

# **JST Super Cluster Program**

**- Industry-Academia Collaborative R&D Program  
on SiC & GaN Power Electronics -**

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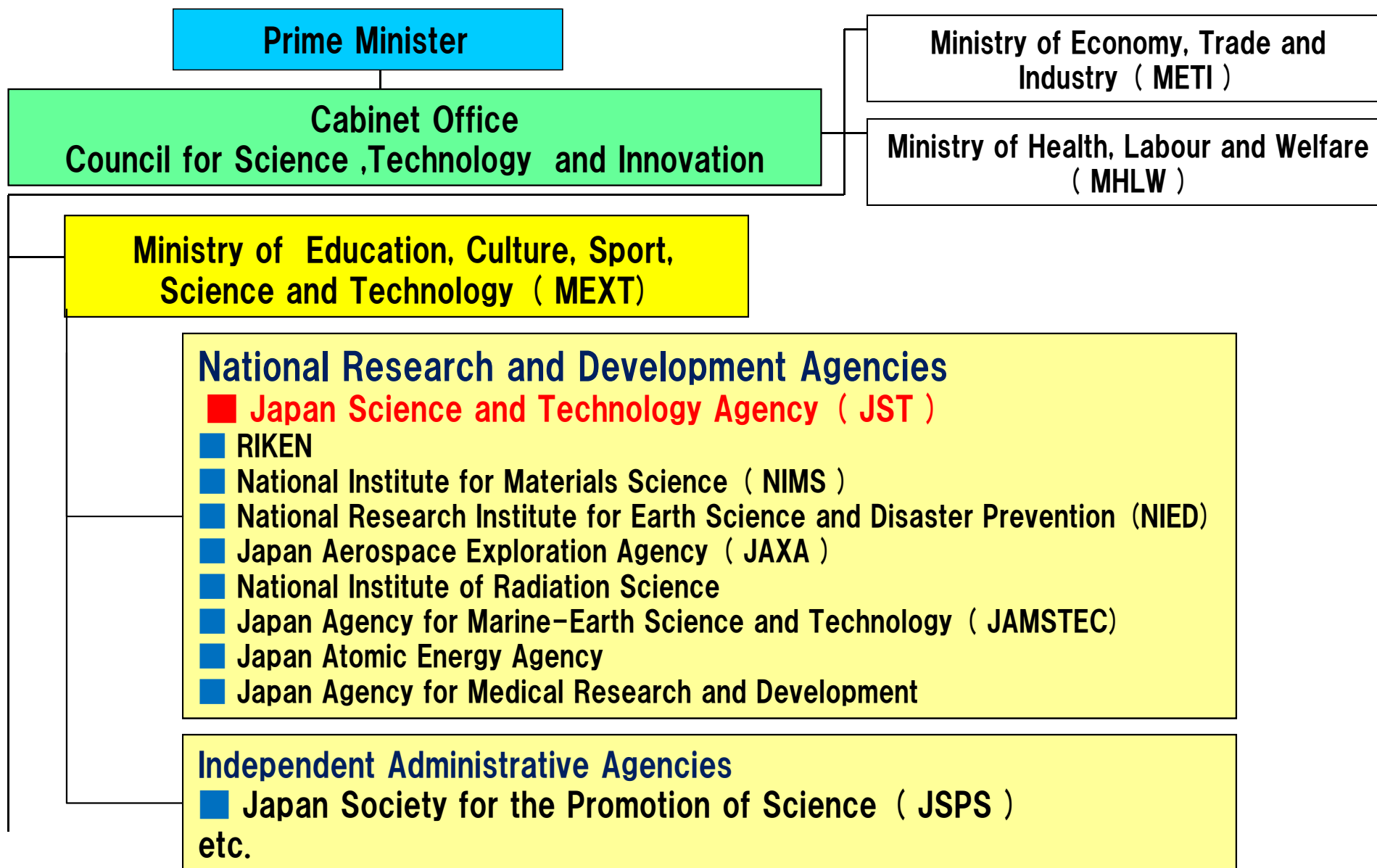
**Strategy Director, Super Cluster Program**

