POWER ELECTRONICS SOCIETY NEWSLETTER

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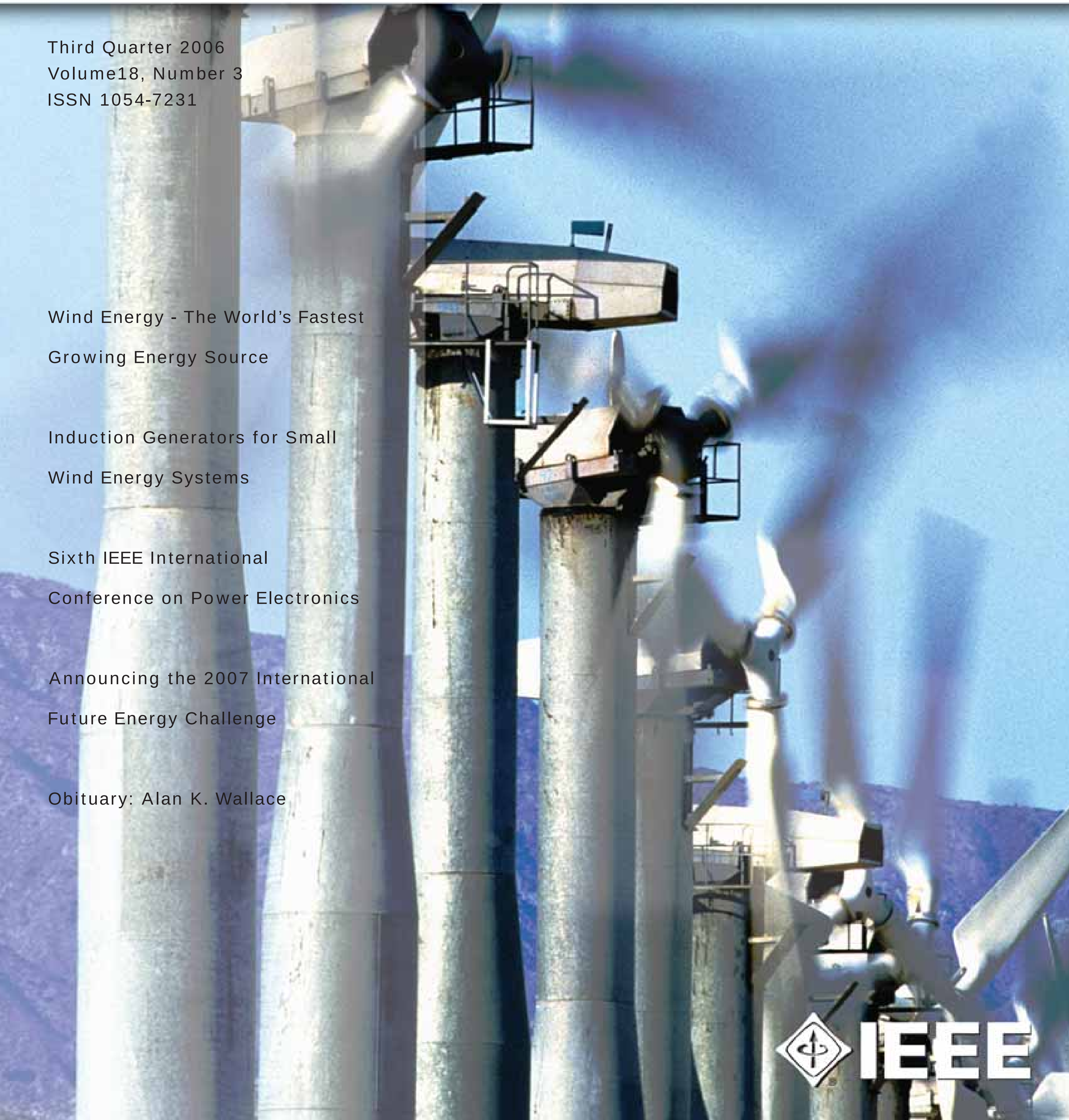

