VISION® ELECTRIC
Super Conductors

SUPERCONDUCTING DC DATA CENTERS

impact for the industry

Most data centers today are receiving AC power, even their primary equipment is using DC power. Multiple conversion from AC to DC power is required.

There is no doubt that DC powered data centers are more efficient on total power evaluation. Evidence is given by numerous investigations and publications within the last years which show a value between 10% and 20% [6, 7]. To demonstrate this approach a few DC-data centers [8] are operating and proofing the advantage of the technology.

But why are DC data center not yet state of the art?

There are different hurdles like lack of experience (where to put the AC to DC conversion), lack of standards for e.g. how to integrate an energy storage like superconducting flywheels that deliver the same performance as UPS'. But one main challenge to overcome is pure physics: Transferring electric power by standard copper and aluminium cables produces losses which heat up cables and surroundings. The more power the more heat losses. The more heat losses the more operating costs. **The use of copper and aluminium cables eat up the advantages of DC in data centers**. The solution for DC data center to become state of the art is Superconductivity.

Like all other systems superconductors have advantages and disadvantages. Overall we believe that **superconductors are the missing link** for the breakthrough of DC in data centers.

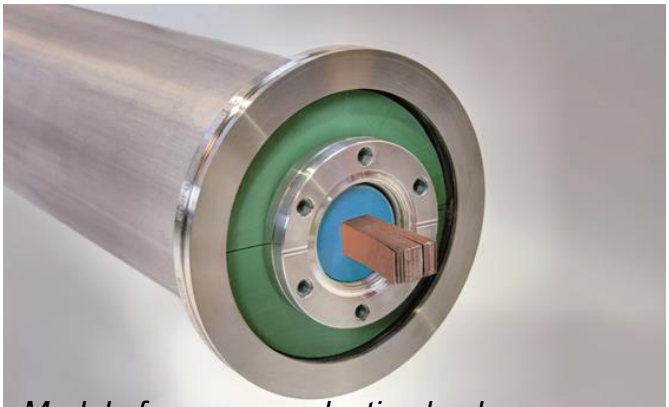
Superconductors do not emit any heat to the work environment of a data center because they are not producing any electrical losses. They are ultracompact due to their enormous power density which is up to 1000 times higher compared to copper or aluminium. Besides the high energy efficiency superconductors are also most material efficient. The environmental footprint for production and operation is lower than of any other electric conductor.
Superconductors are not commodity materials like copper and aluminium and due to the production processes of today more expensive. Superconductors require an operating temperature of liquid nitrogen, of about 70K/-200°C/-330°F. They are placed in a thermal insulation pipe.

The more power transferred the more economical is the use of superconductors. Regarding the total cost of ownership the application of superconductors today is only reasonable for the larger power requirements of hyper scale data centers. If once started initially the high economy of scale potential will lead to reduced investment costs.

What are the technical advantages of superconductors in DC data centers?

IT equipment, servers, storages, switches, monitors etc. are electronic devices that require low voltage DC power. Instead of converting AC to each of the devices it is much more

efficient to supply DC power directly to the devices' power supplies. Therefore the massive use of converters on different voltage levels is not any more necessary.
Today's DC power supplies are working on an input voltage of up to 400 V which is in most cases the battery voltage level.



Model of a superconducting busbar

E.g. on a power demand of 10 MW the total current is 25.000 A which would need space of more than one square meter / 10 square feet along a copper or aluminium line. A superconducting system would need less than 10% of space.

With the installation of superconductor systems all energy equipment, like switchgear, rectifiers, battery, etc. can be located remote. Thermals loads at air-conditioned rooms and electromagnetic shielding are reduced. Civil building costs can be reduced due to lower space and cooling requirements.

