

# Strengthening Europe's Position in Power Electronics

The program for this year's Conference on Integrated Power Electronic Systems (CIPS) from March 11-13 in Nuremberg/Germany included 11 conference sessions with the presentation of 55 technical papers. 84% of them came from nine European Countries, 8% from North America, and 8% from Far East. The program also included 12 invited papers, authored by qualified experts coming from important industrial and academic organisations.



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General Chairman J. Daan van Wyk was proud to announce the participation of more than 180 delegates for this first stand-alone conference, while in previous years CIPS has been held in conjunction with IPSPD oder PESC. For the first time a Session on 'Technology Roadmaps' for Power Electronics has been organised, and five contributions gave an insight to the ECPE initiative on technology roadmaps.

## Projections up to the year 2020

General Chairman Leo Lorenz introduced this roadmap initiative. "Our vision in ECPE is to devise medium to long-term research roadmaps up to 2020 to offer guidelines for power electronic research by universities and research centres, but also to provide an orientation for public research programmes and to help industry to prepare for upcoming technologies. The focus is on power electronics in different key systems and applications, installing system-oriented teams with experts from

industry and university".

Basically, the roadmap development process can start from the application or the technology view. The chosen application-oriented approach is focussing on the requirements in different key systems using power electronics. Therefore, seven system-oriented teams have been formed for the power electronics applications of highest strategic importance which are coordinated from the university side. Included are Power Grid Infrastructure (power generation & distribution, energy storage) and Renewable Energy Sources (wind, PV); Large Drives (large industry and traction drives); High Performance Motor Drives; Small Drives for Home Appliances; High Frequency Power Conversion >1kW (e.g. telecom, server, heating, welding); High Frequency Power Supplies <1kW (e.g. stand-alone & integrated power supplies, chargers, lighting); and Automotive Power Electronics (low and high voltage applications).



**"Our vision in ECPE is to devise medium to long term research roadmaps up to 2020 to offer guidelines for power electronic research". General Chairman Leo Lorenz explained**

"In the vision 2020, the role of power electronics in 2020 is described with special focus on the role of Europe regarding industry position and R&D institutions in power electronics. In the next step, megatrends in society are related to power electronics. Trends and drivers from the customer and end-user side, as well as technology trends and drivers, are investigated. Limiting challenges driven by market needs and major technology gaps to be closed to meet the challenges have to be analysed. Finally, strategic goals are defined answering the key question for the roadmap development process: where do we want to stand in 2020 and what are reasonable intermediate steps in 2010 and 2015, in the power electronic systems view?", Lorenz explained.

## Bottom-up approach

"The use of technology roadmaps in microelectronics is indispensable, but little has been done so far in power electronics, except the activity of the power supply manufacturers association. For this reason, ECPE has started an own technology roadmap initiative in which all power electronics systems are using common materials, components and technologies", Technical Chairman Eckhard Wolfgang stated. For power semiconductor roadmaps are provided by the manufacturers, i.e. by Infineon Technologies.

## Automotive power electronics

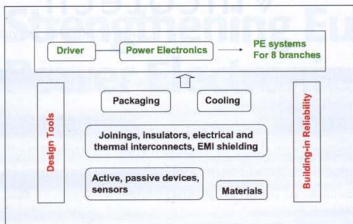
The automotive industry has specific requirements for its power electronic systems, such as a compact design, high reliability, long lifetime and an extremely low cost to power ratio. The systems are further required to operate over a wide



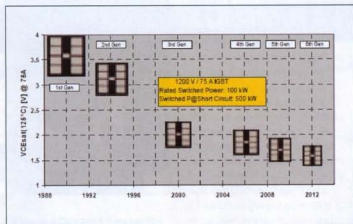
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ambient temperature range and with liquid cooling temperatures of typically 105°C. "In a study from the USA FreedomCAR project, it is projected that the required cost of the power electronic systems has to reduce by a factor of three until the year 2020. The task of the Automotive Roadmap Committee was to clarify which technologies are needed to achieve the performance and cost targets of the automotive industry", Wolfgang said.