Wind Energy - The World's Fastest Growing Energy Source

Induction Generators for Small Wind Energy Systems

Sixth IEEE International Conference on Power Electronics

Announcing the 2007 International Future Energy Challenge

Obituary: Alan K. Wallace

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News Items should be sent to: Dr John M. Miller, PELS Newsletter, Editor-in-Chief, J-N-J Miller Design Services, PLC, 3573 East Gatzke Road, Cedar, MI. 49621, USA; TEL:+1 231 228 5011; EMAIL: pelsnews@ieee.org. Deadlines for copy are March 15, June 15, September 15 and December 15. Email submission of items in MS-Word or plain-text format are preferred. MS-Word and plain-text (straight ASCII) submissions on CDROMs are welcome and should be accompanied by a backup hardcopy. Fax submissions are acceptable, but are least desirable. Include caption with all photos identifying event and individuals in a back-row, left to right, front-row, left to right, etc method. Full-page calls for papers and announcements of PELS-supported conferences are welcome and should be sent as both high-quality hardcopy and MS-Word files. Please indicate all trademarked items, such as INTELEC®, APEC® with the registered trademark symbol, "®".

Technical items should be sent to: Prof Juan Carlos Balda, PELS Newsletter Associate Editor, University of Arkansas, 3217 Bell Engineering Center, Fayetteville, AR 72701, USA; TEL: +1 479 575 6578; FAX: +1 479 575 7967; EMAIL: jbalda@uark.edu

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The Newsletter in PDF format is posted at the PELS website approximately three weeks sooner than paper copies can be delivered. To receive email notification when the internet version is available, go to http://www.pels.org/Mailing/MailForm.html and provide your email address. Additionally, the email notification sometimes includes timely announcements that are not in the printed newsletter.

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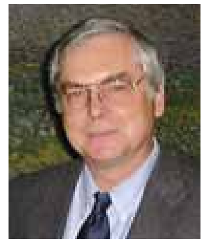
From The Editor

John M. Miller



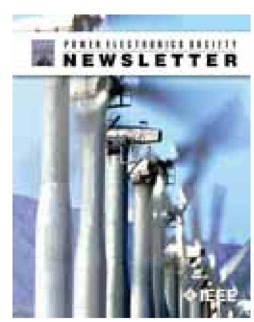
In the last issue it was noted that a new sales manager West area was to be announced. The newsletter staff is indeed pleased to now invite Mr. Tom Flynn to the power electronics society newsletter team. Thank you to Mr. Flynn for agreeing to work with us and to help increase advertising. Kudos go to our own Mr. Walter Chalupa who has worked to bring this about.

In this issue readers will find the first announcement for the 2007 International Future Energy Challenge. Prof. Phil Krein is topic coordinator for the Universal Adapting Battery Charger and Prof. Babak Fahimi is topic coordinator for the second topic, Integrated Starter/Alternator-Motor Drive for Automotive Applications. Also in this issue is an announcement for the new IEEE Power and Energy Library. Thank you to Karen L. Hawkins, Senior Marketing Manager for Corporate Sales and to Bob Dent, Susan Sacks, and Mel Olken for their inputs into this program.

Themes for future issues will be somewhat different as we move into 2007. Over the course of the next two issues the newsletter staff will be engaged in developing a sequence of updates from our technical committees and each TC chair will be invited to submit an article on current activities. This will give our readers a window into the operation of PEL's technical activities and hopefully will be well received. I wish to thank the TC chairs in advance for their support of this initiative.

