The impact of innovation in power electronics on everyday life in cities

The impact of innovation in power electronics on everyday life in cities is a highly relevant topic in engineering and applied sciences, especially in the context of smart cities and the transition to a low-carbon economy.

The evolution of power electronics depends on the evolution of electronic components, especially semiconductors. Traditional silicon (Si) - a semiconductor material used since the 1950s in the electronics industry - has been replaced by silicon carbide (SiC) in numerous applications.

Early research showed the great potential of this material to replace traditional silicon in the 1980s and 1990s. In the 2000s, such SiC transistors and diodes began to be available on a commercial scale, enabling their applications in sectors such as automotive, power generation and distribution, and industrial inverters. In recent years, SiC technology has continued to evolve, becoming an increasingly viable choice for high efficiency and power density systems.

One of SiC's main contributions is its ability to operate at higher temperatures, with greater efficiency and lower energy loss compared to conventional silicon. According to studies carried out by the Fraunhofer Institute in Germany, this allows for greater reliability in systems that handle large amounts of energy, such as power grids and renewable energy infrastructures.

In France, the National Center for Scientific Research (CNRS) points out that the thermal advantage of SiC is directly linked to improving the integration of clean energy sources, such as solar and wind power, by making it possible to build more compact systems that are less dependent on cooling.

Systems using SiC can be miniaturized, as they are capable of operating at higher frequencies and greater power density, with direct implications for cost and energy efficiency in sectors such as electric mobility and power distribution systems. The flexibility and innovation offered by SiC allows for the implementation of innovative mobility solutions, such as autonomous vehicles and wireless charging systems.

The impact on everyday life in cities is therefore remarkable, especially with regard to urban mobility and public transport. Electric and hybrid vehicles equipped with SiC technology are lighter, more efficient and offer greater autonomy and shorter recharging times, factors that are decisive for the large-scale adoption of public transport fleets powered by electricity.

The French city of Grenoble has been an example of how SiC-based technologies can contribute to the evolution of sustainable urban transportation. The city has invested in a system of electric buses and fast charging stations, both equipped with SiC-based power electronics: more agile operation with lower energy consumption.

Another significant impact of the introduction of SiC is related to the energy infrastructure of cities. Systems designed with SiC improve the management of electrical micro-grids and smart grids. These networks, which integrate renewable energy sources and

efficiently manage urban energy consumption, benefit from the speed, precision and miniaturization of SiC equipment and converters to balance electricity supply and demand in real time.

SiC enables the development of more efficient energy storage systems, since its properties reduce electrical losses during the energy conversion process. This is crucial for the success of sustainability initiatives in cities, which are increasingly dependent on technologies that enable distributed energy generation and the optimized use of natural resources.

In short, the innovations that silicon carbide has brought to power electronics are revolutionizing everyday life in cities, promoting significant advances in energy efficiency, sustainability and mobility. This technology is fundamental to the development of smart cities, where efficient energy management and electric mobility play key roles. As innovations continue and SiC-based applications grow, the cities of the future are likely to be more sustainable, connected and prepared to face the challenges of the global energy transition.

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Further Reading

Fujishima, N. (2024). Technical Trends of SiC Power Semiconductor Devices and Their Applications in Power Electronics. IEEJ Journal of Industry Applications, 23005497.

Li, J., Igarashi, S., & Fujishima, N. (2022). SiC Power Devices and Application to Power Electronics. In PCIM Asia 2022; International Exhibition and Conference for Power Electronics, Intelligent Motion, Renewable Energy and Energy Management (pp. 1-8). VDE.

Saha, J., Kumar, N., & Panda, S. K. (2022). A futuristic silicon-carbide (SiC)-based electric-vehicle fast charging/discharging (FC/dC) station. IEEE Journal of Emerging and Selected Topics in Power Electronics, 11(3), 2904-2917.

Victor, Veliadis. (2022). 5. SiC Power Device Mass Commercialization. doi: 10.1109/ESSDERC55479.2022.9947113