DATA CENTRE COOLING: **Benefits of Emerging New Technologies**

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With advancing IT enterprise demands and increasing pressure on data centre energy efficiency this review addresses the common challenges facing the demands made upon cooling infrastructure for critical environments, this article aligns an overview of current cooling technologies and emerging new technologies and their place in the market. This article precedes a more in-depth series of white papers looking at the developments of new cooling technologies and their application to critical environments.

For many years the financial sector has steered data centre infrastructure using a demanding and a stringent set of requirements centred around balancing the business continuity with infrastructure resiliency, redundancy and availability that was introduced some years ago by the Uptime Institute packaged as the Tier Rating System. This has played a crucial part in shaping the critical cooling technology of today that has emerged out of two mainstream conventional strategies namely Chilled Water and DX cooling. However technologies that have been around for decades are now taking the lead and will be instrumental in shaping the future of data centre cooling. The downturn in the economic climate coupled with the recent increase in fuel prices is encouraging facility managers to be ever more energy efficient,

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and as such energy efficiency, reduced cooling energy consumption and the green agenda are now stronger drivers for cooling critical environments.

The Pressure to Cool Efficiently

Developments in European and UK legislation with the impending release of the 2nd edition of the Energy Performance in Buildings Directive (EPBD), and a more frequently updated UK Building Regulations (Part L2a and L2b) means that increasing pressures are surmounting on data centres through the facility building to be more energy efficient. The introduction of data centre metrics and the meaningful use of these to indicate data centre efficiency has been met with mixed response, however the Power Utilisation Effectiveness (PUE) and the Data Centre Infrastructure Efficiency (DCiE) do provide a necessary foundation on which to develop meaningful metrics to measure one data centre against another, formulate benchmarks and eventually lead to data centre energy performance certification. This ongoing development in data centre metrics spearheaded by the Green Grid Consortium will be eagerly followed by the industry.

Best Practice Airflow Management

Cooling regimes and air flow management are often overshadowed by the focus on cooling technology and the infrastructure behind the overall strategy, and as such many data centre facilities overlook basic best practice management of cooling within the data centre which results in huge energy wastage that could easily be rectified by simple and low cost remedies. The choice of cooling regime whether it be hot aisle/cold aisle or mixed, raised floor or displacement, open architecture or closed, in-row or in-rack cooling, or containment or free flow, the necessity of best practice airflow management applies in all cases and can make a huge impact on energy savings. The deployment of simple techniques to mitigate air mixing, air short circuiting, bypass air and improving the air pathway can easily see a 10-15% energy saving on the cooling infrastructure, whilst the further adoption of air segregation using containment can see a further 20% increase in cooling performance.

Energy Efficiency Through Gaining Control

Whilst under cooling or insufficient cooling leading to unwanted hot-spots are a constant worry to the data centre facility manager, a somewhat unnoticed and unfortunately necessary energy waster can commonly occur. A generic reaction to unknown cooling performance and specific environmental monitoring throughout the data centre is to reduce the set point control for cooling in order to ensure a cold air supply is provided to the IT equipment, and inevitably leads to unnecessary energy wastage. This avoidable over cooling can easily be mitigated by ensuring best practice airflow management techniques and ensuring airflow pathways are not obstructed, thus returning full control of the environmental conditions back to the cooling technology. Only with better control over the air conditioned environment can the set point control be increased to an optimal value that still provides the correct amount of cooling that is within the recommended parameters. Typically overcooled data centres can see a 4% energy saving on the cooling plant for each degree set point increased, and in some cases as much as 16% overall could be saved by gaining better control.

Refrigerant Gases

Conventionally DX (Direct Expansion) or split systems and chilled water systems have been the backbone of the data centre cooling industry for years, and will continue to be for many years to come, however capital investment weighed against significantly

reduced running costs over the lifecycle of the data centre will certainly give an interesting future. Conventional technology has by no means been idol, as refrigerant based cooling systems continue to improve performance and energy efficiency, including the development of more environmentally friendly and thermally performing refrigerant gases. CO2 based cooling incorporates in-rack cooling and boasts much higher heat removal capacities when compared to similar water based cooling solutions, however does require special engineering such as stainless steel distribution networks and does operate at very high pressures.

