4E
Energy Efficient End-use Equipment
International Energy Agency

ENERGY EFFICIENCY POLICY BRIEF

Application Readiness Map for Wide Band Gap (WBG) semiconductors

PECTA3

Power electronics condition and control the conversion and flow of electricity, using solid-state electrical devices to handle a wide range of power levels, from milliwatts to gigawatts. Wide Band Gap (WBG) is an emerging power electronics technology that is maturing rapidly and offers enormous opportunities for increasing energy efficiency of devices that condition and control electricity. The 4E Power Electronic Conversion Technology Platform, PECTA, engages with research, government and industry stakeholders worldwide to monitor development, assess the benefit of utilising WBG technology and build the foundation for suitable policies.

The PECTA Application Readiness Map (ARM) for Wide Bandgap (WBG) Semiconductors describes the expected market position through to 2035. It is based on interviews with many experts and various roadmaps and can be used as a basis for deciding, which power semiconductor technology to choose. Readiness levels can be defined in many ways. For example, there is the Technology Readiness Level (TRL), the Market Readiness Level (MRL), and the Adoption Readiness Level (ARL), which focus on technology, market, and adoption risks, respectively. In power electronics, the application readiness depends strongly on the specific application requirements. Here, the improved power efficiency and increased power density, possible with WBG semiconductors are the main drivers for their use.

The objective of the PECTA-ARM is to visualise the readiness level of different WBG devices and corresponding WBG technologies for use in different applications. It describes the introduction of WBG devices in existing markets in these steps: **1)** demonstrator available, **2)** first product available, **3)** significant market share, and **4)** dominant market share achieved. This policy brief summarises findings of the 2023 report, updating a previous ARM analysis in 2020. An annual update until 2028 is planned but will not be published yearly via a policy brief.

Observations for Policy Makers

- The updated status of the WBG market and of the WBG technology, includes additional market segments that are now relevant for WBG power semiconductors. The focus is still on Silicon Carbide (SiC) and Gallium Nitride (GaN) devices. To better assess the validity of the presented ARM, the most influential factors are presented.
- The insights are based on interviews with many experts and various technology roadmaps and could be used as a basis for deciding which power semiconductor technology to choose.
- Compared to earlier versions, additional WBG-relevant market segments have been added, including (1) automotive and railway, (2) photovoltaic inverters, wind, grid, and consumer applications, and (3) industry, automation & robotics, large drives, information/communication technology and data centres.
- Detailed ARM maps have been developed for these applications and markets. An example ARM map is shown for PV inverters below, and for (3) industry, automation & robotics, large drives, and ICT/data centres sectors.

For each application, these maps show technology market development. E.g., PV-inverters: GaN devices are now entering the market for smaller PV-inverter applications, whereas SiC devices are already on the market, and gaining share, for larger PV-inverter applications.

MORE INFORMATION

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Further information is available from **pecta.iea-4e.org** and by contacting the PECTA operating agent at **markus.makoschitz@unileoben.ac.at**

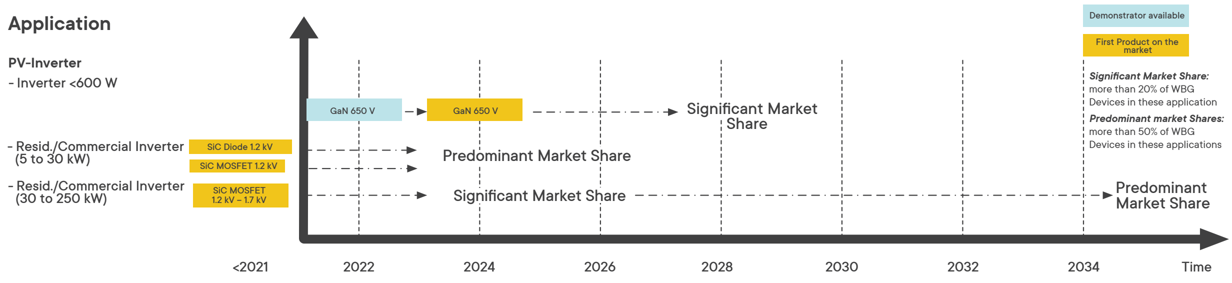


Figure 1: Applications Readiness Map for photovoltaic inverters, wind, grid, and consumer