July 2006	wind power topics
October 2006	transmission and distribution of power
January 2007	start of articles from PEL's technical committees

John M. Miller, EIC
pelsnews@ieee.org



Front cover courtesy of IEEE

President Column

Dear power electronic friends,

Our great society has the honor of leading all societies in growth in 2005, about 1.4% against 2004. This is quite spectacular when most societies were loosing members. According to IEEE headquarters, many IEEE members who hold multiple society membership are canceling multiple memberships because the "jewels" of IEEE, i.e. our IEL library, are accessible via university or company Xplore license. Clearly, societies need to think about new services which are deemed attractive for our members, especially young members. Recently, IEEE asked me how we did it? Without having a complete list, I mentioned several initiatives which our society has undertaken:

- We have been able to increase steadily number of chapters and try hard to keep them active. Together with our Chapter Development Chair, Enrico Santi, and Membership Development Chair, Ralph Kennel, all officers are engaged to convince members to create PELS chapters. We increased our chapter budgets, especially for joint chapters (mostly with IAS). Joint chapters receive from PELS the same amount as any other PELS chapter, no sharing penalty!
- The International Future Energy Challenge (for students) has been budgeted, with more travel grants for its next edition (2008). Our Education Committee Chair, Leon Tolbert is handling the travel grant and made practical guidelines. This IFEC event has been very successful and reaches out to students. Students are our future!
- Within IEEE, PELS has a high citation score outside IEEE. Thanks to all authors and reviewers! A study in IEEE could correlate citation level with timeliness (of review and publication). Thanks to our excellent past Editor in Chief (EIC), Daan van Wyk, our transaction review process has been reduced to an average of 6 months. Our present EIC, Frede Blaabjerg, is switching to manuscript central (a web based review package of IEEE). Frede is confident that this investment will accelerate our review-publication process even further.
- Our Technical Committee Chairs are very active: they are structuring more and more their committees (with officers such as vice chair, secretary, treasurer, etc.). With this structure they can apply directly to our PELS AdCom for budgets.
- Over 50% of the members are outside US. This has been recognized early on by society officers and our annual meeting has been organized often outside US (actually next year, PESC07 will be in US, after 8 years).
- Our conferences (APEC®, PESC®, INTELLEC®) have generated surplus which is invested (within TAB limits) in new products. PELS is concentrating its conferences to improve quality and get industry back in our conferences. In US, PESC joins IAS IPCSD to organize from 2009 onwards the Energy Conversion Conference and Expo (ECCE09). In Asia, a MOU will be signed with the Chinese Electrotechnical Society (CES) to organize jointly IPMC06. MOU's are being planned with KIPE (Korea) and IEEJ (IPEC) to organize alternating a major power electronics event in Asia. In Europe discussions are on-going with major power electronic conferences to jointly organize a conference with expo. From 2009 onwards all major PELS conferences will have an exhibition to draw industry back in our meetings (similar to APEC). We decided that we will stop PESC (after 40 years) to make this happen: we have to move forward!
- Allan Mantooth has reactivated our standards activities.
- Our Newsletter editor is doing a great job. The Newsletter you are holding in your hand is the creation of John M. Miller and has been masterminded by Ron Harley, Publications Chair. John Miller and Ned Mohan have created excellent lecturing films which are produced by professionals under the IEEE XELL program and are becoming the next hot product!
- Maria Cotorega is following on the IEEE Women In Engineering (WIE) call and is creating a Women in PELS (WIPELS) committee in PELS.
- PELS officers are elected from all over the globe. Next year, our president Elect, Hiro Akagi will be the first PELS president from Asia. Actually, next to our Region 8 Liaison (Johan Kolar, Cain O'Mathuna), Region 9 Liaison (Maria Cotorega) and Region 10 Liaison (Jinjun Liu), we appointed a US liaison.

  So what is holding us back of being more successful?
- Time of volunteers, for example, our distinguished lecturer (DL) program is not spending what it should.
- Furthermore, larger projects could be considered (we would like to see IEEE raise the pre-approved project limits to 100 k$ or even higher). Our treasurer, Braham Ferreira, just needs to budget them!
- Get more industry people involved in all levels of the society and its activities. To this end, several TCs have appointed industry members as officers in technical committees. We also appointed an industrial liaison, Ljubisa Stefanovic, to follow up on these items.

Clearly, PELS members and volunteers do not ask what the society can do for them but ask what they can do for our society! I thank all volunteers and PELS officers for their continued support.