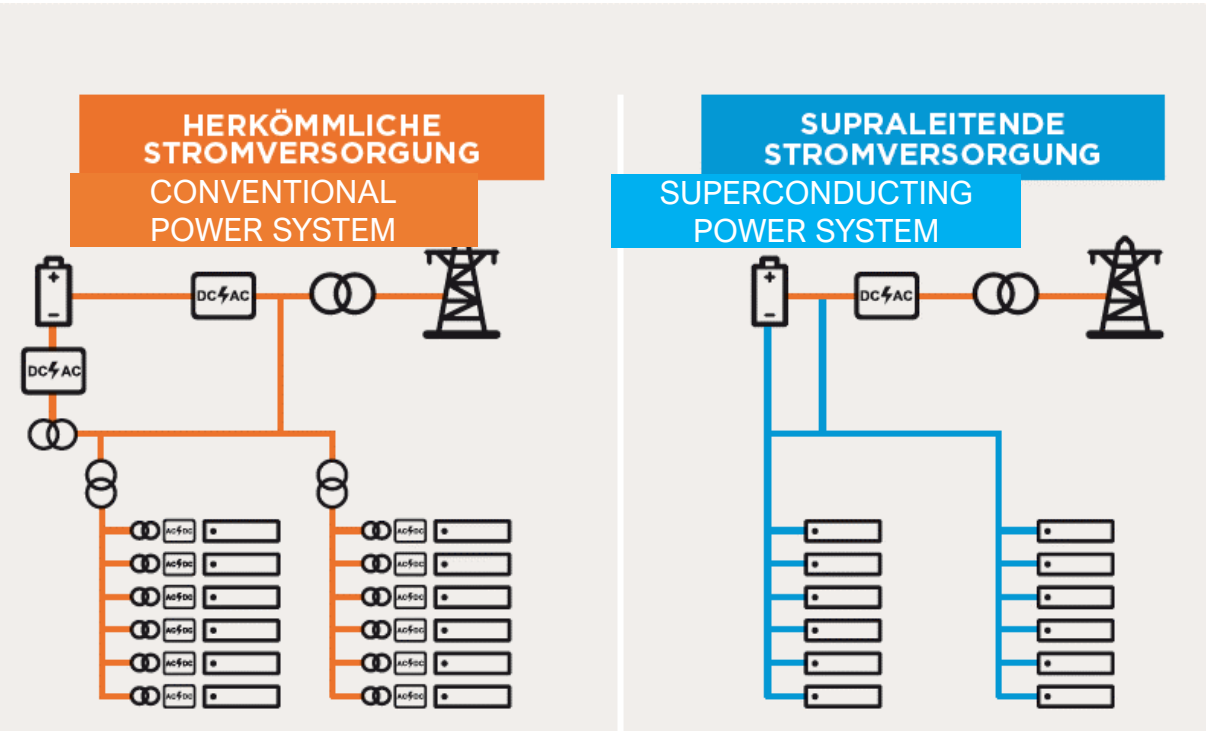
Placing the data center energy supply at a remote place offers the potential to optimize the total electric power system together with the grid supply, DC power from solar plants and wind farms, power regulation systems like flywheels, batteries and emergency generator sets in an easy way.

The distance between the power area and servers is not critical – superconductors enable loss-free power transmission. For A and B power can be really separated without any voltage drop differences at the server racks. It is even possible to connect both ends of A and B power supply which is reducing the problem of overload and damage of server power supplies in case of a disturbance.

Auxiliary devices are in most cases already running on DC. Lighting has changed to LED, most drives use frequency controls which run efficiently on DC input.

Fire load is a concern in data centers. Big energy cables add a lot of thermal load to the fire load calculation. Superconducting systems of Vision Electric Super Conductors are without any outer plastic material and thus reducing the total caloric value of the installation in case of fire.

Of course this also applies to container-based data centers. At least 4 containers can be supplied from one superconductor terminal with DC power. The container space is not occupied by electric power equipment and therefore can be better utilized for IT equipment.



Comparison of power systems

Superconducting DC data centers are the future

There is no doubt: DC technology together with superconductivity will become state of the art for data centers. DC and superconductors offer the possibility for new innovative designs saving energy and improving cost structure and performance.

Superconducting DC data centers are the future because they are much more power efficient than standard AC data center. Furthermore superconducting DC data centers are space saving and more reliable with lower costs.

Let's go for it!

Dr. Wolfgang Reiser

Wolfgang Reiser is CEO of Vision Electric Super Conductors and has more than 40 years experience within the high current industry.

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