IEEE IAS/PELS/IES German Chapter meets at Goldisthal

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More than 60 engineers and students met in central-German Thueringen on October, 13th and 14th, 2005 during a joint meeting of the Joint IAS/PELS/IES German Chapter and the PES German Chapter. It has been hosted by the Technical University of Ilmenau and by Vattenfall Europe who presented their unique pump storage plant at Goldisthal.

After an introduction and a report about the planned chapter activities in 2006 by our chairman Prof. Lindemann, University of Magdeburg, an overview about the research areas of the institute of electrical energy and controls was presented by Prof. Dirk Westermann, TU Ilmenau, followed by detailed introductions of the respective chairs:

Prof. Westermann himself is head of the research group for energy supply. The group's special interests are the security of energy grids, their control and optimization, and real time simulations. In the sequel all research groups presented themselves.

The research group for electrical equipment was presented by Dr. Reichert. The research areas of this group are high-voltage technology, especially switching devices, location of partial discharges, impulse and lightning protection. To develop the necessary equipment finite-element analyses, computational fluid dynamics and circuit simulation tools are in use.

Prof. Petzoldt presented the research group for power electronics and controls. The research areas are power electronics, controls and electrical drives. Actually this group consists of four research assistants at the university and about 16 researchers at the associated industry-driven ISLE GmbH. Also the ISLE GmbH is one of competence centers of ECPE (European Center for Power Electronics). Some of the projects are steer-by-wire systems, power quality analysis, switched-reluctance machines as a pump drive and fuel cells.

Next Prof. Oesingmann presented the research group for small electrical machines. Some examples of the research are small vibrational motors in mobile phones and motors with bell-shaped rotors, which costs should be smaller than 0.37 Euro. The main competence of this research group is the electromagnetic design of such small machines.

The last presentation was given by Prof. Schulze about the research group of electro-thermal energy conversion. The classical field of this research group is induction heating. An actual research topic is the dynamic of magneto-fluids. Special projects are the electromagnetic support of molten metals, turbulent flow of metals and the crystallization of metals in high magnetic fields with flux densities up to 5 T. Furthermore the research group performs numerical simulation for coupled electromagnetic, thermal and flow fields.

After these presentations the participants have had the opportunity to visit the laboratories of the institute of electrical energy and controls.

In the evening, the social meeting took place at the Romantik Hotel Gabelbach in the woody mountainside close to Ilmenau. Besides tasty local food and beverages in homelike atmosphere, the participants enjoyed a program comprising a stirring presentation of Prof. Petzoldt, President for Education of Ilmenau University and Academic Relation Officer of the Joint IAS/PELS/IES German Chapter, about current and foreseeable development of engineering education, academic structure and university financing. Further, PES German Chapter used the event to honour a student with its annual Best Diploma Thesis Award 2005, awarded by Prof. Kindersberger from Technical University of Munich.

The second day, October, 14th, 2005, started in the technology center of Ilmenau with three presentations about the pump storage plant. First Dr. Möhlenkamp, Alstom, explained the behavior of converter controlled renewable energy production like wind power generators in case of blackouts. When the voltage of the grid returns after a shortage, an overshoot of the mechanical torque up to four times of the rated torque is possible. Usually three different types of electrical machines are used for wind power generators: the doubly-fed induction machine, the squirrel-cage induction machine without pitch control of the rotor blades and the synchronous machine with pitch controlled rotor blades.

The presentation given by Prof. Kindersberger, Technical University Munich, dealt with gas-insulated tube conductors for high voltage transmission. With these conductors voltages of about 420

View in the turbine cavern showing generator opened for maintenance

Chapter members at the upper basin (left side) and downhill is the valley (right side).

kV to 550 kV can be transmitted. They consist of an outer cylindrical aluminium tube with a wall thickness of about 8 mm and an inner concentric conductor. The inner conductor carries the high-voltage. Because of this construction there are minimal outer magnetic fields. About each 11 m additional supporting insulators are foreseen to fix the inner conductor. The cavity between the inner conductor and the outer cylindrical tube is filled with a mixture of nitrogen and sulfur-hexafluoride for electrical insulation.