Thus, the road mapping effort is focused on three systems such as a non-isolated DC/DC converter in the 40 to 100kW power range, that can be used as a fuel cell interface; an AC/DC inverter that is integrated into the machine housing of a hybrid drive system (since an integrated solution provides the greatest cost reduction potential); and an isolated DC/DC converter to provide bidirectional power flow between the high-voltage bus and the 14V accessory power system, where the required power range is up to 3kW.



#### ECPE bottom-up roadmap



#### Roadmap for 1200V IGBTs – on-state voltage and chipsize

The roadmap utilised the bottom-up approach, here mathematical descriptions for the electrical, thermal, packaging and magnetic components are developed. Using these descriptions a component technology space is formed. By using the specifications, topologies, and operating parameters, the component space can be mapped into a system performance space, which gives system performance measures such as efficiency, power density and costs.

#### High frequency power supplies

"Europe is in a good position with regard to semiconductor technology and some system level applications, like automotive, medical and lighting, but on the other hand, Europe is in a weak position in power supplies and packaging, especially in the low power range. The proposed strategy for Europe is to use our strengths to improve our weak points", José A. Cobos (Universidad Politécnica de Madrid) pointed out.

Diversity is a keyword in power supplies, since they may be classified

from very different perspectives. Different requirements apply from an application viewpoint, ranging from Industrial or Telecom to Lighting or Information Technology. The energy source also makes a difference: typical off-line AC power supplies

show different metrics than battery supplied converters, and even greater distance from self-powered or autonomous devices. There is also diversity in the loads, which impose different requirements to the power supplies. New power management trends are based on the own nature of the load. Some techniques applied to reduce power consumption in digital circuits (voltage scaling) differ from those used in highly efficient non-linear RF amplifiers. They are also different from the requirements of contactless chargers (i.e. in body implants), and they also differ from the strategy to supply flat panel displays. Power device technology also makes a difference, lateral CMOS devices are more appropriate than standard vertical devices in some low power applications.

Therefore, groups with some commonalities need to be identified, so that the same strategic goals apply to all the possible applications of that group. Pursuing this objective, four different groups (off-line electronics, digital circuits, mobile electronics, and self powered) have been selected, all of them under the umbrella of the Integrated Power Supplies.

#### High frequency power conversion

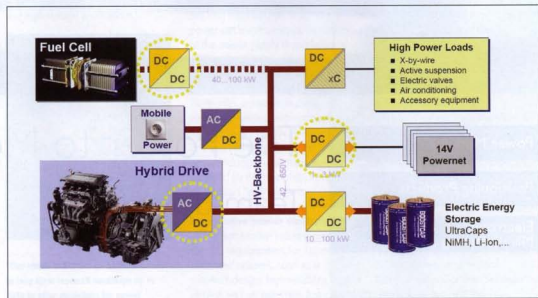
"Europe's worldwide market position has a big chance of remaining very strong in the field of industrial high power supplies, because of two important factors - the innovation in high-power supplies is key prerequisite for industrial manufacturing technologies for high-

volume goods such as electroplating or induction heating, and the final product is not only the power supply itself, but also the sum of technical quality, cost-performance relation, customer support during the design-in process, application as well as technology specific knowledge, maintenance issues, and much more. Moreover, the power supply is the key-part of a very complex final product", Tobias Reimann from ISLE/Germany stated. "Thus, a completely different added-value sharing situation can be utilised, compared to mass market products, and therefore, it is absolutely necessary to gain the basic R&D activities to defend this position in the future.

Examples for main research topics for the next ten to twenty years include fully digital, self-learning converter to load and converter to grid interfaces; active-passive integration at very high power levels; efficient prototyping platforms including electrical, thermal, EMI, EMF, mechanical, and economical issues; materials for high power density passives; self-protected intelligent high power semiconductor switches with high load and temperature cycling capability; multifunctional materials for impedance-optimised system design and shielding; and high performance systems for remote diagnostics maintenance and service.

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Power electronic key systems for the cars of tomorrow, three considered systems in the automotive roadmap are encircled