IOR Annual Conference - The Journey to Net Zero Heating and Cooling - Beyond Refrigeration 2021

Programme with Abstracts.

Time	Day 1: 21st April 2021
8.40-10.25	**Session 1 – Opening sessions Working Together** ***Running in Go to Webinar*** Chair: Robert Lamb **Keynotes Presentations** **8.40** - Welcome and essential conference information - What you need to know to make the most of the conference. **8.50** - Why Net Zero is important. Rob Lamb, Conference Chair **9.00** - Strengthening the RACHP Sector and Supporting UN Sustainable Development Goals Through Refrigerant Transition. Jim Curlin, UNEP **9.30** - A Global Perspective on Sustainability Goals for the RACHP Sector. Didier Coulomb, International Institute of Refrigeration **Working Together and Making Use of Best Available Technology** **9.45** - The Climate Change Agreement for Cold Stores: An industry working together to improve energy efficiency. Tom Southall, Cold Chain Federation **10.05** - Towards a Net Zero Food Cold Chain. Judith Evans, London South Bank University
10.30-11.30	**Coffee Lounge Discussion Session: Beyond Net Zero Refrigeration** ***Running in Zoom*** Co-hosted by: Graeme Maidment Chair of IOR Beyond Refrigeration Committee, Nick Franzen of Refrigeration Advisory Service, James Bailey of Wave Refrigeration
11.35- 12.55	**SESSION 2 - Achieving Best System Performance and Combining/Balancing Heating and Cooling Demand.** ***Running in Go to Webinar*** Chaired by Judith Evans **11.35** –Predictive Maintenance Based on Performance Analysis using System Efficiency Index and Sub Efficiencies is the future. Klas Berglöf, ClimaCheck **11.55** - Energy Saving at Coldstore Doorways by Means of Specialist Air Curtains. Martin Craxton, Craxton Solutions **12.15** - Efficient Cooling at the Heart of Low-carbon Electrified Heat. John Hayes, Erda Energy **12.35 -** Meeting Industry's Increasing Sustainability Demands by Utilising Water as a Refrigerant. Garry Broadbent, Pure Thermal
12.55-13.10	**Comfort break**
13.10-14.10	**Lunch Lounge Discussion Session – Transitioning to low GWP refrigerants – a panel debate.** ***Running in Zoom*** Co-hosted by: Andy Pearson, Star Refrigeration, Mark Hughes, Chemours, Alex Cohr Pachai, Johnson Controls, Daniel Colbourne, Re-Phridge, Monika Witt, Eurammon
14.15-15.45	**SESSION 3 - Using Energy Intelligently and Reducing the Need for Mechanical Cooling** ***Running in Go to Webinar*** Chaired by Dermot Cotter. **14.15** - **Keynote Presentation** How Can We Reduce The Demand For Energy? Ian Arbon, Engineered Solutions **14.45** - How to Reduce the Cooling Demand in Office Buildings and Match the Machinery to Heat Pump Design Demand. Gert Nielsen, Xrgy As **15.05** - River Source Heat Pumps for Residential and Commercial Heat Networks – a Case Study. Andy Pearson, Star Refrigeration **15.25** - Booster Heat Pumps for Space Heating, Hot Water Heating and Process Heating from Geothermal Energy. Neil Hewitt, Ulster University

15.50-16.45	**Coffee Lounge – How to improve the net Energy in cities.** ***Running in Zoom*** Co-hosted by: David Pearson of Star Renewable Energy and Andy Deacon of the Global Covenant of Mayors, Akos Revesz of London South Bank University and Zafer Ure of PCM Ltd
16.50 -17.30	**SESSION 4- Making use of Best Available Technology** ***Running in Go to Webinar*** Chaired by Robert Lamb **16.50 –** New R744 102m^3/h transcritical compressor: Improving CO_2 presence into large cooling and heating systems. Mauro Bonfanti, Officine Mario Dorin SpA **17.10** - A Heat Recovery System for a Passive Ventilation Wind Tower. Daniel Marshall Cross, Free Running Buildings **17.30** – Close of Day - Where do we go from here? Rob Lamb Conference Chair