**Department of Innovative Platform**



**Japan Science and Technology Agency**

# Science and Technology Administrative System in Japan



# Japan Science and Technology Agency ( JST )

## Strategic Promotion of Basic Researches

- CREST(Core Research for Evolutionary Science and Technology)
  - Started in 1996
  - 27 programs ( 27 POs) / 2015
- ACCEL  
(Accelerated Innovation Research Initiative  
Turning Top Science and Ideas into High-Impact Values)
  - started in 2013
  - 10 programs ( 10 PMs) / 2014

## Academia-Industry Collaborations

- COI (Center of Innovation Program)
  - Started in 2013
  - 18 programs ( 18 PLs ) / 2015

*JST Super Cluster Program*

# JST Super Cluster Program

*To promote industrialization and public application of **SiC & GaN power electronics** by accelerating R&D of innovative those devices & systems,*

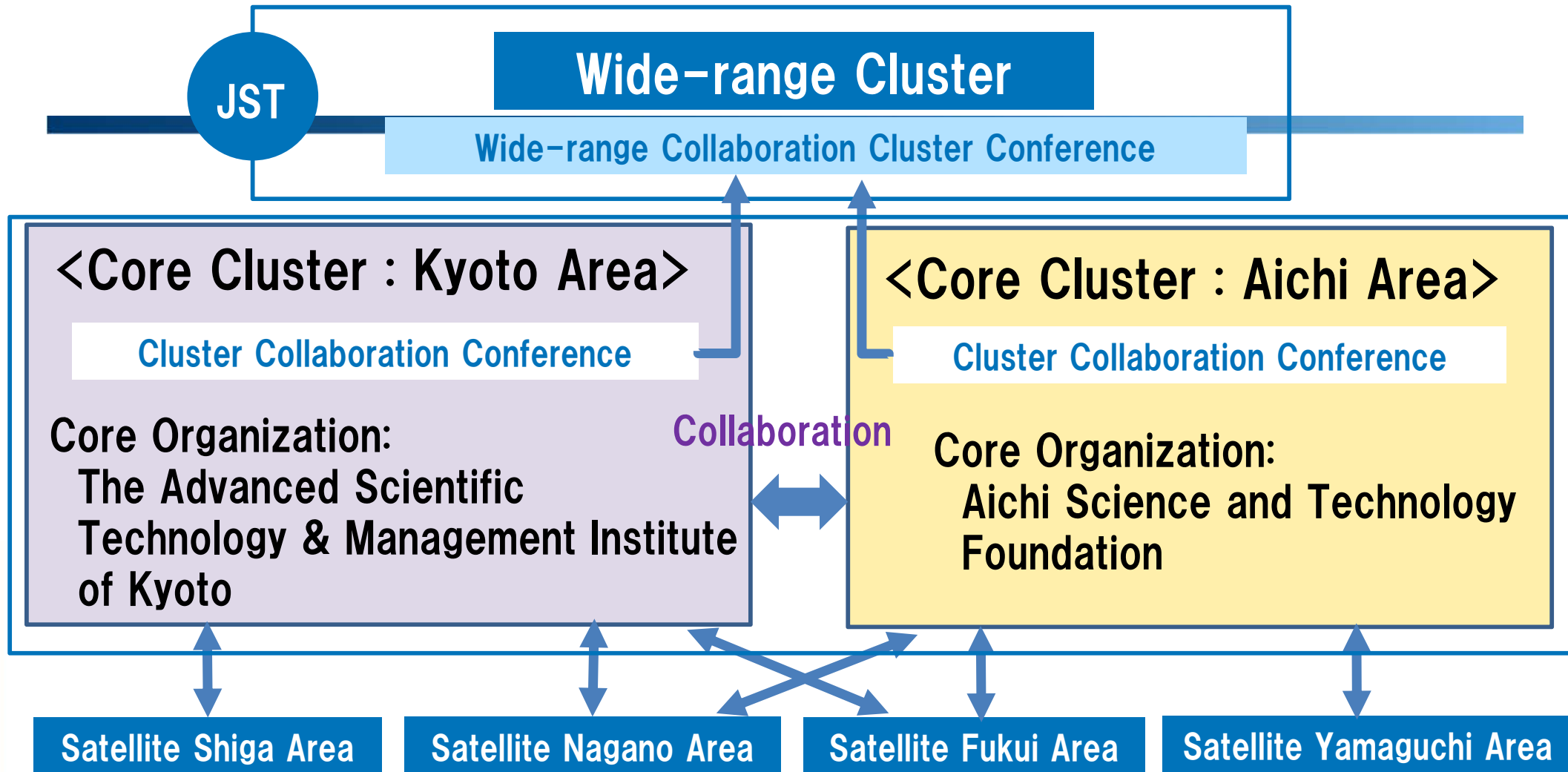
## 1. Objective

The Program aims to form a globally competitive Super Cluster **through wide-range collaboration in order to create innovation** with high-impact in our country.

While exploiting the achievements of science and technology promotion measures in each area thus far, the government will initiate selection and concentration, finding the best match, **based on social and market needs.**

