

International Review of District Heating & Cooling: the History and the Way Forward

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History of DHC in one slide?

District Heating & Cooling (DHC) has history:

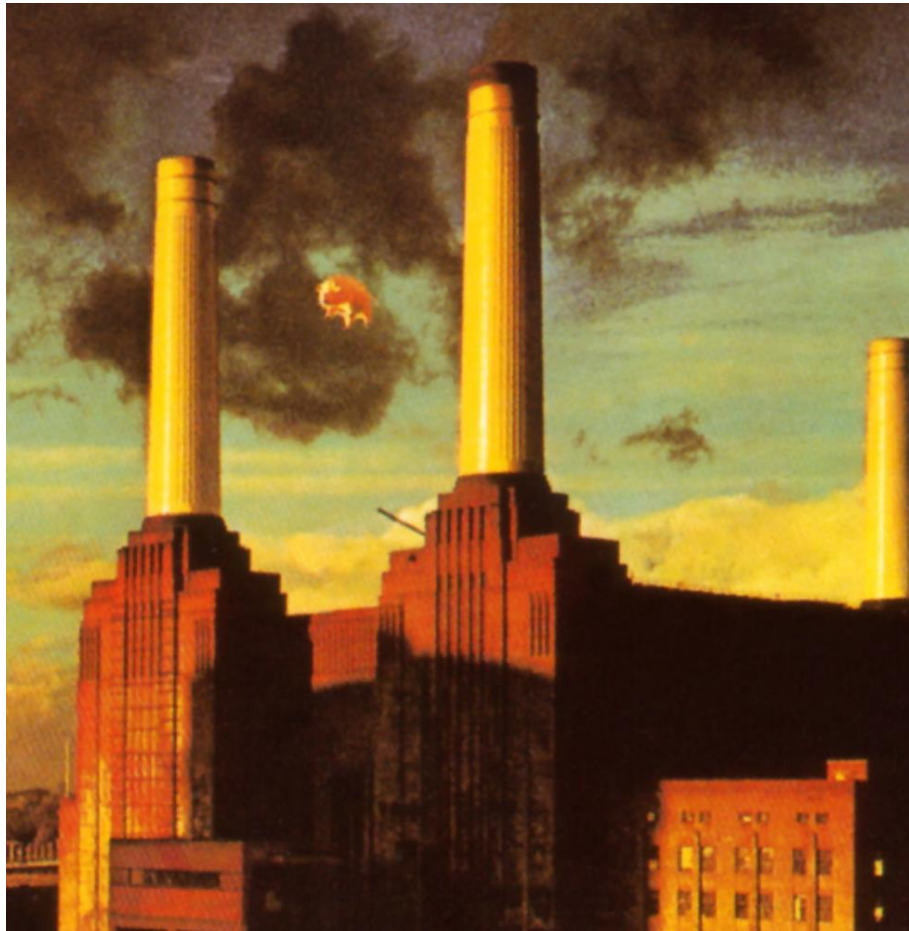
- extending back perhaps to Roman hypocausts...
- and geothermal water distributed through wooden pipes at Chaudes Aigues in the 14th century
- but more recognisably dating from systems of 100+ years ago
- and progressing through stages defined in terms of their temperature and energy carrier (from steam to hot water to medium to low temperature)
- with concerted research taking place over the last few decades, and internationally through the IEA-DHC programme.

History of 'Modern' DHC

- Steam based systems in 19th Century USA, eg New York's system was established in 1882; steam can be seen emerging from pavements in old films
- Steam systems were also established in European cities, eg Bloom St power station in Manchester supplied steam to heat local warehouses and factories from 1911
- The major growth in European DH began with the oil crisis in the 1970s: a change from oil to coal for electricity generation, with some countries developing DH systems to recover the heat
- Also, waste disposal saw a potential problem turned to advantage as heat was recovered by incineration

History of 'Modern' DHC

- The USSR and Eastern Europe also saw DH systems established particularly to serve high density post war reconstructions, with many opting for city-wide DH systems
- Danish, Swedish, German and Finnish DH devoted resources to improving the technology, leading to reduced supply and return temperatures, and pre-insulated piping systems
- CHP became the dominant source, feeding efficient medium temperature DH systems, following research focusing on optimising temperatures, network design, and capacity
- Now there is increasing focus on transition from fossil fuels, using local sources of waste heat and renewables.



Example of evolution of DH... from UK

- The building is Battersea Power Station
- It supplied heat to the DH network in Pimlico, London, one of the UK's oldest DH networks
- This DH network was established in the 1950s following killer smogs, as a result of the Clean Air Act
- One of the worst ever smogs was a long time before that, leading to the statistic for the month with least sunshine:
- Six minutes, in December 1890, recorded in London a few miles from Pimlico at Bunhill
- The London Borough of Islington has made use of surplus heat from the London Underground at its DH system at...
- Bunhill!

What is the IEA District Heating & Cooling Technology Collaboration Programme (TCP)?

The District Heating & Cooling TCP:

- was established in 1983
- aims to improve the design, performance and operation of district heating systems
- current members: Austria, Canada, Denmark, Finland, France, Germany, Korea, Norway, Sweden, UK, USA.