Time	**Day 2: 22nd April 2021**
Short courses and Workshops **Running in Zoom**	
9.30-11.00	Short course: Improving skills in handling flammable refrigerants. Course leaders: Marco Buoni and Marino Bassi of REAL Alternatives
11.30-13.00	Workshop: Learning how to measure impact with environmental, legislative and regulative auditing. Workshop leader: David Blackhurst, Star Technical Services
14.00-15.30	Workshop: Developing the best people and skills – Where are the training gaps? How do we fill them? Workshop leaders: John Skelton, IOR Education Committee, Graeme Fox, BESA Training, and Graham Wright, Heat Pump Association

ABSTRACTS

Session 1 **Opening session: Keynotes/ Working Together/Making Use of Best Available Technology** **8.40-10.25**	
Paper ID	Session details with abstracts
Welcome	**8.40-8.50** **Essential conference information:** What you need to know to make the most the conference. Information about accessing the on-demand content, asking questions, troubleshooting sound issues and more.
Welcome	**8.50-9.00** **Why Net Zero is important. Robert Lamb, Conference Chair**
Keynote	**9.00-9.30** **Strengthening the RACHP Sector and Supporting UN Sustainable Development Goals (SDG) Through Refrigerant Transition. Jim Curlin, UNEP** The global transition from ozone depleting potential (ODP) and high global warming potential (GWP) refrigerants as triggered by the Montreal Protocol, and its amendments, over the last the three decades affected significantly not only types of alternative refrigerants but also types of RACHP technologies that are/should deployed in markets. The linkage to SDGs, placing into market policies and practice regulatory measures are crucial elements in building an overarching framework that can strengthen the sector through best and sound practices during the life-cycle of RACHP applications.
Keynote	**9.30-9.45** **A Global Perspective on Sustainability Goals for the RACHP Sector. Didier Coulomb, International Institute of Refrigeration**

	This presentation will examine the various aspects of the Sustainable Development Goals adapted to the refrigeration sector. The presentation will include an overview of the International Institute of Refrigeration's research on the carbon impact of the food cold chain.
1	**9.45-10.05** **The Climate Change Agreement for Cold Stores: An Industry Working Together to Improve Energy Efficiency. Tom Southall, Cold Chain Federation** The Climate Change Agreements were established in 2003, in response to the introduction of Climate Change Levy as a means to reduce industrial energy and contribute to the UKs commitments under the Kyoto Agreement. The scheme offers energy intensive industries significant discounts on their Levy if they agree to targets for improving their energy efficiency. For cold storage, performance is overseen by the Cold Chain Federation. Cold stores have consistently met the efficiency targets of the scheme and in the process have saved over £10m a year. The Federation has been instrumental in helping the sector to work together to achieve its targets through strong administrative and technical support. The Scheme, recently extended until 2025, is popular with both industry and Government and a recent evaluation found they provide value for the economy and the taxpayer, promote energy efficiency and protect the competitiveness of UK business.
2	**10.05-10.25** **Towards a Net Zero Food Cold Chain. Judith Evans, London South Bank University and Toby Peters, University of Birmingham** 2020 was the year that the importance of the food cold-chain in society became more visible. Its key role in the continuous supply of food was highlighted during the Covid-19 lockdown and the Brexit transition. Globally, a lack of adequate cold-chains is responsible for about a quarter of food losses in emerging economies, impacting rural incomes and food security. Both in the UK and globally, significant challenges exist for cold-chain operators to both ensure resilience and seamless operation, while enabling the sector to become net-zero carbon by 2050. In the UK, more than 60% of our food is dependent on the cold-chain, and with high direct and indirect emissions, food refrigeration alone is estimated to be responsible for up to 4% of the UK's total greenhouse gas (GHG) emissions.

SESSION 2 **Achieving Best System Performance and Combining/Balancing Heating and Cooling Demand.** **11.35-12.55**	
Paper ID	Session details with abstracts
3	**11.35-11.55** **Predictive Maintenance based on Performance Analysis using System Efficiency Index and Sub-Efficiencies is the future. Klas Berglöf, ClimaCheck** HVACR equipment uses 20% of global electricity, whilst the pressure to reduce energy consumption and peak power demand is ever-increasing. The focus on efficiency has targeted product standards and ratings whereas the importance of commissioning and maintenance has been neglected. Effective methods to document field performance is a critical pre-requisite to improve operating efficiency and reliability. COP and Seasonal Performance Factor (SPF) values that change by 2-5% for each degree of operating conditions are wholly impractical to benchmark water chillers, heat pumps and refrigeration systems (RACHP- systems). The increasing number of sensors within equipment and the "Internet of Things" (IoT) opens up good opportunities for predictive maintenance through automated analysis. Experience is built on a large number of systems to facilitate predictive maintenance and optimisation of many plants. Thermodynamic analysis to establish System Efficiency Index (SEI), and Sub-Efficiencies for the compressor, condenser and evaporator offer powerful KPIs. This paper presents the experience gained from the use of SEI and Sub-Efficiencies in predictive maintenance and efficiency optimisation.
4	**11.55-12.15**

