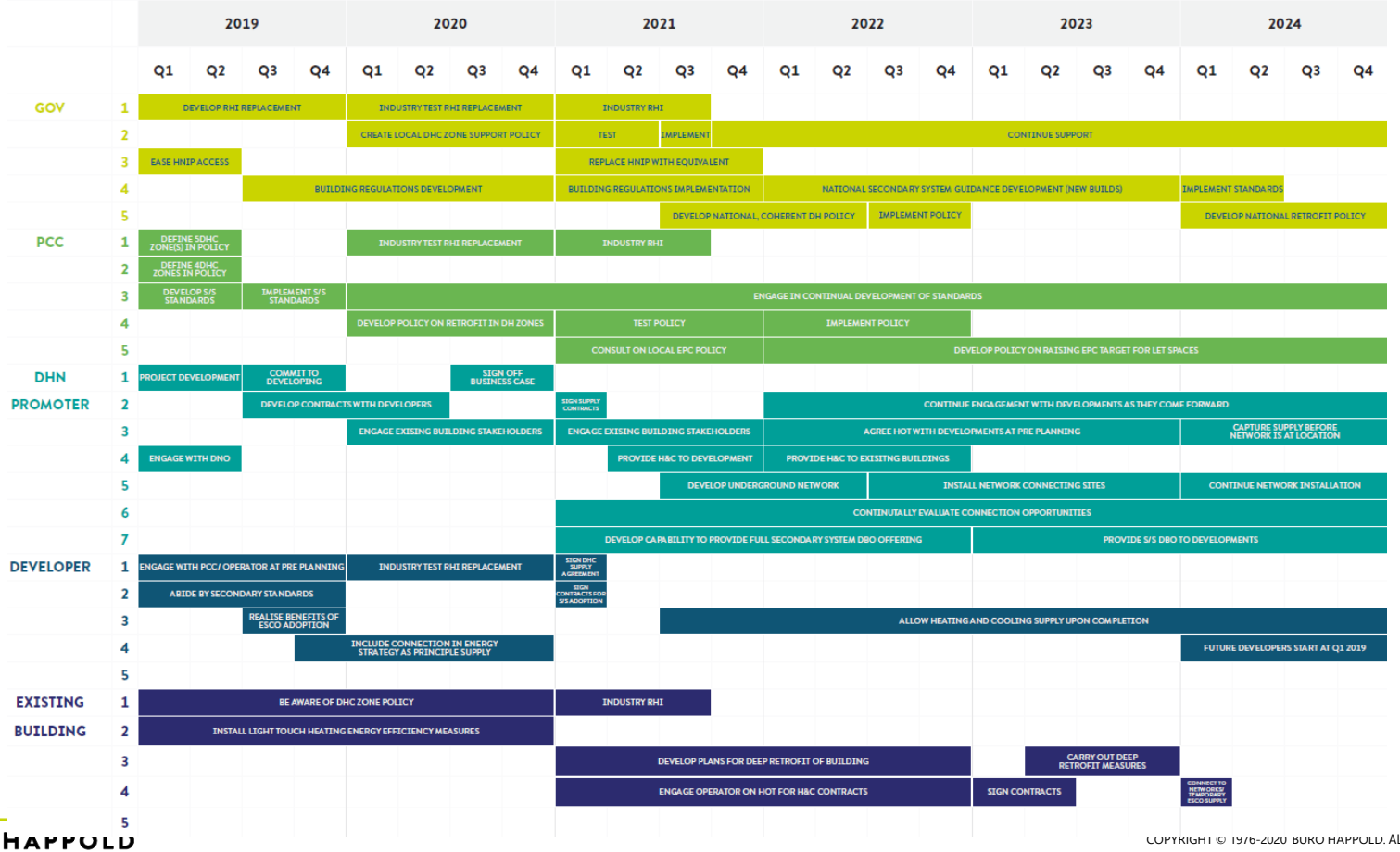
Roadmap- stakeholder actions on a timeline



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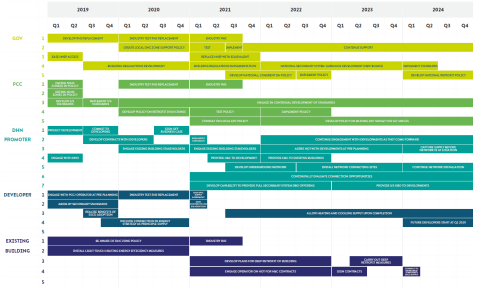
Summary roadmap



REPLACE RHI WITH EQUIVALENT LEVEL OF SUPPORT FOR ELECTRIFICATION

ESTABLISH 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

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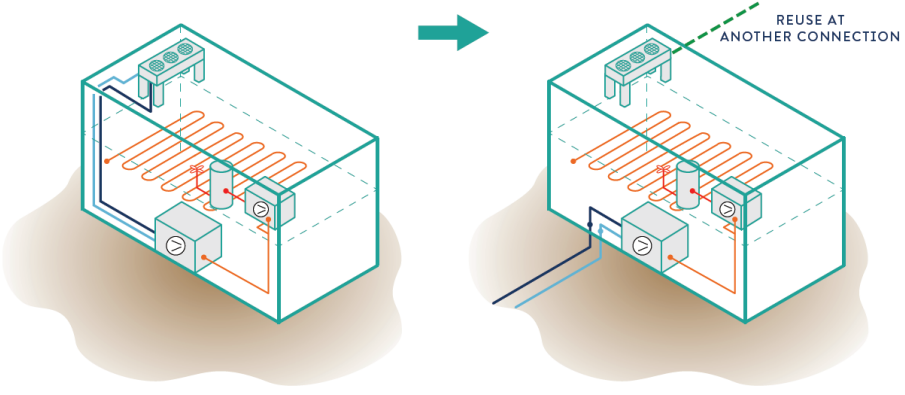
Delivery in Practice

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



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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 parcelled up for re-development
- Pre-planning negotiations underway for highlighted green area

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Multiple use - issues

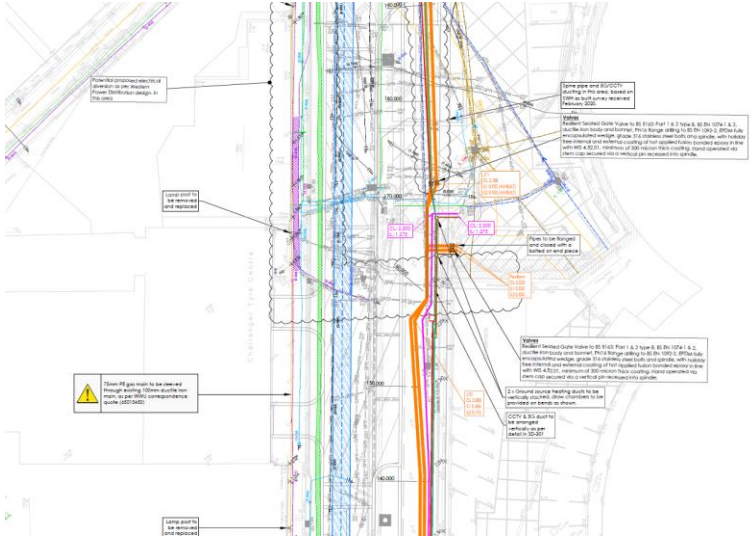
- Won't comply with PCC request for a centralised heating and/ or cooling system with single point of connection
- Won't place any requirements on potential future tenants due to high street retail market:
  - Tenants have supply chains, national agreements, and generally will install VRF
  - Master 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

Bath Street Infrastructure

- 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



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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

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Comparison with Heerlen (Easy Delivery)

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

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

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