## 2. Organization

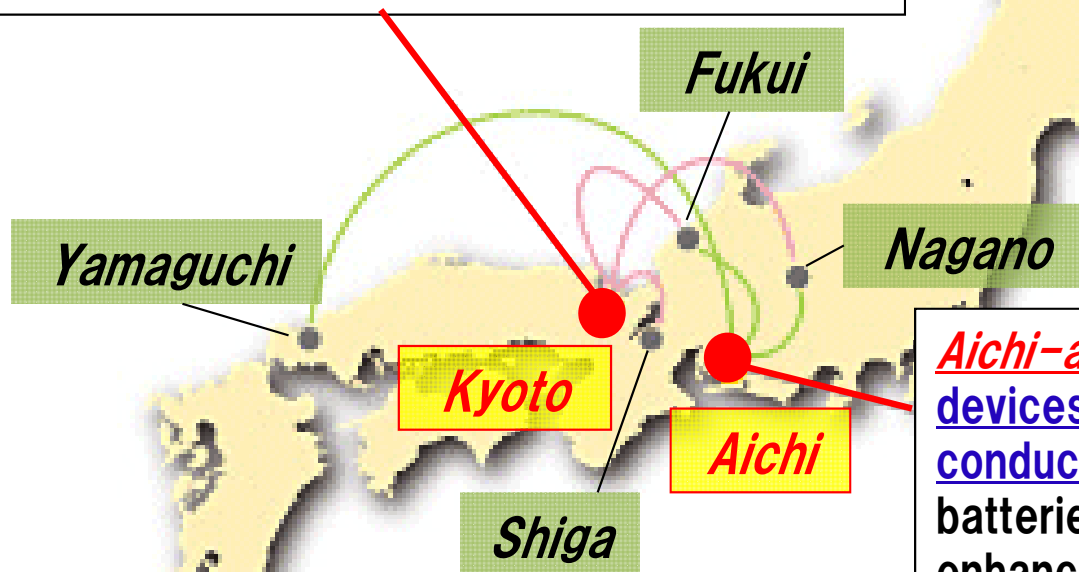
The **“Core Clusters”**, Kyoto area and Aichi area, will enhance potential of the new market development, strengthen the international competitiveness and revitalize R&D activities in the regional industrial sector under close cooperation with **“Satellite Clusters”** focusing on the seeds of technology and business models accumulated in the respective areas.



**Universities – Public research institutes – Industries**

(Dec. 2013 – Mar. 2018      ~1 billion yen/year)

**Kyoto-area Core Cluster** Promoting the social implementation of innovative SiC power devices, and achieving a highly-efficient and comfortable society with a low environmental impact by constructing energy efficient systems, with **Shiga-, Nagano- and Fukui-areas Satellite Clusters**.



**Aichi-area Core Cluster** Developing power devices including GaN, electrodes and conductive materials for rechargeable batteries and fuel cells to advance and enhance the competitiveness of next generation automobiles clustering in the area, with **Nagano-, Fukui- and Yamaguchi-areas Satellite Clusters**.