Rik W.A.A. De Doncker,
President

Announcement: International Conference on Optimization of Electrical and Electronic Equipments, OPTIM 2008.

Prof. I. Boldea, IEEE Fellow, General Chair of OPTIM-2008, and Prof. Mihai Cernat, IEEE Member, General Program Chair of OPTIM-2008, and Conference Secretary.

OPTIM-2008 venue: Biannual (in same Mountain Resort), on Power Electrical and Electronics Enginnering; May 22-24, 2008, Brasov, Romania and technical co-sponsored by IEEE – IAS, IES, and PEL's. For details please visit: http://info-optim.ro and http://optim.8m.com

The Conference OPTIM holds its own domain and has its own management system. All reviewing process will be managed electronically. You only have to fill in your data as author (section Authors); we apologize for this small extra effort but we hope the process will get smoother and we all will benefit. To submit your paper please access: http://www.info-optim.ro/conforg

Notes: Submit a paper using corresponding item in Authors menu. Fill in carefully the Paper Submission form. Please remember, use a valid e-mail address when you submit your paper. You need to choose your own username and password (do not forget them). The paper ID, which you will receive via e-mail upon submission of this form, along with corresponding password will allow you to make future changes to the submission. There is an e-mail based mechanism to recover forgotten username and/or password. Make sure paper is completely blinded (i.e., no author's info).

Contacts:
I. Boldea: boldea@lselinux.upt.ro
M. Cernat :cernat@leda.unitbv.ro"


Prof. Babak Fahimi


Prof. Phil Krein

Announcement
The 2007 International Future Energy Challenge (IFEC'07)

International Future Energy Challenge (IFEC) is an international student competition for innovation, conservation, and effective use of electrical energy. The competition is open to college and university student teams from recognized engineering programs in any location. The 2007 competition addresses two broad topic areas:

Topic (A) Universal Adapting Battery Charger: An efficient battery charger power supply capable of adapting to a range of applications. The requirement is a small plug-in power supply capable of automatically charging a wide range of battery configurations. This would reduce the needs for battery-charging devices in a typical home from several to as few as one.

Topic (B) Integrated Starter/Alternator-Motor Drive for Automotive Applications: The main purpose of this challenge is to conceptualize, design, and develop a 3 kW, 4000 rpm electromechanical energy converter for operating efficiently (not less than 75% at cruising speed) as an alternator and motor. It is also desired to have a (cold) stand still torque of 80 N-m, for duration of 3 to 5 seconds, to accommodate the starter requirement.

Participation is on a proposal basis. Those schools that are interested must submit a proposal no later than September 18, 2006. Each university is limited to only one topic area. Schools with successful proposals will be notified by October 1, 2006. Student teams will then carry out the work and prepare hardware prototypes and reports. Mid-progress reports are due February 19, 2007. Final progress reports are due May 1, 2007. By May 15, 2007, the judging panel will select a group of teams as Finalists. These teams will be invited to a competition event that will begin August 20, 2007. A final report will be due at the competition event. Prizes totaling at least $50K are expected to be awarded. Major sponsor of the 2007 competition is the IEEE Power Electronics Society (PELS).

For further information, please visit http://www.energychallenge.org.

International Electric Machines and Drives Conference

Antalya, Turkey, May 3-5 2007

ANNOUNCEMENT AND CALL FOR PAPERS

The IEEE International Electric Machines and Drives Conference provides an international forum for sharing experience, new ideas, and developments in design, operation, analysis, and practical application and optimization of electric drive systems and their components. IEMDC is a venue for users, designers and manufacturers, and analysts of electric machines and drives and their related power electronics and controls. The conference is jointly sponsored by the IEEE Industrial Electronics, Industry Applications, Power Engineering, and Power Electronics Societies.

In addition to the subjects identified above, the conference will have plenary presentations by recognized experts to highlight various aspects of electric machines and drives, such as automotive applications, renewable energy applications, permanent magnet motor drive systems, fault tolerant operation and survivability, sensorless methods, and turbogenerator operation and maintenance. Papers addressing these topics are encouraged.

