INLET TEMPERATURE

It is well-known that the rack supply air temperature has an influence over the IT power consumption. The influence of temperature on the power consumption varies depending on the cooling system (air cooling or liquid cooling) and server architecture (i.e. AMD, Intel). There are several analyses available in literature characterizing this phenomenon. On one hand, Carbo[1] and Pflugradt[2] have characterized the increment of power consumption of an on-chip liquid cooled server with different server architectures (AMD and Intel). On the other hand, Ham[3] characterized the increment of power consumption due to the increment of inlet air temperature for air cooled servers.

Similar conclusions can be found in the literature, the increase of the inlet air/water temperature affects the energy consumption of the server, consuming more energy to do the same work compared to a reference case which normally is 18 ºC. Therefore, if the air or water supply temperature is over this 18ºC it is expected to find IT power consumptions beyond the nominal IT power.

Figure 1 shows the correlations found by Pflugradt and Ham in their respective studies. Notice that the increments found in air cooling servers are higher than in the liquid, due to the fact that not only the current leakage is affecting the increase of the server consumption, but in the case of air cooled servers, the internal fans are responsible for this extra increase. The velocity of these fans normally is controlled internally by the server and it is function of the CPU temperature.

[1] Carbó, A., Oró, E., Salom, J., Canuto, M., Macías, M., Guitart, J., "Experimental and numerical analysis for potential heat reuse in liquid cooled data centres", Energy Conversion and Management, 112 (2016), pp 135-145.

[2] RenewIT, *TRNSYS a TRaNsient SYstem Simulation program GREEN DATA CENTRE LIBRARY Volume 1 Mathematical Reference,* 2015.

[3] Ham, S., Park, JS., Jeong, JW., "Optimum supply air temperature ranges of various air-side economizers in a modilar data center", Applied Thermal Engineering, 77 (2015).

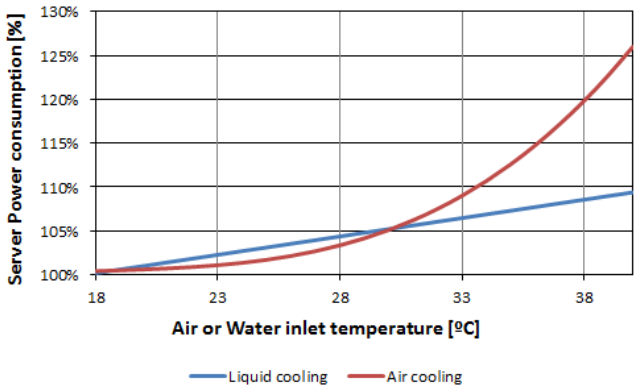

Figure 1 Variation of the IT power consumption for different cooling technologies.

Notice that the reference inlet temperature used in the RenewIT tool is 23ºC. Therefore, it is expected to find a decrement of the IT power consumption if the inlet temperature goes below 23ºC and an increment of the IT power consumption if the inlet temperature goes over 23ºC. Depending on the cooling distribution, another possible advantage introduced by this strategy is the improvement of the chillers COP, which is higher for higher air/water inlet temperatures. But when the inlet air temperature is expected to be increased, the use of correct air management systems by the use of col/hot aisle containment is required. Moreover, this strategy improves the overall performance if it is complemented with a free cooling strategy, due to the fact that for higher inlet supply temperatures more hours of free cooling will be available annually.

Finally, following ASHRAE[4] recommendations, the air inlet range temperature will be between 18 and 27ºC.

[4] ASHRAE TC 9.9, 2011, Thermal Guidelines for Data Processing Environments-Expanded Data Center Classes and Usage Guidance.