



## FACILITY PRODUCT DEPLOYMENT

FACILITY INFRASTRUCTURE PRODUCTS THAT SIGNIFICANTLY IMPROVE DATA CENTER ENERGY AND/OR RESOURCE EFFICIENCY, AS DEMONSTRATED IN A USER DEPLOYMENT

# UNIVERSITY OF LEEDS SAVES ENERGY BY INSTALLING ICEOTOPE/3M LIQUID-COOLED SERVERS

UNIVERSITY OF LEEDS, ICEOTOPE, AND 3M COMPANY

**PROJECT TEAM:** Alan Real, Jon Summers, Nik Kapur, Yon Quiang Chi, Harvey Thompson (University of Leeds); Peter Hopton, Keith Deakin, Nick Evans, April Saunders, Richard Barrington (Iceotope); Mark Nursall, Adrian Hyner, Peter Hobson, Phil Tuma, Il Ji Kim (3M Company)

The University of Leeds has installed the first production model of a liquid-cooled server system developed by UK start-up Iceotope and engineering technologies specialist 3M Company. The organizations claim the technology could cut data center cooling-related energy costs as well as capital costs dramatically.



**UNIVERSITY OF LEEDS**



### STRATEGIC VISION AND BUSINESS DRIVERS

The University of Leeds, in the north of the UK, is a large user of High Performance Computing (HPC) for its research and currently is listed in the Top500 Supercomputer Sites. HPC is used to investigate some of the world's most complex problems, including climate change. But HPC systems also consume large amounts of energy, so a team of researchers led by Dr. Jon Summers from the University of Leeds' School of Mechanical Engineering worked with UK start-up Iceotope to explore ways to reduce the carbon and energy footprint of compute systems.

### TECHNOLOGY

Iceotope's technology is based around an extreme version of liquid cooling that involves immersing server motherboards directly into a highly convective coolant. Other versions of liquid cooling use liquid cool plates to conduct heat away from server components rather than bringing the electronics into direct contact with the liquid. However, Iceotope maintains that its immersion approach provides unparalleled levels of heat dissipation that couldn't be achieved by other means.

The motherboards (or motherboard blades, as Iceotope refers to them) are housed in a sealed server case (module) that also contains the liquid coolant Novec from engineering specialist 3M. Unlike the oils used by some rival products, Novec is highly convective — more than 20 times more convective than water — but crucially, nonflammable and not electrically conductive.

A number of these server modules (each of which contains the motherboard immersed in Novec) can be fitted into a Module Center. Up to six of these Module Centers can then be plugged into the Iceotope Platform — a standard 19-inch rack fitted with a water-cooling system (the Novec and water systems are completely separate). Heat is removed from the sealed Novec modules by water channels built into the outer casing. The inlet water passed through each module does not need to be artificially cooled (it warms the water by approximately 41°F [5°C]). Once the water passes through the server modules into the Iceotope Platform, it then passes through a heat exchanger. The outgoing hot water from the heat exchanger can then be discarded or used for building heating, as in the case of the Leeds deployment.

### PROJECT AT-A-GLANCE

- The University of Leeds cooperated with start-up Iceotope on the development of a liquid-cooled server system
- A silent, liquid-cooled server system replaced HPC servers
- The system requires no mechanical chillers or external air-based cooling
- Input water temperatures can be as high as 113°F (45°C)
- Can use 'gray water' sources to reduce the environmental impact of the servers

### PROJECT ACHIEVEMENTS

Energy consumption used in cooling reduced by more than 80%

The Iceotope system uses 80w of power to harvest the heat from up to 20kw of ICT

Project will influence a wider retrofit across the University, with a great number of clusters/servers eventually connected to the liquid cooling system

# UNIVERSITY OF LEEDS, ICEOTOPE, AND 3M COMPANY: UNIVERSITY OF LEEDS SAVES ENERGY BY INSTALLING ICEOTOPE/3M LIQUID-COOLED SERVERS

## DEPLOYMENT SUMMARY

The first Iceotope production system was installed in Leeds in early 2013 after two years of testing prototypes. The system, partly funded by the University's Digital Technologies Innovation Hub, has been installed in a large thermo-fluid mechanics laboratory within the School of Mechanical Engineering, where wind tunnels, engines, combustion, and refrigeration apparatus are in use.

The project was also designed to explore the possibilities of re-use of waste heat derived from IT systems. The Leeds installation uses a secondary hot water circuit to transfer the heat from the Iceotope server cabinet to the large open plan area to help heat the thermo-fluid mechanics laboratory. This heat transfer is achieved using a series of hot water radiators, a central heating pump and two pumps in the cabinet's primary hot water circuit.



The Iceotope system has a monitored power use of 2.3kW. Approximately 100W is required to reject the heat from the system into the laboratory via the radiators. If a similar air-cooled system were installed in Leeds' existing HPC data center it would require 885W of air-based cooling. This represents a more than 80% saving on cooling energy consumption, according to project organizers.

Another benefit of the Iceotope system is that it can take input water at temperatures of up to 113°F (45°C) and requires no specialized computer room air conditioning or mechanical chillers. Because the units are sealed, humidity, air pollution, and dust have little impact on the system; the system can also be placed in densely populated locations, because the lack of fans means the system is virtually silent. For example, the Leeds deployment is located in the middle of a busy research facility with several academic teams working in close proximity.

The University expects the efficiency gains demonstrated by the project will prompt a more extensive retrofit at the University, with a great number of clusters/servers eventually connected to the liquid cooling system. The Advanced Research Computing department has plans to deploy a similar system, and a PhD student will use the new system as part of their doctorate studies and will feed their analysis back into the project.

## ABOUT UNIVERSITY OF LEEDS

The University of Leeds was founded in 1904, but its origins go back to the nineteenth century with the founding of the Leeds School of Medicine in 1831 and then the Yorkshire College of Science in 1874. Today the University of Leeds' reputation worldwide makes it a truly multi-cultural and international institution with students and staff from over 100 countries studying and working on campus.

## ABOUT ICEOTOPE

Iceotope has been established to develop and deliver 'Full Time Free Cooling for ICT Anywhere.' We do this by combining Next Generation Liquid Cooling Technology, Industry Standard Products and our own I.P. Designed using Cradle to Cradle principles and carrying enhanced MTBF, this is the first truly sustainable and efficient solution to ICT cooling that scales. The Iceotope Elements to the solution are designed, engineered and manufactured in the UK.

## ABOUT 3M COMPANY

3M is a global innovation company that never stops inventing. Over the years, our innovations have improved daily life for hundreds of millions of people all over the world. We have made driving at night easier, made buildings safer, and made consumer electronics lighter, less energy-intensive and less harmful to the environment. We even helped put a man on the moon. Every day at 3M, one idea always leads to the next, igniting momentum to make progress possible around the world.

**Acknowledgements:** The information in this case brief was taken from the Green Enterprise IT Award-winning case study "University of Leeds Saves Energy by Installing Iceotope/3M Liquid-cooled Servers," presented by Dr. Jon Summers of the University of Leeds at Uptime Institute Symposium 2013 (May 13-16, 2013, Santa Clara, California). The organization descriptions are from their Internet sites.



Uptime Institute grants Green Enterprise IT Awards to projects, ideas and products that significantly improve energy productivity and resource use in IT.

The Awards are open to applicants in all countries. All applications are carefully judged by an international panel of independent experts in a double-blind review process. Award winners are honored at the Uptime Institute Symposium annually.

[symposium.uptimeinstitute.com](http://symposium.uptimeinstitute.com)