Information for Authors

Authors wishing to submit papers are invited to submit an abstract of 200 words or less and a digest of five pages or less, including text, tables, and figures, at the conference website: http://www.iemdc07.org. The Abstract and Digest should be in a single-column pdf format in 12 point serif text, such at Times New Roman on either A4 or US letter-size pages. Contact information for the corresponding author should be indicated on the abstract. No author information should appear on the Digest. Submissions should indicate a preference for oral or poster presentation. Acceptance notification will contain instructions for final paper preparation. Registration and payment of fees by at least one author is required for inclusion in the conference proceedings.

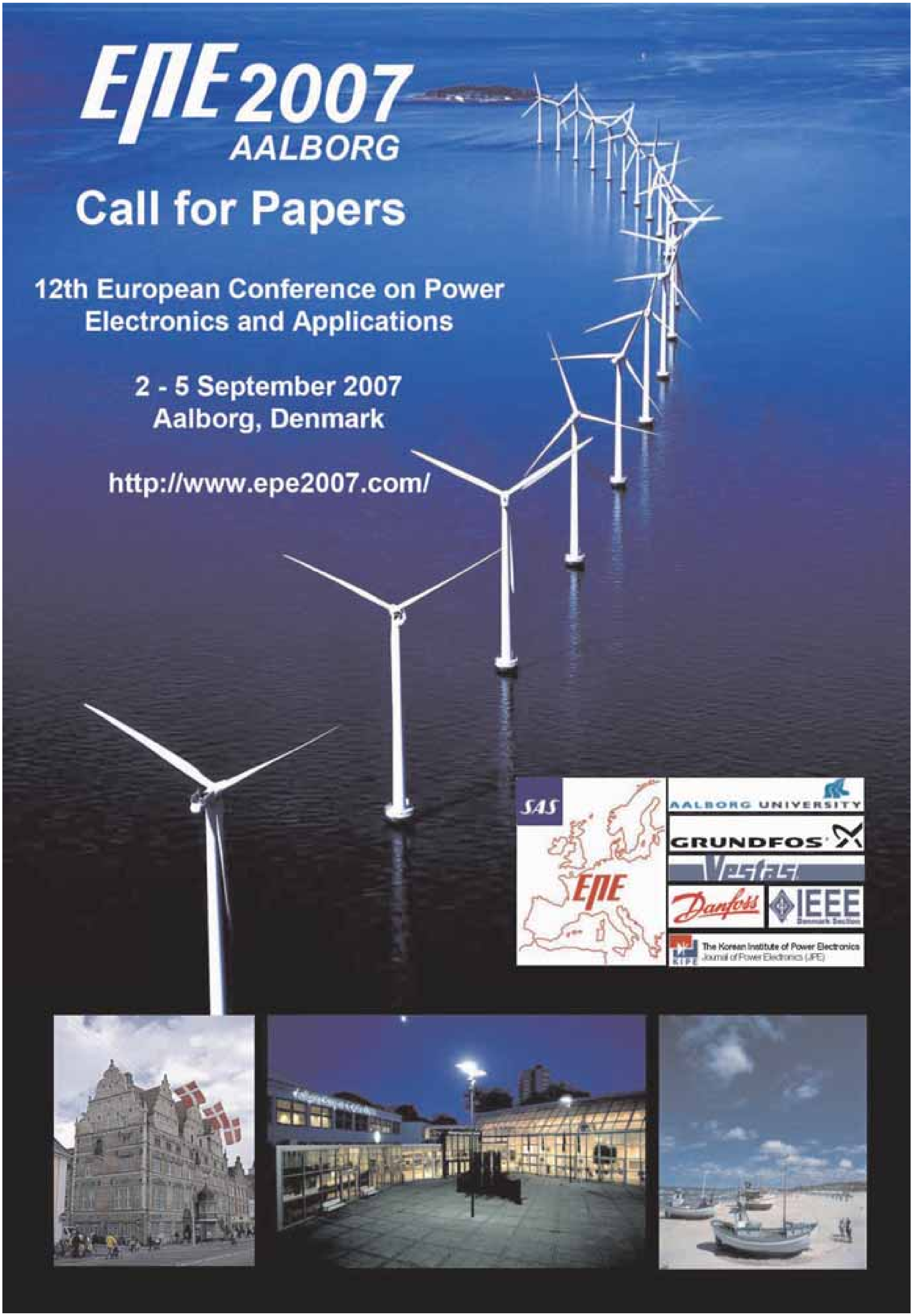
Author Deadlines	
Submission of Abstracts and Digests	October 30, 2006
Notification of Acceptance	January 15, 2007
Submission of Final Papers	March 1, 2007