IEA-DHC: what it does

- Research topics cover all aspects of DHC technology focusing on reducing cost and improving performance
- Research carried out through targeted projects, and extended programmes
- Reflects growing interest including countries with low penetration of DHC, by extending scope to new (often non-technical) target audiences
- Reflects major technology shift from fossil based to renewable based energy systems
- Reports for all projects are available at www.iea-dhc.org

Strategic direction

- DHC is an enabling technology to accelerate renewable heat penetration, and it synergises well with future smart electricity grid
- Under the IEA umbrella links between technology groups are readily established. This is increasing because of...
- ... the widening sphere of interest arising from recognition of the importance of DHC technology in achieving environmental goals for future sustainable cities
- As a knowledge base, IEA-DHC projects gathered over 35 years are available at iea-dhc.org
- Much of this knowledge remains valid even as technology evolves

Scope – some distinctive themes

- Enabling integration of renewables and thermal storage
- Reducing operating temperatures to reduce heat losses and increase the potential for renewables and surplus heat
- Providing assistance to early stages of district energy solutions
- Improving operation
- Determining energy and carbon benefits of this technology.

Annex X (2011-4) targeted projects

- ‘Towards 4th generation district heating (4GDH): experiences with and potential of **low temperature district heating** case studies’
- ‘Economic and design optimisation in **integrating renewable energy and waste heat** with district energy systems’
- ‘**Improved maintenance strategies** for district heating pipelines’
- ‘**Calculation tool for primary energy factors** in DHC systems.’

Reports are available at www.iea-dhc.org

Annex XI (2014 -7) targeted projects

- Transformation roadmap from high to low temperature district heating systems
 - Plan 4DE: Reducing greenhouse gas emissions and energy consumption by optimising urban form for district energy
 - Smart use as the missing link in district energy development
 - Structured for success: governance models and strategic decision making processes for deploying thermal grids
- *All reports now at website. As is the 1st Task Share output:*

Annex XII (2017-20) – successful proposals

- Effects of Loads on Asset Management of the 4th Generation District Heating Networks
- MEMPHIS - Methodology to evaluate and map the potential of waste heat from industry, service sector and sewage water by using internationally available open data
- Integrated Cost-effective Large-scale Thermal Energy Storage for Smart District Heating and Cooling
- Stepwise transition strategy and impact assessment for future district heating systems.

Low Temperature District Heating for Future Energy Systems – IEA-DHC's first wider programme

- Fundamental link between low temperature systems, integration of renewables, thermal storage, heat demands of future buildings...
- Case studies to demonstrate low temperature district heating as one of the most **cost efficient technology solutions** to achieve 100% renewable and GHG emission free energy
- Concluding Guide now available '**Future Low Temperature District Heating Design Guidebook**'.
- Follow-up now established: **Practical realisation of low temperature DH systems.**

New initiatives for wider programmes

Practical realisation of low temperature district heating systems

Kick-off meeting held 9/10 April 2018. Contact: Kristina Lygnerud at kristina.lygnerud@hh.se

Hybrid Energy Networks – District heating and cooling networks in an integrated energy system.

In preparation. Contact: Ralf-Roman.Schmidt@ait.au

DHC for future sustainable communities

- Global urban development will continue to grow, so aggregation of thermal demand will remain a highly effective way to reduce carbon emissions and primary energy consumption. DHC is a key enabling technology!
- Community sustainability will be underpinned through use of surplus energy within the community, and through local renewables
- Increasing levels of integration of renewable energy, and the opportunities for individual buildings to be energy producers as well as energy consumers means that smart control technologies will be crucial
- This requires a great deal of work both in increasing efficiency of individual technologies and in their connectivity and integration.

IEA DHC – evolving programme of research

- Technical innovation such as ‘Transformation from High to Low Temperature Systems’ will allow existing systems to lower their costs and be more fuel flexible
- However, barriers to the wider adoption of district energy networks are often institutional and financial rather than purely technical
- Hence IEA-DHC has widened target audience to include planners and decision makers.
- Further sustainability acceleration will come from opportunities for integrated infrastructures for smart sustainable future communities.

Future Annexes beyond 2020

- District energy networks are developed as large infrastructure projects; requires local and national strategic view for decades
- Fits well for countries with 2050 visions for low/ zero carbon futures
- Many themes need to be continued: migration towards lower temperature systems; integration of local energy sources, smart systems; synergy of infrastructures
- DHC networks are a key enabler for low and zero carbon technologies; hence increased co-operation between technology programmes in pursuit of effective integrated future energy systems.

Links with other TCPs

- IEA-DHC held joint workshop May 2016 with IEA research groups on Solar Thermal, Storage, Heat Pumps and Energy Efficiency.
- Joint workshop March 2018 to discuss ways to work together.
- Relevant work in other TCPs include:
 - Solar Thermal ‘Towards the Integration of Large SHC systems into DH.’
 - Smart Grids: cooperation in Hybrid Energy Networks .
 - Storage ‘Distributed Energy Storage for the Integration of Renewable Energies’.
 - Heat Pumps ‘Large Scale Heat Pumps in DHC Systems’
 - Energy Efficiency ‘LowEx Communities’

Other Co-operation

- **Mission Innovation** IEA-DHC has agreed in principle to support Mission Innovation #7 Heating and Cooling
- **Working Group on Cities and Communities** IEA-DHC representative attended workshop April 2018
- **Future Building Forum** October 2018; topic was Hot and Humid Climates.
- **International symposium for District Heating & Cooling** Hamburg, 9-12 September 2018.

Further information

For more about the IEA-DHC programme, contact:

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