

Network H+ C Annual Report

October 2022-September 2023

INTRODUCTION:

Network H+C commenced in October 2020 as a four year EPSRC funded project to bring together all researchers working within the field of Decarbonising Heating and Cooling and more specifically the 22 projects that have been funded from 2020 under the Decarbonising Heat programme. These are listed within the Appendix.

This report covers the third year of the Network, over the period October 2022 to September 2023. Over the third year of the Network, we have emerged from lockdown restrictions and have organised physical events and researcher development opportunities, together with online webinars and workshops responding to the research interests of the Network+ Co-Investigators and the research community.

Due to Covid impacts, EPSRC have approved an extension to the Network until June 2025.

AIMS:

The H+C Zero Network aims to provide leadership, coordination and facilitate this by

1. Building on recent investments by EPSRC into previous thermal energy networks and exploiting the benefit of utilising an established network and experienced management team who are currently running distinguished national and international events, workshops, conferences and special issues on the thermal energy theme.
2. Growing a "world-leading" UK based network in thermal energy to deliver across its themes by connecting all national and international stakeholders relevant to a net zero carbon heating and cooling future for residential, business and industry sectors.
3. Bringing together technology developers, end users, social scientists and policy-makers: a net zero carbon heating and cooling future will only be realised if rapid progress can be achieved through properly managed decarbonation strategies taking account of engineering pursuit, cost, infrastructure requirements, finance, public acceptance, behavioural change etc. A variety of stakeholders will be engaged in a series of events e.g. meetings, workshops, secondments, studies, public engagement events etc.
4. Address specific cross-cutting challenges via research: the key research opportunities and policy interventions for deployment from a whole systems' perspective will be identified, leading to the development of technology roadmaps.
5. Expedite the development of the state-of-the-art and create opportunities: targeted calls in relevant areas will be issued via feasibility fund for research, secondments and travel bursaries to stimulate research development, innovation translation and capacity/skill enhancement among Early Career Researchers (ECRs)

Building on EPSRC investment

During 2022/23, Network H+C has organised 23 events, funded 6 research projects and brought together over 450 people, from 280 organisations including 37 Universities and 28 overseas organisations.

We have endeavoured to create events and conversations that bring together researchers across all 22 of the EPSRC Decarbonisation of Heat projects, with many researchers attending our events and providing online presentations on their projects. New relationships have been nurtured and future funding opportunities disseminated via our email, twitter and LinkedIn accounts.

Our in-person events have brought together people from academia, industry and policy and have led to relationships, ideas and proposals for future working, as well as established Networks within areas of interest such as Heat Pumps and Thermal energy storage.

Feedback from our events has been overwhelmingly positive, particularly around the opportunity to meet in person, following 2.5 years of online interaction.

“Great to see people” “I learnt a lot” “I now feel as though I have joined a community” “Thank you for the opportunity”

All of our webinars have been edited and uploaded to the Durham Energy Institute YouTube [\(1\)](#) [Durham Energy Institute - YouTube](#), the launch of the EERA White Paper on Industrial Thermal Energy Storage has now been watched 175 times.

Growing a world leading Network

Our Network has achieved global reach and welcomed speakers from across Europe in 2023. We hope to build on this over the next year to establish a European Network of interested practitioners and researchers.



In August 2023 we organised a **Summer School**, welcoming 30 Early Career and PhD students to Durham for 2.5 days of lectures and activities covering all 5 themes of the Network.

The Students came from 12 Universities including Cardiff, Surrey, Birmingham, Newcastle, York and Warwick and the Network agreed to cover the travel costs for those who did not have access to other funds. We were also delighted to work with [C-DICE](#) to support attendance from students within their own Networks.

Feedback included "*Beyond the knowledge, the event was a fantastic platform for fostering connections, sparking discussions, and collaboratively envisioning the path ahead. Grateful for the opportunity to engage with fellow thought leaders and looking forward to more such enlightening experiences*".

In September 2023 we held our **Annual Conference** in London at The Institute of Physics.

This was the first time that we were able to organise the conference as an in-person event and it was great to meet the researchers from all 22 of the Decarbonisation of Heat programme projects and listen to the updates from their projects. The full list of projects included within the programme is appended at the end of this report. Many projects have sought an extension to their original end dates in order to manage delays caused by Covid, amongst other impacts.

During the Conference we also discussed the future use of our flexible funding within the Network grant and will be taking these suggestions forwards in 2024.