Contact Information

Contact information is posted on the conference website: http://www.iemdc07.org. The preferred mode of contact is e-mail. For general conference information, please address comments and questions to:

Professor Okyay Kaynak
General Chair, IEMDC'07
kaynak@boun.edu.tr

Professor Herbert L. Hess
Technical Chair, IEMDC'07
hhess@ieee.org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Journal of Power Electronics (JPE)

Organization and Venue

The European Power Electronics and Adjustable Speed Drives community will gather in Aalborg, Denmark, in September 2007 to exchange views on research progresses and technological developments in the various topics described hereunder. The EPE 2007 conference is sponsored by the EPE Association and will be held in the Aalborg Congress & Culture Centre from 2 to 5 September 2007. It is hosted by Aalborg University's Institute of Energy Technology. Denmark is the distributed power generation nation. More than 20% of the electricity is covered by wind and small combined heat and power plants are covering even more. A perfect place for new power electronic solutions.

Aims of Conference

EPE is the place for specialists in power electronics, systems and components, to present papers and attend sessions on state-of-the-art technology in this challenging and evolutionary sector. The conference aims to be a meeting forum for researchers, developers and specialists from the industry. Papers are encouraged on all topics described hereunder for interdisciplinary discussions of new ideas, research, development, applications and the latest advances in the field of power electronics and adjustable speed drives.

Topics

Advances in Energy Conversion and Conditioning Technologies (ECCT), exploiting new power electronic systems, energy conversion devices and system control regimes, are all fundamental and crucial to the development of the clean, efficient and sustainable technology of the future. Over 50 % of the European, Japanese and North-American electric energy consumption passes through electronic conversion and conditioning equipment. This exploitation of ECCT increases steadily. Next to the improved behaviour of systems, the reduced energy consumption is a key factor, helping to achieve the Kyoto requirements and to address key issues related to the reduction of Greenhouse gases and pollutant emissions in industrial processes and transport; to increase the use of renewable energy sources and to allow their integration in the grid. Most of the electricity production based on alternative energy sources must undergo conditioning through ECCT equipment before use. ECCT is also a major means to achieve enhanced competitiveness of all industrial processes. Basic ECCT technologies alone constitute a world market estimated at multi-billion Euro value of which the EU has a 40% share. Significantly, ECCT is a core enabling technology providing the central electrical, control, diagnostic and management systems. The EPE 2007 conference will offer a wide discussion forum on all topics related to these aspects.

The list of topics hereunder holds only the headlines. A detailed list of subtopics is available at: http://www.epe2007.com

A. DEVICES, PACKAGING AND SYSTEM INTEGRATION

Topic 1: Active devices

Topic 2: Passive components, system integration & packaging

Topic 3: Power system integration

B. POWER CONVERTERS TOPOLOGIES AND DESIGN

Topic 4: Soft switching converters and control

Topic 5: Hard switching converters and control

C. MEASUREMENT AND CONTROL

Topic 6: Modulation strategies and specific control methods for static converters

Topic 7: Application of control methods to electrical systems

Topic 8: Measurements and sensors (except speed and position sensors)

