Energy
National Research Programmes 70 and 71

Project

Cooling of SiC solid-state transformer

Clever Cooling System for Power Electronics

Switzerland's power grid is in need of new components that can deal with the integration of fluctuating sources of renewable energy. For such power electronics, an EPFL research group has developed a cooling system that does not itself consume energy.

The electricity grid of the future will undergo major changes: Because of the many decentralised photovoltaic and wind power plants, new, high-performance cooling systems are needed for components. *Source:* Shutterstock

At a glance

- In the future, power grids will no longer be supplied by a handful of central power plants as they are today, but by many decentralised renewable energy sources such as wind and photovoltaic power plants.
- The power grid depends on novel power electronic components in order to be able to deal with the strongly fluctuating supply of renewable energy sources.
- These components heat up during operation and need to be cooled.
- A research group at the ETH Lausanne (EPFL) has developed an efficient cooling system requiring no fans or pumps.

Based on the federal Energy Strategy 2050, Switzerland will gradually shut down its nuclear power plants over the next few decades. Consequently, the large input sources currently feeding power into the electric grid will no longer be available. At the same time, the number of photovoltaic and wind power plants feeding small and inconstant amounts of electricity into the grid will increase.

This progression from a few centralised power plants to a large number of small decentralised plants poses new challenges: the power grid depends on a constant adjustment between the power needed and that provided by the power plants, in order to ensure constant mains frequency and voltage regardless of fluctuations in consumption and feed-in.

New power electronics, such as components that can raise or lower the electrical energy in the grid to a desired voltage, or so-called rectifiers and inverters that turn alternating voltage into direct voltage or vice versa, are a must to achieve this.

New cooling systems are a necessity

The design of these power electronics places extremely high demands on the engineers because the elements become very hot during operation. The efficiency of the components drops rapidly when an upper temperature limit is exceeded, which is why novel and highly efficient cooling systems are also a necessity.

The development of such a cooling system was the goal of the engineering team in the Heat and Mass Transfer Laboratory at the EPFL Lausanne. To design their cooling system, the researchers chose a new and innovative approach: the cooling system needed to function while consuming no additional energy.

To achieve this, the researchers built a thermal siphon. The components of the power electronics requiring cooling are located on one side of the closed system. On the other side is the ambient air to which the heat is transmitted. A refrigerant draws the heat from one side to the other. The trick involved in the EPFL researchers' thermal siphon is the following: due to its special design, the refrigerant moves solely by gravity, which means that no electricity-consuming pumps or fans are needed.

Considerable energy-saving potential

This system can save considerable amounts of energy, which the power grid would otherwise consume solely through its own operation. The researchers estimate that by using this cooling technology throughout Switzerland, thousands of gigawatt hours of energy could be saved every year. The innovative cooling system could also be used in other fields, for instance in high-performance computers which also require cooling.

In order to determine the optimal conditions for the thermal siphon, the researchers operated a prototype with a range of different refrigerants. They compared their thermal conductivity, thermal resistance and overall efficiency during operation. The most efficient and environmentally friendly refrigerant was R-1234yf, which is also used in car air conditioning systems. Its global warming potential is lower than that of carbon dioxide, whereas the potential of the other tested refrigerants is in some cases thousands of times higher than that of carbon dioxide. Thus, the EPFL researchers' cooling system is not only good for the power grid, but also for the climate.

Produkte aus diesem Projekt

- Kickoff-Poster
  Date of publication: 30.01.19
- Experimental Evaluation of a Passive Thermosyphon Cooling System for Power Electronics
  Date of publication: 08.02.19
- Experimental evaluation of a passive thermosyphon cooling system using dfferent low-GWP refrigerants
  Date of publication: 08.02.19
- Experimental performance of a completely passive thermosyphon cooling system rejecting heat by natural convection using the working fluids r1234ze, r1234yf, and r134a
  Date of publication: 08.02.19
- Experimental evaluation of the thermal performances of a thermosyphon cooling system rejecting heat by natural and forced convection
  Date of publication: 08.02.19

Contact & Team

Prof. John R. Thome
Laboratory of Heat and Mass Transfer (LTCM)
École Polytechnique Fédérale de Lausanne (EPFL)
1015 Lausanne

+41 21 693 59 81john.thome@epfl.ch

Brian D'Entremont

John R. Thome
Project direction

Filippo Cataldo

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