Bringing together stakeholders to identify research and innovation gaps

Over the past year we have organised three Workshops to explore heat pump and hydrogen research and research gaps.

Heat pumps are a key decarbonisation technology and the leading instrument to decarbonise domestic heating. The uptake of heat pumps has fallen far below UK Government targets, these workshops were organised to engage with stakeholders to explore the research and demonstration projects to date and to understand how heat pump flexibility could be used to manage future demand.

25th January 2023 - Heat Pump Trial Workshop, Birmingham with ES Catapult

This was the first in-person event organised by the Network, jointly with the Energy Systems Catapult. The Workshop was led by Network Co-I, Dr Tina Fawcett of Oxford University, and welcomed 60 attendees from industry, policy and academia to share experience of residential heat pump trials. The reports from the Workshop can be found here: [Residential Heat Pump Case Studies | Net Zero Research Network \(net-zero-research.co.uk\)](#)

Feedback from attendees was overwhelmingly positive, as, for most this was the first in person event for 2 years. The workshop successfully gathered information on all research projects to date, and produced a summary of the research gaps identified.

14th June 2023 – Heat Pump Flexibility Workshop, Westminster, joint with CREDS

Organised jointly with CREDS and UCL, this workshop invited 50 experts representing heat pump manufacturers, electricity distribution and transmission, energy suppliers, trade associations, government, consultancy and academia contributed to a day of discussion aiming to answer the following question:

In 2035 we plan to have a decarbonised electricity system, which will require demand flexibility to keep system costs down. **What will be the role of heat pumps** in providing that flexibility?

The Outputs from the workshop can be found here: [Heat Pump Flexibility Findings](#)

21st September 2023 – Technical and socio-economical aspects of hydrogen transition Workshop, Institute of Physics

In September we met to discuss the technical and socio-economical aspects of the hydrogen transition commencing with presentations from Professor Andrei Lipnatiev of Chalmers and Professor Simone Hochgreb of Cambridge University describing the outcomes of their research in Hydrogen combustion, we progressed the discussion with presentations from David Parker of Vaillant, Professor Joe Howe of Lincoln University, Keith Howell from DESNZ and Dr Stuart Hawksworth from the Health and Safety Executive.

The afternoon sessions discussed the research and innovation gaps in exploiting hydrogen for heating, with the main conclusions settling around the need for more and larger demonstration projects.

Address Cross Cutting Challenges

The Network benefits from Co-Investigators from Heriot-Watt, Leeds, Brunel, Oxford and Northumbria Universities, all of whom champion themes within the Network and provide a large network of industry contacts and insight. Our Co-Is meet bi-monthly to agree the Network plan of activities, report on opportunities and review the Network budget.

The Network benefits from an Advisory Board including representatives from across the industry. The Board membership is represented by; Energy Systems Catapult, Department for Energy Security and Net Zero, the Committee on Climate Change, EoN Energy, Arup, UCL, Imperial College and EPSRC. The Board meets 3 times per year to review progress on Network activities, update on relevant activity from within their sector and to provide contacts and resources to support Network activity. The support of the Advisory Board has been invaluable over this year.

Feasibility Funding Opportunities

The Network funding included an allocation of £400,000 for research idea development, especially targeting Early Career Researchers.

A Workshop was held in Leeds on the 1st November 2022, to bring together interested parties to pitch a project idea for feasibility funding. The workshop was attended by 40 researchers from across the UK, with 20 researchers invited to pitch their project idea, which was then voted on to identify the top 6 ideas to develop.

Each of the 6 projects was then required to identify at least one researcher from a different Institution and with whom they had not previously worked to develop their idea. The final proposed project were then developed and submitted for funding approval in December 2022, with most commencing from January and completing within 6-9 months.

The projects funded were as follows.

Award 2: *Distributed green hydrogen for building heating and cooling decarbonisation using circular economy and AI control*

- Led by Dr Lu Xing, Northumbria University

Award 3: Whole-life heat decarbonisation of existing campus building

- Led by Dr Julio Bros-Williamson, University of Edinburgh

Award 4: Solid-solid phase change materials for thermal energy storage applications

- Led by Dr Sumit Konar, University of Lincoln

Award 5: Pump Priming

- Led by Dr Jake Barnes, University of Oxford

Award 6: Increasing urban overheating risk from colling decarbonisation by heat pumps

- Led by Prof Vincent Luo, Cardiff University

Award 7: Impact of REMA on the electrification of heat

- Led by Dr Andrew Lyden, University of Edinburgh

Each project was funded to @£40,000 with a 20% contribution being required from the participating Universities.