Air or Water?

The debate for air cooling or water cooling based solutions is a continuous one, with benefits and issues related to all technologies on both sides, where the logical solution should be to rate the priority of all pro's and con's against the data centre business requirements, so that the best possible solution is employed.

Free Cooling Economisers

Economiser technology as part of the development of conventional cooling systems has made a huge contribution towards reduced energy consumption cooling by which the cold external air conditions are utilised through a secondary cooler to replace the compressor stage of an outside chiller unit, thus saving energy by making redundant the highest energy component of the chilled water system at certain times. Significant energy savings can be made by taking advantage of outside temperatures of less than 22˚C, and as a self controlled unit the overall chiller plant can be made to operate much more efficiently. Economiser technology can either be dry cooling using air where the unit does not contribute to much more plant space and in many cases the economiser is built into the chiller unit, or the technology can be utilised as water cooled and integrated with existing plant such as cooling towers.

Fresh Air Brings High Energy Savings

Fresh air cooling provides the unique opportunity to fully utilise low outside air conditions and employ very low energy cooling technology. Met with initial scepticism regarding bringing outside air directly into the data centre and issues over dust ingress and humidity control, new technical application has addressed and mitigated all of these risks and issues, thus making this technology much more desirable for critical environments, especially given the huge energy savings to be made. New technology developments keep a closed loop system where by the cold outside air is drawn into the technology but kept separate from the recycled data centre air, and the cooling exchanged across the two air streams is by the means of a thermal wheel. Constraints on architectural design and installation have to be considered, however the benefits include simpler engineering resulting in lower maintenance and better resilience, but above all the main benefit is very low energy consumption, achieving as much as five times the coefficient of performance over conventional cooling systems. A backup integrated DX system provides redundancy cooling and for short periods when the outside temperature is too high for the primary system. Typically in the UK on average this type of fresh air cooling could be utilised for over 75% of the year making huge energy savings.

Fresh Air Cooling with Low Energy Consumption

Evaporative cooling has also taken its place as a serious cooling technology for data centres with several installations throughout the UK. An age old principle that has been treated

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The Renewable Option

Renewables such as wind, solar and wave generated power continue to see growth and application with large scale projects providing energy for data centres, however will always be constrained to geographical location and to where the renewable energy is most abundant. More cooling specific renewable technology driven data centre systems are producing some interesting low energy cooling sites that are at the forefront of green cooling application. Albeit geographically constrained such technologies as ground source cooling using the rock, aquifer water or lake or river water as a heat sink or by utilising the naturally chilled water with conventional cooling techniques can produce huge energy savings, provided the location and ease of technology application can be identified.

The development of cooling technology within the data centre industry has clearly made huge advancements for energy efficiency and performance, and there are several new technologies that have proven applications. The potential energy savings to be achieved with careful technique selection and technology implementation is currently a huge driver for the future of cooling in data centres. It is clear that low energy cooling solutions can provide a high level of resiliency and availability that is to be expected within critical environments. It is evidently crucial that not just the energy efficiency and low energy consumption of cooling technology should be considered, but that equally high standards and best practice methods should be applied to airflow management within data centres, where significantly huge energy savings can be recouped. ■

> Significant energy savings can be made by taking advantage of outside temperatures of less than 22°C.

with scepticism due to issues over humidity control that have now been addressed with careful development over environmental control. Cooling modules provide latent cooled air that is drawn through wet filters and supplied directly into the data centre, whilst exhaust fans remove hot air which is exhausted to the outside. With very simple engineering this alternative use of external air also has the huge benefit of using very low energy cooling and can give as much as twenty times the coefficient of performance of conventional cooling systems. However does require careful design of supply and extraction and detailed environmental control of air temperature and humidity which is specific to the IT heat load in the data centre.