MEETING CLIMATE CHANGE TARGETS IN THE UK

In light of the UK's recent introduction of a Climate Change Agreement for data centers with colocation space, Dr Beth Whitehead, sustainability engineer at Operational Intelligence, describes how facilities in the UK can look at cooling to reducing their non-IT energy consumption

Four years ago the process began to establish a climate change agreement (CCA) for data centers in the UK. The agreement, which enables continued sector growth, provides a reduction in CCL (Climate Change Levy) taxes and exemption from the CRC (Carbon Reduction Commitment) in return for efficient energy consumption. Achievement of this milestone is recognition that the government understands the importance of the data center sector to the UK economy.

The agreement is applicable to colocation providers, which are eligible if they can demonstrate facility temperature and humidity control, a power supply of at least 200kW and on-site back-up supplies in case of a mains failure. A number of facilities from the same company can be combined under the same target or assessed individually. The sector target is a 15% reduction in power usage effectiveness (PUE) below a 2011 baseline by 2020. To acknowledge that some facilities already have very low PUE and some very high, a site target of 30% reduction in non-IT energy has been set.

To further account for this and the late start of the agreement, targets have been spread unevenly over the lifetime of the scheme. The first target period is the end of 2014 and has a target of 1% reduction in PUE or a 2% reduction in non-IT energy. The next target period runs to the end of 2016 and is expected see changes to baseline values and the method and standards used for measuring targets as the sector gets up to speed with the agreement.

The targets can be met, missed or exceeded. By meeting the targets, the facility gets a 90% rebate for electricity and a 65% rebate for other fuels on the CCL, and exclusion of the energy captured under the CCA from the CRC. If facilities miss targets, the difference between the target CO2 and actual CO2 is calculated and paid for at a price of £12 per ton CO2. Conversely, if facilities exceed targets, the CO2 is carried forward to future targets. Once the application process has been completed, and a participant has signed the Underlying Agreement, the scheme begins and the facility must work towards achieving these goals. After IT load, typically the biggest savings and PUE reduction opportunity are with the cooling systems. This article offers some practical solutions to achieve this reduction through cooling efficiencies.

1. AIRFLOW MANAGEMENT

Appropriate management of airflow ensures that minimal air supplied by computer room air handling (CRAH) units bypasses servers and IT equipment to return directly back to the CRAH units; that minimal hot server air is recirculated from server exhausts to satisfy required air volumes; and minimal air is induced into the floor void. In legacy data centers increased IT inlet temperatures result from mixing of hot and cold air streams created by bypass and recirculation. CRAH set points are often reduced to compensate, leading to higher energy consumption and inefficiency.

Bypass can be improved by:

- Ensuring floor grilles are located in front of loaded racks in the cold aisle and not the hot aisle
- Ensuring air speeds are not so high that surplus air volumes are supplied from grilles
- Blocking cable cut outs in the floor
- Sealing gaps between racks in contained cold or hot aisle arrangements

Recirculation can be improved by:

- Installing rack blanking plates and blocking any gaps in racks

A WORKING EXAMPLE

The table below shows what the energy bill could be for a data center with the following characteristics, assuming the target period runs from 1 July to 31 December 2014

		Energy (MWh) in 6 months					
2% Target	Actual non-IT load saving	Non-IT	Total energy	Purchase Price (p/kWh)	Gross price (£)	CCL tax (£)	Net price (£) without adjustments
Missed	1% additional	3,981	8,361	10	836,142	45,235	881,400
Missed	0% saving	3,942	8,322	10	832,200	45,022	877,200
Missed	1.5% saving	3,883	8,263	10	826,287	44,702	871,000
Achieved	2% saving	3,863	8,243	10	824,316	44,595	868,900
Exceeded	3% saving	3,824	8,204	10	820,374	44,382	864,800
Exceeded	4% saving	3,784	8,164	10	816,432	44,169	860,600
Exceeded	4% saving	3,745	8,125	10	812,490	43,956	856,400

- Ensuring sufficient air reaches the IT equipment
- Ensuring equipment with a-typical airflow directions are dealt with to avoid disrupting normal airflow philosophy, for example by using baffles or housing equipment in separate racks
- Using rack doors with high free area and avoiding legacy glass doors

Negative pressure can be avoided by reducing air velocities under floor grilles, which may be improved by reducing obstructions in the raised floor.