In the following Mrs. Bocquel, Alstom, presented the 300 MW variable speed drive for the pump storage facility of Goldisthal. Four turbines are installed there equipped with two synchronous machines and two doubly-fed induction machines each with a rated power of about 340 MVA. The synchronous machines have a bore diameter of 6 m and a classical excitation. The rotor circuits of the two induction machines are supplied by a 100 MVA cycloconverter each, carrying a rated current of 9 kA. The speed control of these electrical machines uses the concept of a Kalman filter to estimate flux and torque.

The presentation by Mr. Voigt, Vattenfall Europe, gave an introduction to the history, technical aspects, and economic use of the pump storage facility of Goldisthal. Planned in 1965 for 3000 MW the geological exploration was finished in 1972. Official approval started in 1991. In 1997 the construction started and in 2002 the pump storage facility of Goldisthal was connected to the power grid. Continuous operation started in 2003. The upper basin has a capacity of 12 million cubic meters of water. The falling height is nearly 330 m. The peak current of each turbine-generator set is 12 kA. The two synchronous machines and the two doubly-fed asynchronous machines each have a bore diameter of 6 m. The synchronous machines have an air gap of 35 mm. The asynchronous machines have an air gap of 15 mm.

The very highlight of the meeting was the following visit of the pump storage facility itself operated by Vattenfall Europe. During this excursion all participants have had the opportunity to visit the turbine cavern nearly 800 m inside a mountain and both basins. The turbine cavern has a length of 150 m, a height of 50 m and a width of 30 m to 40 m. The water flows from the upper basin to the four turbines through two tubes, each having an inner diameter of 6 m. The peak water flow is 80 cubic meters to 100 cubic meters per second. The upper basin is located on the leveled top of a mountain about 330 m over the turbine cavern. The Vattenfall team had thoroughly prepared the reception of the large group. The guides gave a deep insight into the impressive technology, related potential and challenges and its daily operation.

To obtain copies of various presentations and for further information about the IEEE Joint IAS/PELS/IES German Chapter in general including 2006 meeting plan, please visit our homepage at http://www.ewh.ieee.org/r8/germany/ias-pels

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Emerging Capabilities in Electronics Technologies for Extreme Environments Part I – High Temperature Electronics

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Abstract

This article describes the current status of technologies used to realize electronics for extreme environments. While VLSI technologies predominantly focus on supporting commercial applications ranging between -55ºC and 75ºC, many applications such as electronics for under the automobile hood and electronics for geothermal systems would be best served by technologies that could survive the environmental conditions in which the system is deployed. While each of these applications could be considered as niche, together they form the basis for research into extreme environment electronic systems. Power electronics are widely used in these applications, but constitute only one facet of a fully integrated system. Focusing primarily on temperature effects, this article indicates the areas of research needed to move forward with a sound design methodology for realizing high performance, fully-integrated electronic solutions.

I. Introduction

Electronics have dramatically changed the way we live our lives, conduct business, communicate, and educate. However, the environments in which electronics can reliably operate are at present limited. For example, in consumer applications, typical operating temperatures range from -40 oC to +85 oC and the 'wider' military standard is still just -55 oC to +125 oC. The Semiconductor Industry Association (SIA) 2003 International Technology Roadmap for Semiconductors (ITRS) only extends the ambient operating temperature for integrated circuits in harsh environments to -40 oC to +150 ∞C in 2005 and to -40 ∞C to +200 ∞C beginning in 2010 [1]. Electronics are also susceptible to radiation exposure, not just in space applications [2] but also here on Earth. This is because the continued scaling of device dimensions has made the effects of residual radiation a critical reliability issue for manufacturers of consumer electronics [3, 4]. For example, single-event effects (SEE) caused by cosmic rays, which can produce either hard or soft errors, have been observed both on the Earth's surface at levels that can measurably impact commercial microelectronics technologies [2-5], and in avionics at levels that would jeopardize the reliability of these systems if mitigation strategies are not employed [6]. Using electronics in corrosive chemical or high vibration environments also places severe constraints on system complexity and reduces overall reliability.

Future advances in engineering, scientific discovery, and exploration of key importance to national priorities will require advanced electronic systems to operate in environments that combine extremes of temperature with corrosive chemistry/biochemistry, mechanical vibration, and radiation. The narrow confines of commercial electronics are such that it will be impossible to address many of these priorities such as those related to energy, transportation and Earth and space exploration. A new approach will be needed; one that allows electronics to function in a combination of extreme environments.