Actual Status:
DC Power for Data Centers

Improving data center efficiency continues to be the foremost issue when planning new data centers and optimizing existing ones. Now that huge increases in efficiency have been achieved in the air conditioning sector in the recent years, another sector, the power supply and distribution from the grid to the chip, is becoming the focus of the industry. There is enormous potential for reducing losses through conversion, transformation and distribution, and therefore for increasing efficiency. The transition from AC power supply to 380 VDC entails several advantages.

Today's AC architecture is usually as follows:

- 16.000 VAC from the grid into the building.
- Transformation to 400 VAC
- Conversion to DC in the UPS for battery feed
- Inversion to AC
- Conversion to 400 VDC in the server power supply unit (PSU)
- Transformation to 12 VDC in the PSU

The 380 VDC architecture is less complex:

- 16.000 VAC from the grid into the building.
- Transformation to 380 VAC
- Conversion to 380 VDC
- Transformation to 12 VDC in the PSU

Advantages of 380 VDC power supply:

- Increased efficiency from the grid to the chip: up to 10%
- Reduction of investment cost for the electrical infrastructure: approx. 15%
- Space requirement for the electrical infrastructure: approx. 25% lower
- Installation costs: approx. 20% lower
- Operating and maintenance costs reduced by up to 30%
- Greater reliability through reduced complexity as fewer components are used. NTT research results show a tenfold increase in reliability.
- Simplification of the integration of renewable resources such as photovoltaic, wind, fuel cells and other DC consumers and energy storage systems.
- DC increases the power quality, no more problems with harmonic distortion. Phase correction is no longer necessary.
- No need for synchronization to connect multiple sources.
- No need for rectifiers or inverters for connecting batteries to the grid.
- …and many more…

There have been attempts to use the proven -48 VDC architecture that is used in the telecommunication industry, but this entailed too many disadvantages. For the same capacity the required current is eight times higher and increases the cost of cabling. This is not feasible for data center applications in the high kilowatt or megawatt range.

There are several challenges to master beside the obvious advantages:

- Experience and expertise must gathered and shared.
- The availability of DC components is still very limited and therefore still expensive.
- There are safety concerns in handling DC. There are various analyses available showing that the handling of DC is not more difficult or dangerous than AC.
- The use of DC power supply requires holistic planning from the grid to the chip.
- Cooperation between component manufacturers, server manufacturers, designers and data center operators is required.
- Standards need to be defined and established.

Currently companies like NTT and ABB are bringing this topic into the spotlight. Besides these, many other companies, component manufacturers and associations (the Green Grid, EMerge Alliance…) are working on the establishment of this technology. IBM and HP are already offering servers with DC power supply. NTT built their first test data center with -48 VDC in 2006, followed by another with 380 VDC power supply in 2007. ABB supplied the 380 VDC power supply and distribution systems for the 1 MW Green data center in Switzerland in 2012. Today, there are approx. 25 data centers with DC power supply in operation globally, most of them test or demonstration data centers with a capacity between 4 kW and 100 kW. Publications from ABB, NTT, Intel, HP, The Green Grid and others on this subject can be found on the internet and many of them have been used for this article.

The air conditioning systems for these data centers with 380 VDC need to be adapted accordingly. STULZ, a well-known manufacturer of efficient, reliable and safe air conditioning equipment, already offers a wide range of perimeter and row chilled water cooling models for 380 VDC. STULZ air conditioners are already in operation in many 380 VDC powered test data centers. Chillers in the 100 kW to 1,5 MW range are most likely to be AC powered for the time being, as the required compressors are not available for DC. The implementation of DX air conditioning units with small capacities is currently under review.

SWOT-Analysis:

Strength	Weakness
Lower investment, installation, operating and maintenance costs and smaller footprint.	Experience and expertise is not yet widespread. The availability of DC components is still very limited and therefore still expensive. Holistic planning is required. Standards need to be defined and established.
Opportunities	**Threats**
Increased efficiency. Increased reliability. Simplified integration of renewable resources. Better quality power.	Safety concerns in handling DC.

Summary:

When or how quickly direct current power supply will enter the data center market on a large scale is obviously just a matter of time. Significant progress can be expected in the next 5 to 10 years. STULZ is part of it right from the beginning.

June 2015, Benjamin Petschke