Physical properties superior to Si

Low Loss

High-Speed Switching

High Breakdown Voltage  
(Small size, large capacity)

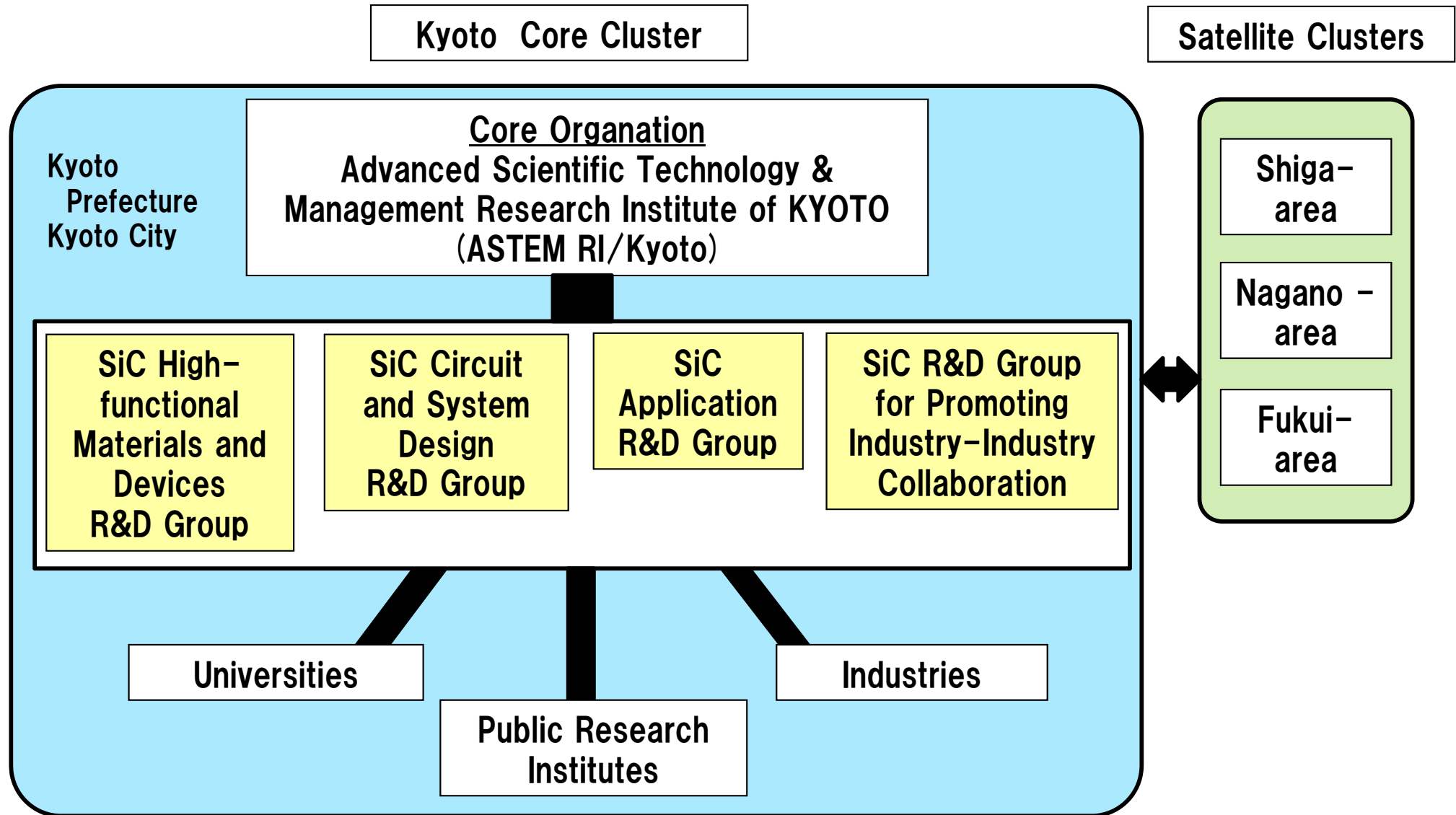
High Operating Temperature

Next generation power devices: SiC and GaN

**SiC device** has an advantage in high breakdown voltage/high power applications, such as in motor drive applications.

**GaN device** has an advantage in compact, high frequency applications, such as in switching power supply.

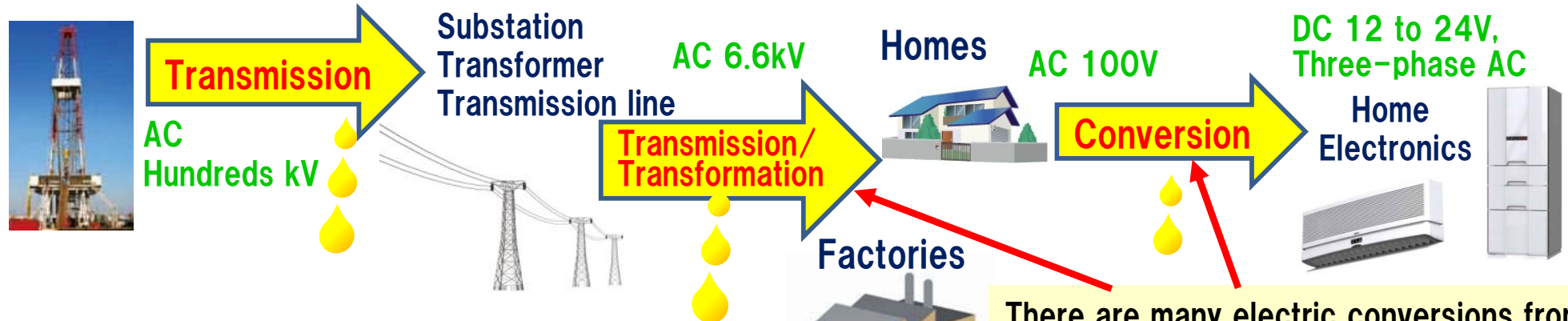