It must be noted that airflow management in itself won't save energy, but by ensuring cold air from the CRAH reaches the IT and does not mix with hot exhaust air the facility can safely reduce consumption by raising CRAH set points and reducing fan speeds.

2. AIR CONTAINMENT

Segregation of hot and cold air streams, using physical containment solutions, further limits the opportunities for bypass and recirculation air.

With air containment, the opportunity for hot and cold air streams to mix is minimized (depending on how effectively the streams are segregated), IT inlet temperatures are reduced and air no longer needs to be oversupplied. CRAH set points can therefore be raised and fan speeds reduced.

Air containment solutions include: cold aisle, semi-cold aisle, hot aisle and chimney exhaust containment, the choice of which is based on the cost and physical restrictions of the facility. The efficiency, however, is dependent on the quality of installation and an adequate control system.

3. FAN SPEEDS

In cases where airflow has been properly managed, CRAH fan speeds can be reduced or (where there are no variable speed fans or air volume is lower than the minimum fan speed) the number of operating units reduced, to eliminate an oversupply of air. This reduces the energy consumption. Understanding that the cube law governs the power consumed by fans, as well as pumps, and compressors, will optimize the extent of these savings.

For example if 1 fan of 10kW is used, the power consumed is 10kW. If a second redundant fan is added the total power is now 20kW. However, using variable frequency drives and local controllers to run both fans at half of the original speed can still fulfil airflow requirements.

Rather than reducing the energy consumption of each fan by a half, the cube law dictates that, if efficiencies of fans, drives and motors remain constant, power is now (1/2)3 of that at 100% - or 10kW x (1/2)3 x 2 fans = 2.5kW compared to 20kW.

(Note, in practice the reduced consumption is likely to be closer to 4-5kW tan 2kW due to changes in the efficiencies.)

4. TEMPERATURE CONTROL ON SUPPLY RATHER THAN RETURN AIR

Changing the CRAH unit control strategy from return to supply air control also helps maintain air supplied at the server inlet to within a narrower range as the control location is nearer the server inlet temperatures. It also avoids air being supplied from the units at too cold a temperature, which is often the case with highly loaded return air control units. With return air control, when the load distribution in the data hall is uneven, each CRAH unit will supply a different temperature to maintain a constant return air temperature.

5. INCREASE SET POINTS

With air properly segregated set points can be increased, preferably a degree at a time to enable monitoring of temperature changes in the facility. This reduces compressor loads by improving the coefficient of performance (COP) of the cooling system and increasing the number of free cooling hours (if available), and can be implemented until the ASHRAE upper limit for the recommended range for IT inlet temperature (27°C) is met. However, operation at higher temperatures that fall within the ASHRAE allowable ranges should also be considered for limited periods of time rather than dismissed, if it means (for example) that 100% free cooling can be achieved.

6. FURTHER CHANGES

Where applicable other smaller savings can be achieved by making the following changes:

- Optimization of the UPS system by matching operational strategy to load modules within the best efficiency range
- Ensuring ventilation flow rates are no greater than required for data hall pressurization
- Disabling extract fans if only pressurization is required and not ventilation
- Widening of minimum humidity control in line with ASHRAE recommendations, moving away from 50% relative humidity to controlling dew point between 5.5°C and 15°C
- Disabling dehumidification in cases where 15°C dew point is exceeded only for a limited period (ASHRAE maximum recommended)
- Installing presence detectors for lighting control. ■

This data center has the following characteristics:
• Grid electricity carbon factor (Carbon Trust, 2013) = 0.44548 kgCO2e/kWh
• IT load: 1000 kW • PUE: 1.9 • Total load: 1900 kW

Rebate (£)	Energy saving (£)	kgCO2e saving	kgCO2e carried forward	Penalty (£)	Total Energy Bill (£million)	Saving compared to site with no change (£)
0	-3,942	-17,561	0	632	882,000	-4,800
0	0	0	0	421	877,600	-400
0	5,913	26,341	0	105	871,100	6,100
40,136	7,884	35,122	0	0	828,800	48,400
39,944	11,826	52,682	17,561	0	824,900	52,300
39,752	15,768	70,243	35,122	0	820,800	56,400
39,560	19,710	87,804	52,682	0	816,800	60,400