



Elsham Tech Park Water Requirements Report

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Introduction

Background

Elsham Tech Park is a proposed AI data centre project located in North Lincolnshire. The design encompasses a 1GW IT load, distributed across eight data centre buildings. This site aims to address nationally strategic and significant demand driven by the rapid growth of Artificial Intelligence and Machine Learning.

Introduction to Future Tech

Founded in 1982 Future-tech has provided 100% data centre specific technical services to a broad variety of customers and facilities. These have included financial services, petrochemical, aerospace, research, pharma, media, NHS, central and regional government, higher education & Universities, real-estate investment and property, IT, MSP, telco and co-location.

Our teams have provided services across the EMEA and APAC regions in locations such as UK, Ireland, Finland, France, Switzerland, the Netherlands, Poland, Italy, Spain, Kazakhstan, Nigeria, Kenya, Uganda, South Africa, Bahrain, India, Malaysia and Thailand.

Future-tech is a specialist company, only working in data centre facilities. Our projects range from “crown jewel” high density and micro-edge environments, to multi-MW campuses. Over the last three years, Future-tech has been engaged on more than 3GW of data centre capacity. These engagements have been varied and included concept, developed and detailed design, peer review, cost analysis, technical and commercial due diligence, technology analysis, optimisation, post outage forensic engineering, co-location selection and operational consulting and supervision.

During these engagements, we have seen designers, developers, investors and operators make many of the same mistakes time and time again. In each instance, we have integrated with these teams, identified and helped rectify these mistakes, with the result of producing better designs, better infrastructure and ultimately better data centres.

This is one of the benefits of being a specialist organisation that is dedicated to data centre investment, design, construction and operations focussed services. Together with our own experiences, we have engaged with organisations such as the Uptime Institute, Royal Institute of British Architects, the Institute of Engineering & Technology, the British Standards Institute, the IEEE and the UK and European Data Centre Associations to gain further knowledge and insight.

Overview of Data Centre Cooling

All data centres require cooling systems to remove heat from servers and maintain appropriate temperatures within the space. Various methods exist for cooling data centres, and the ideal solution for each facility is determined based on a range of factors including its size (in terms of computing power), density, availability of physical space, required power efficiency, climate and availability of water.

Industry Examples

In the data centre industry, operators are increasingly working to minimise water usage through the adoption of new technologies.

Digital Realty has stated that their standard data centre designs have not incorporated cooling systems reliant on constant water use for over a decade. Additionally, 75% of their global portfolio, comprising more than 300 data centres, do not utilise water for cooling. Similarly, Equinix reported that, as of 2023, evaporative cooling is employed in only 40% of their data centres worldwide. CyrusOne has not only designed data centres to avoid reliance on water for cooling but has also developed a net positive water strategy.

Examples of operating facilities that avoid evaporative cooling include CyrusOne PAR1, a 27MW IT Load facility in Paris, France, which employs a closed-loop system, thereby achieving low Water Usage Effectiveness (WUE), and Digital Realty's LON1-3 facilities in London, UK, which utilise free cooling chillers.

The integration of new technologies that minimise water usage is becoming increasingly prevalent in modern data centre designs. This trend is particularly notable with the rise of AI infrastructure and High-Performance Computing, which necessitate advanced cooling strategies to support high-density server configurations. Immersion cooling and direct-to-chip technologies are being developed by leading industry players worldwide. Plans are underway for facilities as substantial as 1.2GW, such as Crusoe's deployment in Abilene, Texas, which will incorporate direct-to-chip liquid cooling through a zero-water evaporation system that continuously recirculates water within a closed-loop system.

The industry has also seen the introduction of initiatives such as the Climate Neutral Data Centre Pact (CNDCP) with many European operators, such as AWS and Google, committing to meeting WUE targets for both new and existing data centre developments.

“Dry” Data Centre Cooling

Elsham Tech Park has been designed with two data centre cooling systems, both of which use closed-loop cool water systems, with no net water usage. They are resultantly considered “dry” systems, with water only being required for the initial filling of the systems. This can be accomplished by using tankers or by filling the system in phases to minimise any effect on the local water network.