# Kyoto-area Super Cluster





# Background and aim of developing SiC power device technology

(Courtesy of ROHM Co., Ltd.)

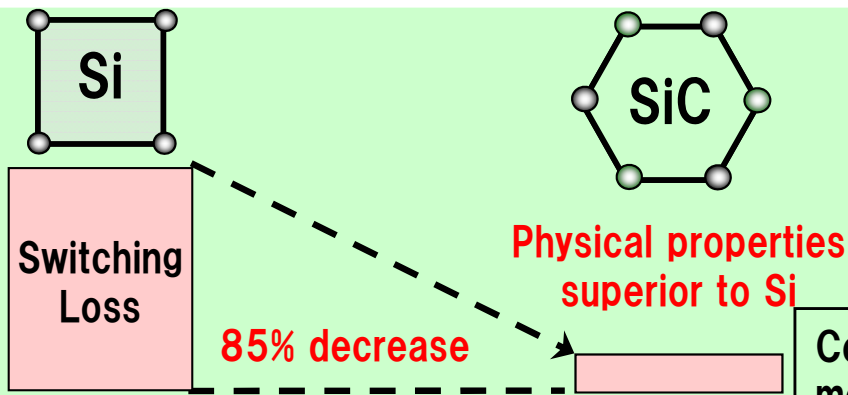


Total energy availability is approximately 40%.  
 (Average of 10 power companies, actual values for Fiscal 2004)  
 \*From the website of Osaka Gas CO., Ltd.

There are many electric conversions from generation to consumption.  
 Each conversion loses 3 to 5 % electricity.

Approximately 60% of electricity is lost through exhaust heat !

SiC can significantly reduce energy lost through electric conversions.