	Energy Saving at Coldstore Doorways by Means of Specialist Air Curtains. Martin Craxton, Craxton Solutions Energy analysis reveals that the Air Change Load at doorways has a large impact on overall refrigeration heat loads. Air Change reduction be achieved by a variety of means but at open doorways, air separation technology, a derivative of air curtains, comes into play. Air separation technology is introduced and explained. At sub-zero cold store entrances, demisting is one of the components of the technology described. This requires heat input and occurs within the cold side of a cold store doorway. This may sound counter intuitive. If available, waste heat of refrigeration can be employed in the demisting process thereby cutting running costs of the air separation installation. Applications in the cold chain are described. Case studies will demonstrate its effectiveness.
5	**12.15-12.35** **Efficient Cooling at the Heart of Low-Carbon Electrified Heat. John Hayes and K Stickney, Erda Energy** A decade of amalgamating the refrigeration, heating and the earth in food retail proves highly efficient and credible zero carbon pathway. 5th Generation Energy (heat) networks must apply the principles learnt – putting cooling at the heart of efficient heating, a focus on the optimisation of all connected energy sources and sinks across many buildings rather than capturing "waste". Air and the earth are key tools in an holistic balancing strategy. This paper explores these principles to discuss: • 10 years proven operation across multiple installations. • Promoting added benefits of cooling to human comfort – without added cost. • Improving cooling-system reliability • Benefits of continuous energy monitoring, application of machine learning and AI. • Intelligent use of electrical and thermal energy storage - time-shifting energy use and optimisation for electrical grids. • Improved efficiency – 40%+ lower electrical energy on food retail refrigeration, 80%+ less heating energy • Efficient cooling at the heart of low-carbon electrified heat
6	**12.35-12.55** **Meeting Industry's Increasing Sustainability Demands by Using Water as a Refrigerant. Garry Broadbent, Pure Thermal, Peter Kaden, Efficient Energy** German company Efficient Energy has developed a unique and innovative technology – a water Chiller that utilises water (R718) as its refrigerant. A paper detailing the technology was delivered to the Institute back in 2015 when the chiller was in the final stages of development and a lot has happened since then. Over the last 5 years the technology has moved through the development stage and has now built a solid customer portfolio with scaled production and growing demand. Clearly the drivers in the market have changed somewhat since 2015 and we now see a real intent across various sectors to reduce energy costs and importantly also reduce carbon emissions. As a result of this sustainable focus a chiller using water as the refrigerant can provide real benefits to the user. This paper is intended to provide a 2021 update showing how R718 is now a practical proven method of delivering higher flow temperature cooling.

SESSION 3 **Using Energy Intelligently and Reducing the Need for Mechanical Cooling** **14.15-15.45**	
Paper ID	Session details with abstracts
Keynote	**14.15-14.45** **How Can We Reduce The Demand for Energy. Ian Arbon, Engineered Solutions** When looking at how we move to 'Net Zero' GHG emissions, we often focus on how to improve cycle or system efficiency, make better use of monitoring/data, use alternative technologies and provide better training to the industry. All play their part in the journey but we often overlook why we need to use the energy in the first place and whether this can be reduced or in some cases eliminated. The Energy Hierarchy, developed back in 2009 and republished by