The projects completed over Summer 2023 and the final reports can be found on the Net Zero Research website here: [Funded EPSRC Projects | Net Zero Research Network \(net-zero-research.co.uk\)](https://net-zero-research.co.uk)

In addition all of the project leads were required to present their project and findings at a Network H+C webinar. The recordings of these can be found here : [Webinars | Net Zero Research Network \(net-zero-research.co.uk\)](https://net-zero-research.co.uk)



40 people attended the Sandpit event



24 of the cohort are part of 1 of the 6 project teams, either as a PI or Co-I, 18 of which are ECRs and all 5 females are involved



The 24 researchers come from 15 different institutions

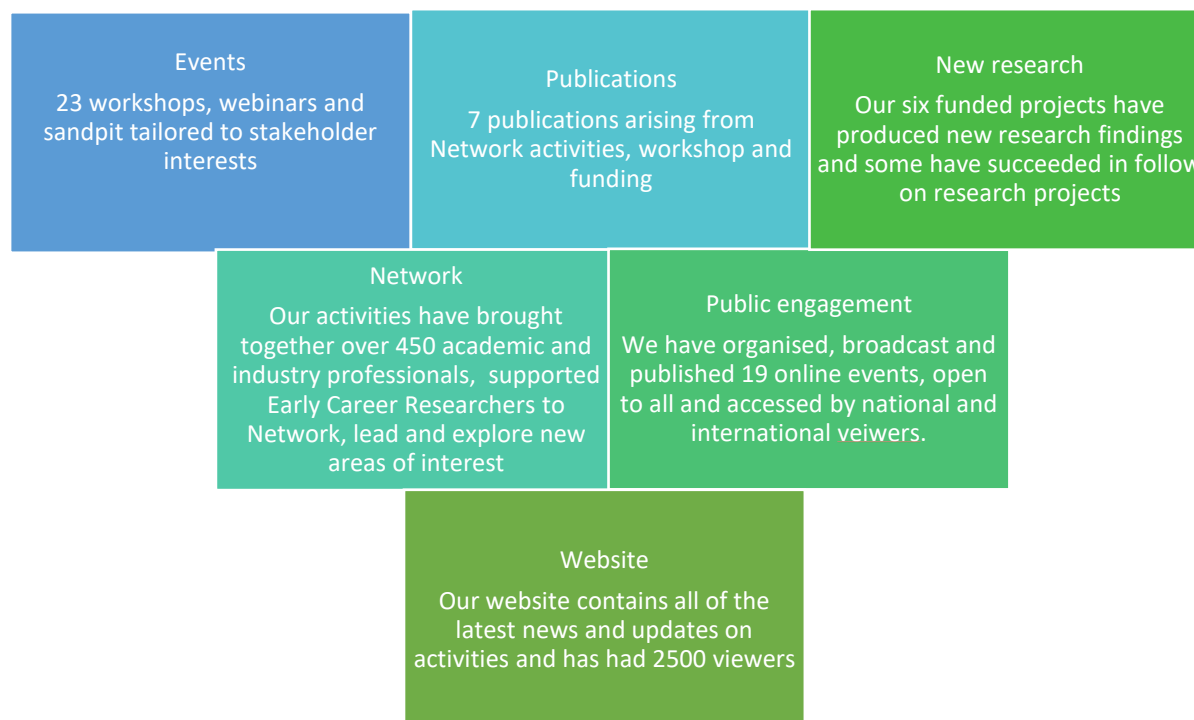
(University of Edinburgh, University of Durham, Cardiff University, University of Surrey, Northumbria University, Loughborough University, University of Birmingham, Plymouth University, Cranfield University, Oxford Brookes University, University of Exeter, University of Bristol, Keele University, University of Lincoln and University of Oxford)

Our Network has achieved international reach and welcomed speakers and audience from across Europe in 2023. We hope to build on this over the next year to establish a European Network of interested practitioners and researchers.

Impact

Network H+C aims to bring together academics and practitioners to share knowledge, develop relationships, identify research and innovation gaps and to support career and knowledge development, particularly for those in early career.