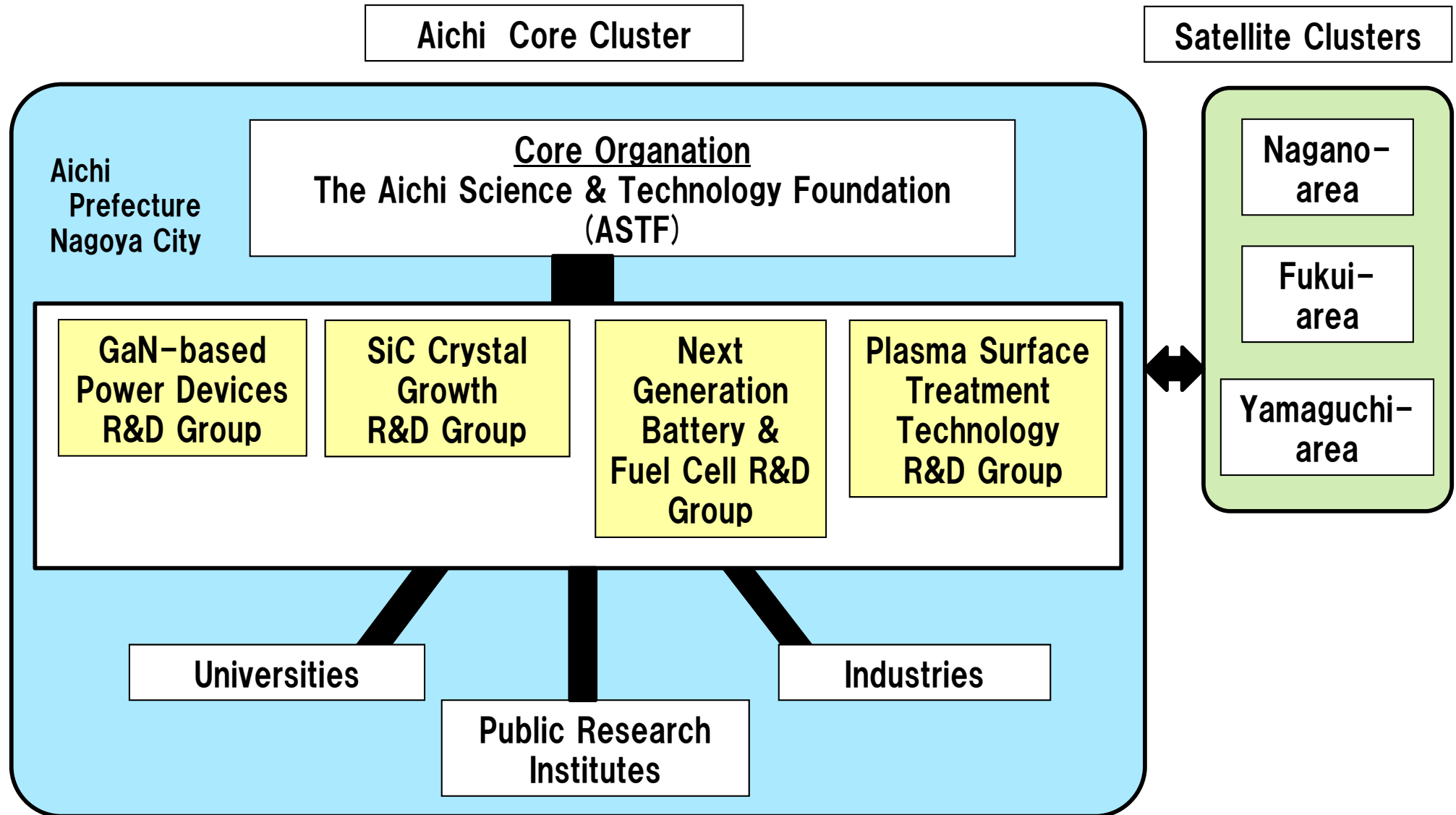


Full-scale popularization of SiC power devices will conserve approximately 30 TWh (equivalent to 3 to 4 nuclear power plants) of energy per year just in Japan !