D. ELECTRICAL MACHINES AND DRIVE SYSTEMS

Topic 9: Motion control and robotics, communication in drive systems

Topic 10: Electrical machines

Topic 11: Adjustable speed drives

Topic 12: High performance drives

E. APPLICATIONS OF POWER ELECTRONICS IN GENERATION, TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY

Topic 13: Electrical energy generating systems, renewable energy systems

Topic 14: Transmission and distribution of electrical energy

F. APPLICATIONS OF POWER ELECTRONICS IN USERS DEVICES / PROCESSES

Topic 15: Power supplies

Topic 16: Electrical systems in aerospace, space, surface and marine transport

Topic 17: Operating quality of systems

Topic 18: Industry specific energy conversion and conditioning technologies

Topic 19: Energy saving technologies

Topic 20: Energy conversion and conditioning technologies in physics research and related applications

G. EDUCATION

Topic 21: Education

Presentation of Papers

Contributions to EPE 2007 must be presented either as a lecture presentation or as a dialogue presentation. A manuscript must be submitted in English in both cases for inclusion in the Conference Proceedings (CD-ROM). Papers for lecture sessions will be strictly limited and selected on the basis of wide audience appeal, ease of understanding and potential stimulation of broad ranging discussion.
Dialogue presentation will take place in the afternoon. No lecture session will be organized during the dialogue sessions.

Tutorials - Call for Proposals

Several tutorials will be held prior to the conference. Authors willing to propose a tutorial at EPE 2007 are invited to send a proposal to the scientific secretariat (EPE Association, c/o VUB-IrW-ETEC, Pleinlaan 2, B-1050 Brussels, Belgium, e-mail: epe-association@vub.ac.be) before January 15, 2007. The proposal will consist of a three-page summary including tutorial title, name and affiliation of the lecturer(s), tutorial objectives and audience, topical outline and provisional schedule of the tutorial. Tutorials will be organized at the University of Aalborg on Sunday September 2nd, 2007.
Tutorial proposals are particularly welcome in the following topics, although other topics may be proposed as well:

- New Devices for Sustainable Energy Applications
- Understanding the Electrical Grid Behaviour and Management
- Building and Connecting Wind Energy Sources
- Building and Connecting PV Energy Sources
- Connecting Fuel Cells to the Electrical Applications
- Power Electronics and Adjustable Speed Drives for Clean Road Transport
- Application of Drives
- New Topologies for Sustainable Energy Applications
- Storage of Electrical Energy in the Electrical Grid
- Storage of Electrical Energy for Transport Applications
- Education issues
- More…

Content of Synopses

The synopses should consist of:
- a 2 to 3 pages **summary**, including an **abstract** with no more than 50 words; topic number and indication of the preference for dialogue or lecture presentation. These must be clearly mentioned;
- key diagrams;
- a references list.

The synopses will be submitted using the host of the conference on the internet. A link to the site will be available from **http://www.epe2007.com** a link from **http://www.epeassociation.org** will be available as well. Detailed information and guidelines can be downloaded from the site to help you preparing the needed material for submitting a synopsis. The site will be open for upload from 1 September 2006 onwards.
Authors of papers provisionally selected for presentation will receive a notification and can download the instructions for preparing the dialogue papers and/or the lecture papers from the internet site. Final selection will be based on the full paper. The paper will only be included in the Conference Proceedings after receipt of one full registration fee per paper in due terms. Student registration fee is only valid for student participants, not for authors. One single author may not present more than two (2) papers. In that case, the fee to present the two papers will be 150% of the registration fee.
A selection of outstanding conference papers will be published afterwards in the EPE Journal, which is an ISI registered journal. The paper will also be registered in IEEEXplore.

Deadlines

Intending authors should note the following deadlines:

Receipt of synopses	1 November 2006
Notification of provisional acceptance	1 March 2007
Receipt of full typescript for final review	15 May 2007

Working Language

The working language of the conference is English, which will be used for all printed material, presentations and discussion.

