

Economical profit of establishing a renewable energy society

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The amount of energy saved worldwide through the use of LEDs for general lighting is estimated to be 952.5 TWh/year, which is comparable to the total electricity generation in Japan (1043.6 TWh/year, 2016). Also, nitrides are thought to be semiconducting material systems that can be used in high-power microwave and millimeter-wave devices in next-generation ultrabroadband 5G and post-5G wireless communication systems. The energy loss of all-electric power circuits such as inverters and converters can be reduced to one-tenth by replacing Si-based MOSFETs and IGBTs with GaN-based transistors and diodes. In the future, the mobility of humans will be increasingly dependent on vehicles driven by electricity. Electric vehicles (EVs) are one of the most important items for establishing a sustainable society. One of the problems of EVs is their short driving range owing to the insufficient capacity of the battery. Another is their long charging time. We can reduce the electricity consumption of traction inverters in EVs by 60% by replacing conventional IGBTs with GaN-based high-power HEMTs. In our newly developed EVs, IGBTs will be replaced with GaN-based power devices not only in the traction inverter but also in all the DC–DC converters. GaN-based systems will also be used in all the displays inside the car, and the headlights will be composed of GaN-based high-brightness LEDs/LDs lamps. Thus, we call such a vehicle, “All GaN vehicle”, some of which will be driven at the 2021 Tokyo Olympic Games. We can also utilize the GaN-based power devices for managing electricity generated by renewable energy system. Economical advantage of using renewable energy systems will be discussed.

We are presently developing an open innovation platform to realize such novel power devices and systems. We have established the Center for Integrated Research of Future Electronics (CIRFE). The purpose of CIRFE is to gather specialists in different fields such as those in the crystal growth of GaN, AlN, SiC, and carbon nanotubes, device fabrication and characterization, simulation, circuit design, module design, and system applications, thus contributing to realizing a zero carbon emission society. We have also established a new consortium connecting all the research and development levels from fundamental science to system applications in which GaN-based devices are used. To date, 45 private companies, 20 universities, and two national research institutes have joined this consortium and are starting to collaborate toward realizing a sustainable, smart, secure, and safe society.

ACKNOWLEDGEMENTS

Our works are supported by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan, through its “Program for Research and Development of Next-Generation Semiconductor to Realize Energy-Saving Society”, the Ministry of Environment, “Project of Technical Innovation to Create a Future Ideal Society and Lifestyle”, and the Cross-ministerial Strategic Innovation Promotion Program (SIP). The studies mentioned were conducted by members of CIRFE. I would especially like to thank Professors Y. Honda, S. Nitta, A. Tanaka, K. Shiraishi, Y. Kangawa, C. Sasaoka, K. Shiozaki, M. Yamamoto, M. Pristovsek; Drs. M. Deki and M. Kushimoto; and N. Fujimoto and H. Watanabe.