Comparison between IGBT modules and full SiC modules

According to estimates of Engineering Advancement Association of Japan

# Aichi-area Super Cluster



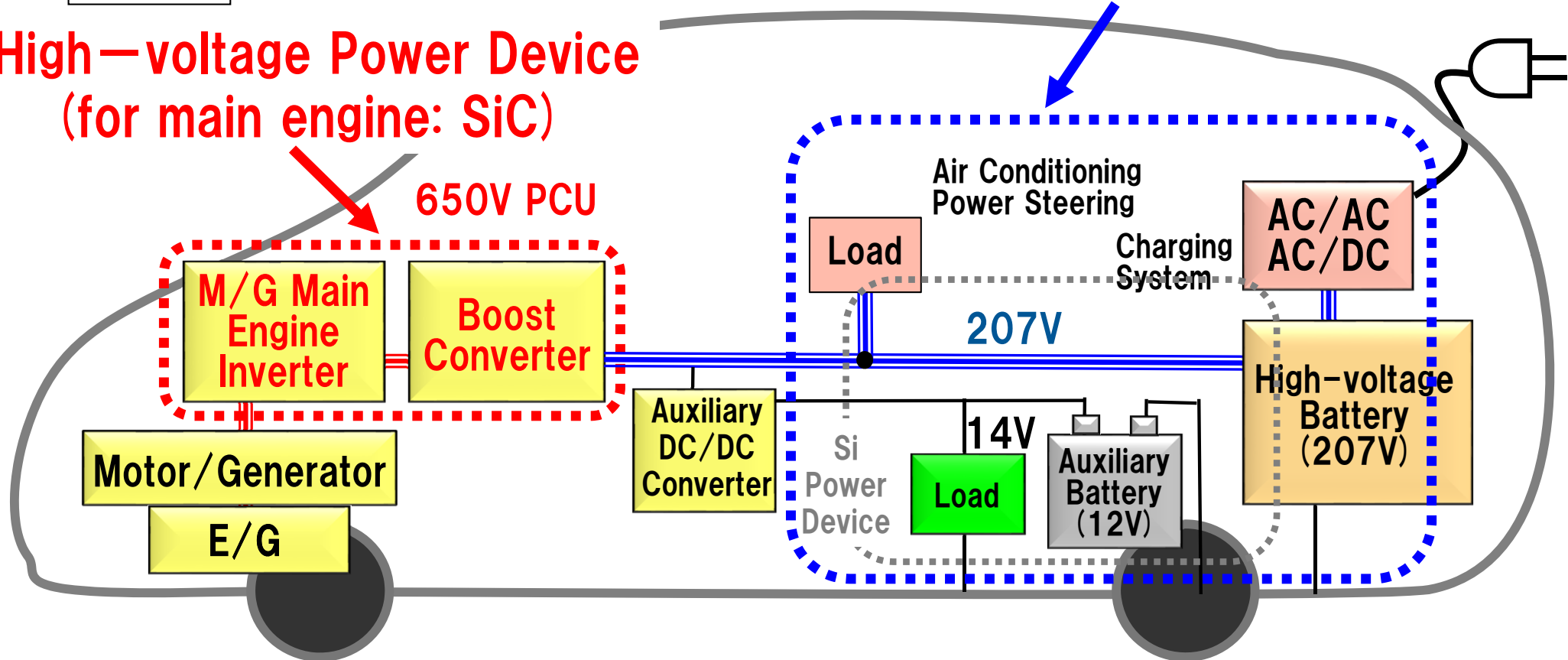
# Image of In-Vehicle Use of SiC and GaN

(Courtesy of Toyota Motor Corporation)

PHV  
EV

Medium/Low -voltage Power Device  
(for auxiliary engine: lateral GaN)

High -voltage Power Device  
(for main engine: SiC)



Lateral GaN: for medium/low-voltage auxiliary engine;  
SiC: for high-voltage main engine ⇒ Promotion of cost reduction

# Examples of product by Kyoto-area Super Cluster



## Micro smart grid system using SiC power modules

10kW-class smart power conditioner system with SiC power module and Li-ion battery, achieving 70% reduction of energy loss.

## High-voltage, high-frequency pulse generator using SiC-MOSFET technologies

SiC-MOSFET technology can provide a much higher-voltage, higher-current, higher frequency pulse generation in comparison with Si-IGBT technology.



## SiC based inverter integrated SR motor system

Compact and lightweight motor drive system for a magnet-less SR motor (SR: switched reluctance) with an SiC based inverter.

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*Thank you for your attention*