New Challenges of Power Electronics in Energy Management

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**Electrical Energy:** the most valuable and flexible form of energy

- Lighting
- Traction
- Heating
Electrical Energy Areas

- Energy generation (1)
- Energy transmission & distribution (2,3)
- Energy storage (4)
- Energy usage & conversion (5,6)
Electricity has to be transformed from the generation plants to the consumer

Power Electronics
Examples
Key Components: Silicon Power Devices
Power Electronics ranges from Giga/Mega-watts to mwatts
Power Electronics is:

“efficient processing of electrical energy through means of electronic switching devices”

40% of Energy consumed as electricity

Power Electronics Make Renewable energy possible
Power Electronics: Energy Processing
Extensive use of Power Electronics is required.
30% Reduction of Electricity Consumption with Highly Efficient Electronic Systems (efficiency > 90%)
**ITRS**: International Technology Roadmap for Semiconductors

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**More than Moore**: Diversification

- Analog/RF
- Passives
- HV Power
- Sensors
- Actuators
- Biochips

**Interacting with people and environment**

- Non-digital content
  - System-in-package (SIP)

**Combining SoC and SIP**: Higher Value Systems

**Digital content**

- System-on-chip (SoC)

**Beyond CMOS**

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**More Moore**: Miniaturization
The Electric / Hybrid Vehicle
Why WBG Semiconductors?

- Si devices are limited to operation at junction temperatures lower than 200 ºC.
- Si power devices not suitable at very high frequencies.
- SiC and GaN offer the potential to overcome both the temperature, frequency and power management limitations of Si.
Electric Car: Traction Electronic System and Controls

- Overall vision of the Power train

- GaN HEMT 80V

- SiC diodes
- SiC JFET

- 600V GaN HEMT Ultra low $R_{on}$
- 900V SiC MOSFET $T_j$ 250ºC
Wide Band Gap Semiconductor Devices for Rational Use of Energy (RUE)
Consolider CSD2009-00046

The Consortium

CNM
Centre Nacional de Microelec"atronica
IMB
CSIC

ISOM
POLITÈCNICA

Universidad de Oviedo
La Universidad de Asturias

Universitat de València

Universidad de Zaragoza

robotiker
tecnalia
The RUE Roadmap

1. Wind Turbines: On-shore
   - 3.3 kV

   1. Wind Turbines: Off-shore
      - 3.3 kV
      - SIC MOSFET (VJFET) + SIC Rectifier
      - SIC IGBT + SIC Rectifier

2. Solar Panels
   - 600 V
   - SIC MOSFET + SIC SBD

3. Electric/Hybrid Car
   - 600 V
   - SIC MOSFET + SIC SBD
   - GaN HEMT + GaN or SIC SBD

4. Communications (RFPAs for UMTS, 4G or DTT)
   - 600 V – 1.2 kV
   - GaN HEMT + GaN or SIC SBD

5. Industrial Induction Heating
   - 1.2 kV
   - SIC MOSFET (BJT, IGBT) + SIC Rectifier

Aims
- Power Devices for Real Applications
- Area!! (i.e. Current) > few mm²
- Yield > 50%
- Packaging high T

Applications Fields
1. Renewable Energy Production: Wind Turbines
2. Renewable Energy Production: Solar Cells
3. Electric/Hybrid Car
4. Communications (RFPAs for UMTS, 4G or DTT)
5. Induction Heating
## ON-GOING PROJECT/CONTRACT FUNDING

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<td>4 MICINN PROJECTS</td>
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<td>1 MITyC PROJECT (CENIT)</td>
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<td>1 GENCAT PROJECT</td>
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## PERSONNEL

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Thanks for your attention!