During 2022/2023 we have supported:



Publications

Over the past year Network activities have produced the following publications:



“Industrial Thermal Energy Storage, supporting the transition to decarbonise industry” [Energy Efficiency in Industrial Processes - News & Resources \(eera-eeip.eu\)](#) – Written by; Professor Tony Roskilly, Dr Zhiwei Ma, Durham University et al, December 2022 “Heat Pump Trial Workshop Report” Dr Tina Fawcett, Oxford Environmental Change Institute, February 2023

“A decision-support framework for residential heating decarbonisation policy making” [A decision-support framework for residential heating decarbonisation policymaking - ScienceDirect](#), - Dr Lirong Liu, Dr Mona Chitnis, Dr Michael Short, Professor Matthew Leach et al, University of Surrey, April 2023

“Domestic heat pumps: A rapid assessment of an emerging UK market” ([PDF](#)) [Domestic heat pumps: A rapid assessment of an emerging UK market \(researchgate.net\)](#) [committees.parliament.uk/writtenevidence/123747/pdf/](#) - Dr Jake Barnes, University of Oxford, Dr Taru Silvonen, University of Bristol and Dr Michael Taylor, Cardiff University, June 2023

“Summary of findings from heat pump flexibility expert workshop” Dr Jenny Crawley, University College London, July 2023

“Written evidence submitted by Prof Peter Connor, University of Exeter, and Dr Andrew Lyden, University of Edinburgh” Call of evidence “Heating our Homes” [committees.parliament.uk/writtenevidence/123747/pdf/](#), August 2023

Presented “Whole-Life heat decarbonisation of existing campus buildings” at the ICARB Conference [ICARB 2023 Conference | ICARB](#), Edinburgh, September 2023

“No courage at the heart of Government’: What are the most important changes needed to accelerate heat pump deployment in the UK?” ([PDF](#)) [‘No Courage at the Heart of Government’: What are the Most Important Changes Needed to Accelerate Heat Pump Deployment in the UK? \(researchgate.net\)](#), Dr Jake Barnes, University of Oxford, Dr Taru Silvonen, University of Bristol, Dr Mike Taylor, University of Cardiff, September 2023

Budget 22/23

TOTAL NON-STAFF BUDGET

BUDGET 22/23	Spent	Remaining
Flexible Funding	299763	58,700
Events	23,800	64,000
Secondments	0	0
Travel Bursary	1435	10810
Communications	2725.07	24000
Consumables	980.07	49000
TOTAL	£328,703.10	£206,510

Note that 22/23 was the first year in which we have been able to organise in-person events, hence the remaining budget at the end of 2023.

Equality Diversity and Inclusion

The Network+ aims to consider accessibility and inclusion in all of its activities. The sector is traditionally very male centric and there is only one Female PI within the 22 Network+ programme. Throughout this year we have aimed to achieve at least 50% representation of female speakers at our events and an improved gender ratio of attendance at all of our events. We have organised events specifically to support the career progression of Early Career Researchers and have aimed to distribute funding equally across genders within this group.

80% of our events have been online, supporting accessibility to knowledge, discussion and engagement.

Our registration and participation details show that we have



Activities

Within the year 22/23 we have delivered 19 online events;

Webinars:

28th October 2022

Community Scale Energy Demand Reduction in India – Professor David Jenkins, Herriot-Watt University

Dispatchable Air Conditioning in Indian Homes – Dr Andrew Peacock, Herriot-Watt University

2nd December 2022

Low Carbon climate-responsive buildings – Dr Jesus Lizana, Oxford Martin School, Future of Cooling Programme

Towards a Circular Economy for Cooling – Dr Giovanni Palafox-Fox, Future of Cooling Programme

13th December 2022

Launch of EERA JP EEIP White Paper “Industrial Thermal Energy Storage”

27th January 2023

Balanced Heating and Cooling Networks – Modelling and Simulation – Dr Michael Taylor and Dr Wu Gao, Cardiff University

Opportunities and costs for shared ground heat exchange – Dr David Barns, Leeds University

24th February 2023

Residential Heat and an energy system service “LATENT” – Professor Patrick James, University of Southampton

Advanced Seasonal Thermal Energy using thermochemical compression technology for domestic space heating applications – Dr Saleh Meibodi, Durham University

24th March 2023

Modelling Building, national and global heating & cooling with Demand.ninja – Dr Iain Staffell, Imperial College London

The Electrification of Heat – Dr Matthew Aylott, Department for Energy Security & Netzero

28th April 2023

The Four Generations of District Cooling – Professor Poul Ostergaard, Aalborg University, Denmark

Deliberating disruption: public perceptions of low carbon heating technologies and infrastructure –
Dr Gareth Thomas, Cardiff University