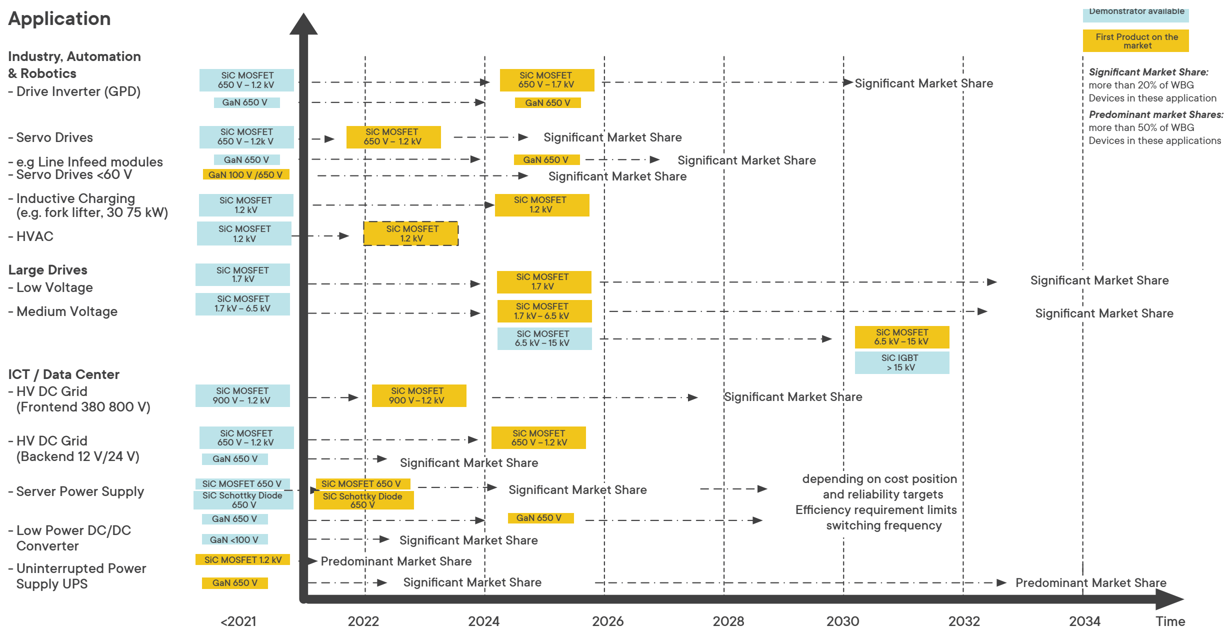
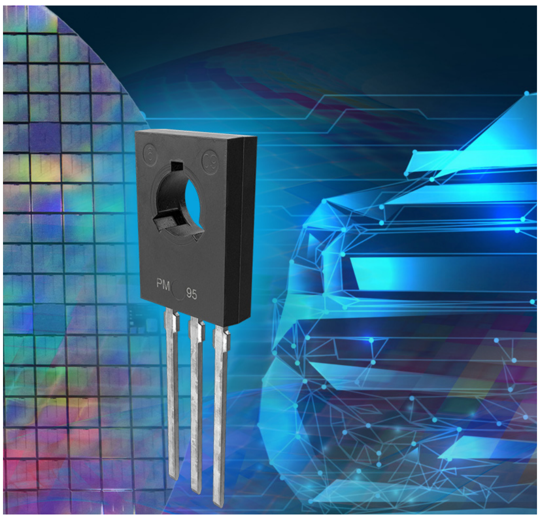


Figure 2: Applications Readiness Map (ARM) for industry, automation & robotics, large drives, and ICT/data centres

Key Findings



The automotive SiC device market is expected to grow at a rate of more than 26% from 2022 to 2028 (CAGR), despite recent announcements to reduce the number of SiC components in automotive powertrains.

In the consumer market, GaN devices already achieve a dominant market share for USB power supplies. Here, the priority of application requirements is first purchase cost, then power density, and finally efficiency. A typical efficiency of only 91% is accepted for USB power adapters, 93% is common, with higher values often achieved in more powerful USB chargers. The demand for smaller adapters requires high switching frequencies of 150 kHz or more, which can be achieved with GaN devices, even though most chargers still use frequencies below that.

In comparison, power supplies for data centres have a different priority in the application requirements due to its 24/7 service. Here efficiency is the priority, then purchase cost, then power density. This application uses 40 to 70 kHz switching frequency to achieve efficiencies above 96% (with over 99% for the power factor correction), where also SiC devices are a good choice.