	IMechE in 2020, provides a refreshing approach to tackling the challenge of 'net zero' by putting energy demand reduction at the top of the list of things to consider when developing a sustainable energy policy for the future. It highlights the need to challenge why we use the energy in the first place and how we can reduce or even eliminate demand. The benefits of doing this are far greater than the incremental improvements that can be made in efficiency and a kWh saved is more valuable than a kWh supplied when trying to meet the 'net zero' goal; the impact is also immediate and not something confined to future development. This is true for the HVACR industry where demand is often in response to existing working practices and is applied without any challenge to improving the process or in some cases eliminating it altogether
7	**14.45-15.05** **How to Reduce the Cooling Demand in Office Buildings and Match the Machinery to Heat Pump Design Demand. Gert Nielsen, Xrgy As** The most efficient cooling is cooling not needed. By applying a combination of cooling recuperation in AHUs, indirect evaporative cooling, indoor temperature set point glide depending on ambient temperature the demand for mechanical cooling can be reduced by app. 50%. By combining this with thermal energy storage the necessary machinery could be further reduced, and thereby give a better match for the design performance, when the cooling machinery is used as a heat pump**.**
8	**15.05-15.25** **River Source Heat Pumps for Residential and Commercial Heat Networks – a Case Study. Andy Pearson, Star Refrigeration** The decarbonisation of our use of energy in all its forms requires a radical re-think of the way in which we provide heating to our homes and commercial buildings. River source heat pumps provide one part of the solution and are particularly suited to the geography and climate of the United Kingdom. This paper presents one such project, the development at Queens Quay in Clydebank, Scotland, as a case study of current technology in this sector. The paper describes the technical challenges in engineering a river source system, outlines the solution adopted and gives an overview of actual performance since commissioning. The paper concludes with a review of obstacles to the widespread adoption of this technology which need to be addressed if the targets of the UK government commitments are to be achieved.
9	**15.25-15.45** **Booster Heat Pumps for Space Heating, Hot Water Heating and Process Heating from Geothermal Energy. Neil Hewitt, Mingjun Huang, Nik Shah, Ulster University** This paper addresses the use of shallow to deep geothermal energy in Northern Ireland for space heating, process heating and power generation. It considers the temperatures of potential sources of heat and the technical, social, economic and institutional barriers that must be overcome in order to deploy this significant heat resource in Northern Ireland. The role of advanced heat pumps, the development of heat networks and the potential efficiency and environment gains are noted through using elevated temperatures as a heat source for heat pumps. For space heating, R410a alternatives e.g. mixtures using R160 are assessed for ground source heat pumps. For industrial processes such as Northern Ireland's Dairy industry, the performance of booster heat pumps is presented that utilise new working fluids, such as R1233zd(E). A similar working fluid is utilised for lower temperature Organic Rankine Cycles and the performance of such a machine is noted. A summary of likely heat network techno-economic challenges is given alongside the benefits of higher efficiency and reduced carbon emissions that the use of geothermal heat can give.

SESSION 4 **Making use of Best Available Technology** **16.50 -17.30**	
Paper ID	Session details with abstracts
10	**16.50-17.10**

	New R744 102m^3/h transcritical compressor: Improving CO_2 presence into large cooling and heating systems. M. Bonfanti, M. Dallai, F. Faralli, Officine Mario Dorin SpA Dorin CD Range of compressors for R744 transcritical and subcritical applications are well known for efficiency, environmental friendliness and long term reliability. The introduction of the CD600 range was the result of over 30 years of experience in R744 transcritical compression technology, earning Dorin the 2021 AHR Expo Innovation Awards. The new range features unique technical solutions; the new compressor operates on 6 cylinders and boasts a 100/150 bar standstill pressure platform with max motor nominal power of 180 hp and 102.4 m^3/h displacement at 50 Hz. The innovative design and materials allow for discharge temperatures up to 160°C, the use of both PAG or POE oils (subject to system design), and a generous application envelope with extended pressure ratios. Use of this new platform pairs the environmental benefits of using CO_2, a natural refrigerant, with a reduction in the number of compressors required to run larger systems.
11	**17.10-17.30** **A Heat Recovery System for a Passive Ventilation Wind Tower. Daniel Marshall Cross, Free Running Buildings** Wind towers provide passive building ventilation, where natural air flows generate air exchange between the building and outside environment. The harnessing of natural air flows results in zero energy input for ventilation. A drawback of such an approach is that there is no control over the air drawn into the building. If the air is cold, then building users may feel increased discomfort. Heated air drawn out of the building represents a loss and an energy demand. To increase building comfort and reduce energy demand a heat recovery system was investigated to transfer heat from the air leaving the building to the air entering. A series of full-scale tests were carried out in a wind tunnel at the BRE, with liquid-vapour heat pipes used for heat recovery between the two air streams. The results show that system is effective at recovering heat from one stream to the other.

Find out more about the IOR's ongoing Beyond Refrigeration net zero programme and how you can contribute or download more resources at www.ior.org.uk/beyondrefrigeration