26th May 2023

NetZero GeoRDIE – Professor David Manning, Newcastle University

Modelling Analysis of a Thermochemical Energy Storage Reactor – Yong Zhang, Nottingham
University

28th July 2023

Solid-solid phase change materials for thermal energy storage – Dr Sumit Konar, University of Lincoln

Public perceptions of Hydrogen – Professor Fiona Fylan, Leeds Sustainability Institute

29th September 2023

Distributed green hydrogen for building heating and cooling – Dr Lu Xing, Northumbria University

Pump Priming – Dr Jake Barnes, University of Oxford

The Next Year

This year has been an exploration of returning to face to face meetings, discussing what is important to the community and organising events and providing funding events to bring together people around those themes.

We have been grateful for the support of our Advisory Board and well as the Co-investigators across the Network who have been so generous with their time and expertise in forming and supporting the Network activities.

Over the next year we will be focussing on highlighting the outputs from the Decarbonising Heat programme projects, producing roadmaps and summaries of the emerging findings and organising events to bring focus to Heating and Cooling Challenges to 2050. We have one more round of flexible funding to distribute and time to gather opinions from the Heating and Cooling community on the most useful outputs from the Network over the next year.

We look forward to continuing to grow the Network and benefit all of those working within it.

Summary

2022/23 has been an active and exciting year for the Network+ in which we have worked with projects and Network partners to identify areas of common interest around which to develop activities and events. Our events have been held at venues around the country to attract a diverse audience and we have engaged with an increasing number of academics and industry stakeholders. Outputs from these activities have shaped the future events of the Network+ and we look forward to engaging with all areas of the Heating and Cooling industry over the extended period of project.

Dr Andy Smallbone

Principal Investigator – EP/T022906/1 “Network+ Decarbonisation of Heating and Cooling”

APPENDIX - Decarbonising Heat Programme projects

<u>ROUND 1</u>	DURATION
<u>DELTA-PHI</u> Led by Professor Philip Eames of Loughborough University	1/10/20 – 30/9/24
GREEN-ICEs – Led by Professor Yongliang Li of University of Birmingham	1/9/20-31/08/24
H2-Heat – Led By Professor Yunting Ge of London South Bank University	01/21-12/24
HUMAN – led by Professor Lazaros Papageorgiou of University College London	1/4/21-31/3/25
Integrated CHP networks for prosumers – led by Professor Meysam Qadrdan of Cardiff University	1/4/21-31/3/25
INTEGRATE – led by Professor Daniel Friedrich of University of Edinburgh	1/10/20-30/9/24
LATENT – LED BY Professor Patrick James of University of Southampton	1/10/20-30/9/24
NEUPA – LED BY Professor Robert Gross of Imperial College London	1/7/20-31/1/24
Net Zero GeoRDIE – led by Professor David Manning of Newcastle University	1/10/20-30/9/24
Solar S&HP – led by Dr Zhiwei Ma, of Durham University	1/10/20-30/9/24
ThermoStore – led by Professor Yuehong Su of Nottingham University	1/9/20-29/2/24
Zero Carbon ICHP – led by Professor Tony Roskilly of Durham University	1/7/21-31/3/25
Network H+C – led by Dr Andrew Smallbone of Durham University	1/10/20-30/9/24

<u>ROUND 2</u>	DURATION
ATESHAC – led by Professor Matthew Jackson of Imperial College London	1/11/21-31/10/24
Barocaloric materials for zero-carbon heat pumps – led by Dr Xavier Moya of University of Cambridge	1/1/22-31/12/24
DISPATCH – led by Professor Sasa Djokic from the University of Edinburgh	1/10/21-30/9/24
FASHION – led by Professor Zhibin Yu of University of Glasgow	1/9/21-31/8/24
Flex-Cool-Store – led by Professor Carlos Ugalde-Loo of Cardiff University	9/21-9/24
GEMS – led by Professor Jeroen Van Hunen of Durham University	1/9/21-31/8/24
H2COOL – led by Dr Sanliang Ling of Nottingham University	1/9/21-31/8/24
HARVEST led by Professor Yongliang Li of University of Birmingham	1/10/21-31/3/25
SaFEGround – led by Dr David Taborda of Imperial College London	1/9/21-31/8/24
VTTESS – led by Professor Jo Darkwa of University of Nottingham	1/7/21-30/6/24
ZECC – led by Professor Toby Peters of Birmingham University	1/6/21-31/5/25