Air Cooling - Chilled Water System

The first system, known as a chilled water system, circulates cool water around the facility to cool the air in the data hall and electrical power rooms. The chilled water is pumped through coils in fan wall units and computer room air handling units (CRAHs) which use fans to draw warm air over a coil, cooling the air, before it is then distributed into the room. This cool air is then drawn into the servers in the data hall to prevent overheating. Air cooling maintains the temperature of the space at a comfortable level.

Heat from the servers that has been absorbed by the air-cooling system is rejected to the air using efficient free-cooling air cooled chillers. At favourable ambient conditions, the chillers can cool the warm water returning from the data hall using external air only. As the ambient temperature increases, refrigerant compressors are used to maintain the required cooling water temperature. This system has no net water usage.

The figure below shows an air-cooled chiller.

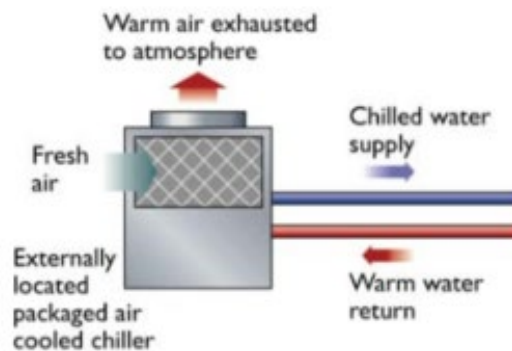


Figure 1 - an air-cooled chiller. Image reproduced from BSRIA Illustrated Guide to Mechanical Cooling BG1/2010

Server Cooling - Direct to Chip System

Elsham Tech Park will be fitted with high-performance, high-density servers that can utilise direct to chip cooling. This is a very efficient method of cooling as a fluid is circulated through the servers to cool them, rather than relying on high volumes of air. Direct to chip circuits can have higher temperature water than air cooling circuits and are therefore more efficient. However, an air-cooling system must be utilised alongside a direct to chip system to condition the air in the data hall (and other spaces) to comfortable temperatures.

Dry air coolers will be used to reject heat from the direct to chip system. These do not require the use of refrigerant or compressors and are therefore very energy efficient. The Humber area has relatively

low peak summer temperatures compared to much of Western Europe. Therefore, it is likely that for 99% of the year, using dry coolers alone will be sufficient for all the heat rejection from the direct to chip cooling system. This is dependent on the selected servers and the acceptable temperatures for them. For the remaining 1% of the year, chillers will be used to provide any additional cooling that is required. There is no additional water required for cooling, other than the initial filling of the closed system.

As shown in the sections above, there is no need to evaporate significant volumes of water to cool data centres. This is especially true given the favourable climate in the Humber area, where for 95% of the year, the ambient temperature is less than 21°C.

“Wet” Data Centre Cooling

An alternative option to air or dry cooling a data centre is to use water. There are two main methods of cooling using water: evaporative and adiabatic cooling. Both of these methods use less energy than dry systems, which has made them popular in the past.

Evaporative Cooling Systems

Evaporative cooling systems involve the use of cooling towers for heat rejection. Cooling water would be circulated around the facility within a closed system, as is the case for dry cooling systems, and cooled by a chiller. The heat would be rejected from the chiller to a cooling tower circuit. A cooling tower works by spraying the warm water over packing material within the tower, with cool air being drawn into the tower through fans to evaporate and cool the water.

In cooler ambient temperatures, the chiller can be bypassed, and heat can be rejected through the cooling tower directly to save energy (as the chiller is not required). Cooling towers do however use large volumes of water, which often has to be chemically treated. As a result, they are not recommended in areas of water stress or scarcity. The figure below demonstrates an evaporative cooling tower system. The chiller is shown in its two parts: condenser and evaporator.

