Ark Continuity - Continuously Delivering high integrity data centres

Free-Cooling in this green and pleasant land

Comparing ambient conditions in rural Wiltshire to London and the increased opportunity for sustainable free-cooling

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Ark Continuity delivers high integrity data centres for Government and Corporate occupiers. Ark is now building its data centre campus at Spring Park, Wiltshire with the first phase opening in November 2009. The facility will be one of the most secure, available and sustainable in Europe.

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Introduction

Mechanical cooling has always been the second highest consumer of energy (electrical or gas fired) in the data-centre, second only to the load itself. With the rapidly increasing pressure to make ITC in general, and specifically data centres, 'sustainable' the mechanical and electrical design engineers' attention has, rightly, turned to reducing the power needed to cool the facility. In this quest the target has been to reduce as far as possible the Power Usage Effectiveness (PUE) – that is to reduce the 'overhead' that the facility consumers over and above the actual electric power delivered to the ITC hardware itself. The average PUE has reduced from over 3[1] as little as 5 years ago to less than 2 in 2009. In the vanguard of that improvement is the adoption of 'free-cooling' technology that takes advantage of the external ambient conditions in the refrigeration cycle.

It is a generally understood and accepted fact that the ambient temperature within the M25 ring around Central London is higher than rural Britain due to the energy density of the city itself creating a micro-climate effect. At the same time, for a variety of reasons that do not concern us here, the population density of data centres has continually increased within the M25 and often in high-rise facilities where plant-space is at a premium.

This paper will demonstrate the advantages in energy saving by maximising the free-cooling effect by locating the data centre outside of Central London. In this case we shall consider and investigate the location of the Ark Continuity SQ17 facility in Corsham, Wiltshire.

Defining Free-Cooling

The traditional data centre uses chilled water to transport waste heat from the 'white space' to the external ambient. To re-chill the water electrically driven compressors are used, in an identical way to the domestic refrigerator, and the heat is rejected via finned-coils direct to the air or via adiabatic (water) cooling. The chiller compressor cycle typically consumes 30-35% of the ITC load to perform its task.

The chilled water temperature has traditionally been 6°C cold-feed and 12°C warm-return to help the computer-room air-conditioners (CRACs) maintain 20-22°C internal average temperature2. The principle of 'free' cooling is to use the external ambient conditions to help (or substitute) cool down the water instead of using the compressor. In broad-brush terms (in the case of 6°/12°C chilled water temperatures) this means that whenever the external ambient temperature is below 12°C the compressor can be turned off and energy saved. Of course the cooling plant has to be arranged and

[1] PUE=3, where for every 1kW supplied to the ITC load 3kW enters the facility

[2] Despite the commonly held view that the computer room temperature is maintained at a precise set-point, e.g. 22°C, the physical reality of using air as a carrier of thermal energy means that that CRAC units have to supply air at much lower than the set-point and draw the waste air back at higher than that the set-point. It is not unusual to find feed temperatures as low as 16-17°C and returns at 26-27°C.

provisioned to operate in this way and, generally, carries an initial cost premium although with a rapid RoI.

However modern practices (driven by energy saving) include raising both the internal room set-points[3] and chilled water temperatures. Chilled water temperatures now can be set higher, e.g. 9/15°C, and free-cooling plant has become very much more sophisticated – for example operating in partial mode with the compressor and maximising the potential energy saving.

Today we can achieve, through technologies that are a separate subject for a white paper by themselves, high rates of free-cooling even when the external ambient temperature is 12°C and higher.

It is probably worth noting here that nothing is 'free'. To run in free-cooling mode the cooling system still has to operate the CRAC fans, the chilled-water circulation pumps and the heat rejection fans. However the energy consumed will, typically, be reduced from a total of 50% of the ITC load to less than 15%.[4]

Ambient Temperature & Degree Days

To compare the ambient temperature delta between Central London with Corsham, Wiltshire we can utilise 'Degree-Days' data provided by the many hundreds of weather stations that cover the country[5]. Degree-Days are a simple way of expressing (in our case on a daily basis) the amount of heating/cooling required compared to a base temperature that occurs at a particular location. The most common use is for domestic heating energy consumption on a base temperature of 15.5°C – below which it is generally assumed that a house will need an increasing level of heating.

In our case we interested in the delta between two locations to assess, regardless of the free-cooling technology or plant used, the increased (or decreased) opportunity for free-cooling. These two locations were chosen on the basis of (>99%) continuous daily measurements over the last 12 months and, to avoid any doubt, to have precisely the same geographical latitude, 51.50°N:

- London: Kensington. Station ID. IKENSING2 (0.21°W)
- Corsham: Lyneham. Station ID. EGDL (1.98°W)

We have taken 12°C as our base temperature and the results are plotted on the graph below.