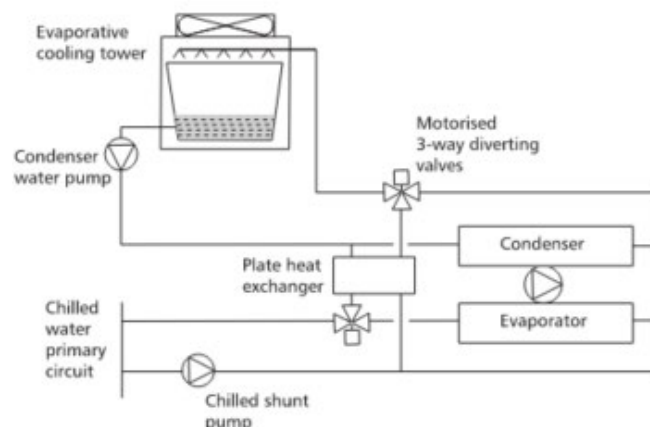


Figure 2 - Evaporative cooling tower system. Figure reproduced from CIBSE Guide KS03 Sustainable Low Energy Cooling: An Overview (2005)

Adiabatic Cooling Systems

Adiabatic cooling systems can be fitted to dry heat rejection systems such as air-cooled chillers and dry air coolers to improve their performance and energy efficiency. This is achieved by using water to cool the air moving across the cooling coils through either a water spray or using a wetted media. These systems use significantly less water than cooling towers and can be set up to use water only when there are very high cooling loads at the hottest times of day or year. Operating in this way is known as peak lopping – using water only during peak high ambient conditions to save energy.

Water Usage for Elsham Tech Park

Estimated Water Usage

The water usage for Elsham Tech Park will be minimal due to the cooling systems operating dry, so no water is evaporated during the cooling process. However, the park will include an office which will have water requirements, and some water will be required for humidification of incoming fresh air in both the office and data centre.

Office water usage is estimated at up to 45l/person per day (reference: BSRIA BG9 2011). For the 900 personnel assumed to be employed by the facility this would equate to 40,500 litres per day, or 10,530m³ per year (based on 5 days a week, 52 weeks a year). To maintain comfortable working conditions, it is recommended that offices maintain a relative humidity of 40-60%. Therefore, air handling units will be fitted with humidifiers which will primarily operate in winter. It is anticipated that 3,886m³ of water will be required per year for humidification across the campus. Due to the dry cooling systems utilised in the facility, it is anticipated that wastewater drainage rates will also be low.

Additional water may also be required for maintenance activities such as cleaning equipment, and irrigation for the site. This load could be offset through rainwater harvesting.

Alternative “Wet” Design

If the cooling systems for the facility were designed with “wet” cooling systems, utilising either adiabatic cooling or evaporative cooling, the water usage for the facility would be significantly higher.

If the two cooling systems were both to use evaporative cooling systems (cooling towers), the annual water usage could be as much as 2.03 million m³/year.

For the high-density AI racks, direct to chip cooling will be used. This can operate with higher cooling water temperatures and therefore, for 99% of the year, it is anticipated that the system could run without any water or refrigerant cooling. For the remaining 1% of the year, during very hot periods, water could be used for “peak lopping” using an adiabatic system. This would be around 59,000m³/year.

Similarly, adiabatics could be used in the air-cooling system to reduce power consumption by using water to cool the air drawn into the chillers, thereby reducing the load and power consumption of the compressors. It is estimated that this would be around 392,000m³/year.

Summary Table

This table summarises the annual water usage of the facility under the proposed design, compared to if the cooling systems were designed with adiabatic or evaporative systems. Additional water will be required for maintenance and initial filling of the cooling systems.

Annual Water Usage m ³ /year	Proposed Design	Adiabatic System Design	Evaporative Cooling Design
Office and Humidification	14,416	14,416	14,416
Air Cooling System	0	392,000	1,862,000
Direct to Chip Cooling System	0	59,000	141,000
Total	14,416	465,416	2,017,416

Conclusion

Elsham Tech Park is an AI data centre campus with the capacity to support an IT load of 1GW. The facility has been designed with a key focus on sustainability and therefore the cooling systems have been designed to operate dry, saving potentially up to 2 million m³/year of water. This approach will reduce the demand on the local water infrastructure without any detriment to the operation of the site. Globally, data centre operators are increasingly prioritising the reduction of their environmental footprint, leading many to select cooling systems that do not require water evaporation. Elsham Tech Park is located in an area with a climate that lends itself to operating dry as it does not experience such high peak summer temperatures seen in other regions of the United Kingdom.

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