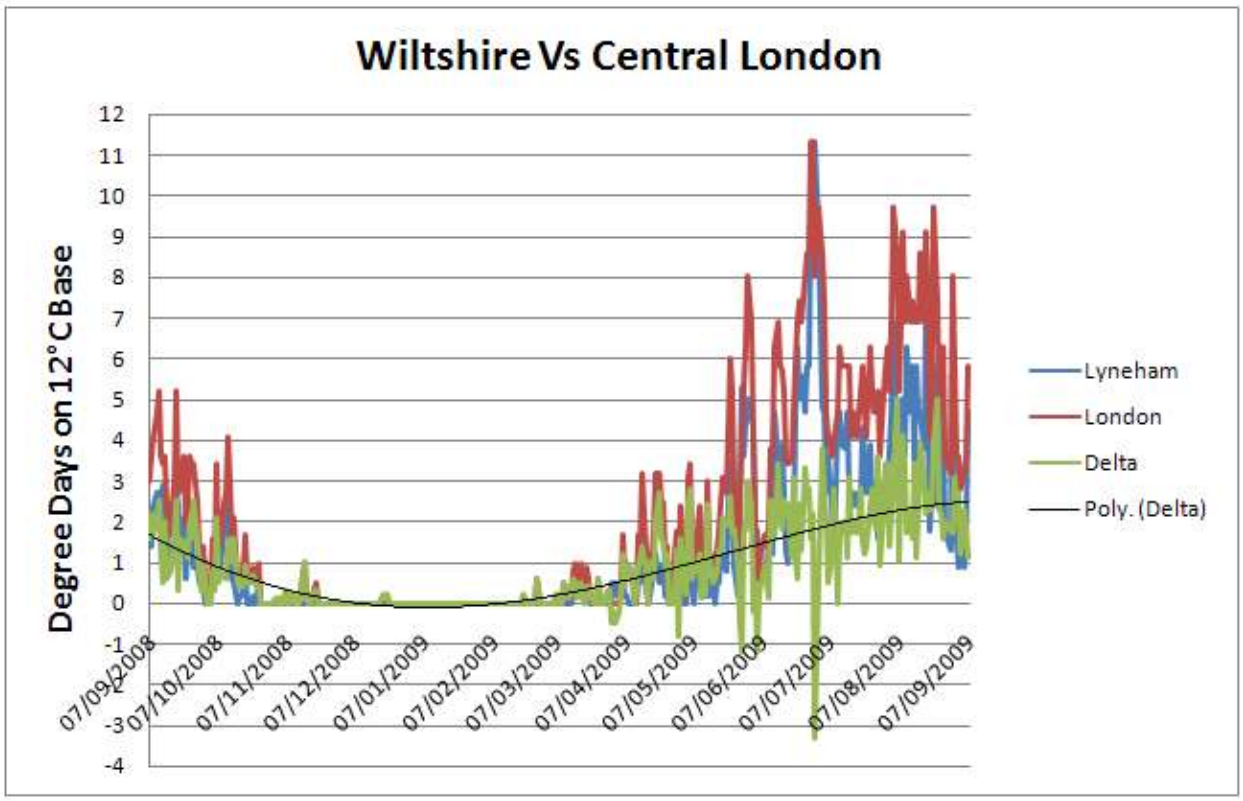
Although the expected 1.5-2°C difference in the ambient is clear, in the data summary, with a 12°C base, the delta in the Cooling Degree Days (CCDs) is remarkable:

- London requires 792.5 CDDs
- Corsham requires 475.4 CDDs – a reduction of 40%

[3] ASHREA TC9.9 allowable limits are currently up to 28°C server inlet temperature with 20-80%RH, which is a substantial movement away from, and improvement upon, the traditional and typical SLA of 22°C±1°K and 50%±10%RH.

[4] That is assuming that all of the other energy saving measures are taken. These can be found in the Best Practices Guide contained within the 2009 EU CoC on Data Centre Efficiency

[5] Source www.degreedays.net based on temperature data provided by www.wunderground.com accessed 20th September 2009.



Conclusions

Clearly in both locations, thanks (?) to our temperate climate there is substantial potential for free-cooling and such technology should always be applied. However this 40% improvement for rural Corsham in free-cooling opportunity compared to London when applied to a usual air-cooled water/glycol free-cooling chiller will raise the typical total free-cooling from 50% of the year to 70% - with an annualised PUE improvement in the order of 0.2.

Further improvements to the PUE at Ark

However, the Ark Continuity site offers further opportunity for energy saving cooling technology over the typical London data centre location:

The underground facilities[6] introduce the opportunity to utilise ground-source water (no more than from rainfall) and adiabatic cooling technology. With copious space underground and water at a constant temperature of 9°C the Ark facility is able to operate at 100% free-cooling regardless of the above-ground external temperature and (it is worth noting) even without elevating the traditional computer room set-point temperature.

With ground-source adiabatic cooling the annualised PUE will fall to 1.2 and below – without introducing fresh-air into the critical facility and full UPS protection.

[6] For further details please refer to White Paper (ARK/0001) – *Did Brunel help build the Ark?*