Programme and Registration

A provisional programme and registration form will be published a few months before the conference, and sent to all who submitted a synopsis – all authors & co-authors who completed their data sheet – and to all who requested a copy at the EPE secretariat by sending an e-mail with their coordinates to: epe-association@vub.ac.be.
Additional information: http://www.epe2007.com

Exhibition

There will be an exhibition integrated in the conference. If you would like to know more details please go to http://www.epe2007.com or contact us via e-mail: hk@aalborg.dk, bj@iet.aau.dk or epe-association@vub.ac.be

Venue

The venue is Aalborg, which is a beautiful and lively city, steeped in history and rich in great experiences. It was the Vikings who founded a settlement at this point where the Lim Fjord is narrowest, and through the years, the city developed into one of the busiest trading centres in Denmark. Trade and wealth set their mark on the city and many of the old buildings from that time have been preserved as natural elements in the city scene. Sightseeing is possible both in the city as well around Denmark. More details found at http://www.visitaalborg.com/show.asp?ID=53

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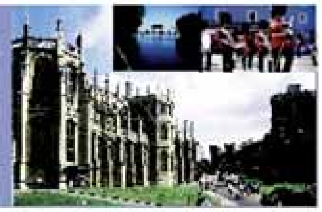
IEEE

2006 IEEE VEHICLE POWER and PROPULSION CONFERENCE (VPPC 2006)

September 6-8, 2006
Windsor England, United Kingdom
www.vppc2006.com



Call for Special Session Abstracts

The 2006 IEEE Vehicle Power and Propulsion (VPP) Conference is located in Windsor, England, UK. The VPP conference will conduct sessions in different technical tracks and paper offers are being invited on the following or related topics (www.vppc2006.com).

VPP Track 1: Vehicular Electric Power Systems and Loads
VPP Track 2: Vehicular Power Electronics and Motor Drives
VPP Track 3: Advanced Vehicles
VPP Track 4: Energy Storage Components/Systems
VPP Track 5: Modeling, Analysis, Dynamics, and Control

Prospective authors are asked to submit their 1-page abstract, (including an abstract title, authors, affiliations) to the following email address: secretariat@vppc2006.com . The deadline for submitting the abstracts is **APRIL 23, 2006.** Submissions from both academia and industry are strongly encouraged.

Special Session Themes

Fuel cell systems control and optimization (For further details please contact Dr.-Hab. **Daniel HISSEL**, Associate Professor, SM IEEE, Associate Editor IEEE TIE at, *email:* daniel.hissel@utbm.fr)

In-wheel Traction Machines for electric and hybrid vehicles (For further details please contact Dr. **Christophe Espanet,**, *email:* Christophe.Espanet@univ-fcomte.fr)

Multi-role Electric Vehicle Design

Cruise controls for Hybrid Electric Vehicles

Active Vehicle Suspension Systems

EMI/EMC Vehicle Design

Vehicle Electric Power Steering

Advanced Management systems for Electric Vehicles

Vehicle Supercapacitor technologies for land vehicles

Flywheel Vehicle Energy systems

Vehicle Thermal Analysis and Management

Vehicle Power and Propulsion in Higher Education

Control Methods for Hybrid Electric Vehicles

Power Semiconductor technologies for Hybrid Electric Vehicles

High-Tech made in Germany

The first meeting of the German IEEE IAS/PELS/IES chapter in 2006 was held at Lust Antriebstechnik GmbH in Wetzlar/Lahnau on March, 30 - 31.

The afternoon of 30th of March started with a guided tour through the city of Wetzlar. Wetzlar has about 50000 inhabitants and is a center of fine-mechanics and optics industry in Germany. Companies like Leica systems, Buderus and Hensoldt have their headquarters here. The participants walked around the nice old downtown of Wetzlar with its old houses made of timbered framework and the cathedral used by lutherans and catholics simultaneously. Also Wetzlar is one of the towns where Germanys best known poet Johann Wolfgang von Goethe resided for some years. During his stay in Wetzlar Goethe got the inspration for his famous novel "Die Leiden des jungen Werthers".

After the guided tour Prof. Andreas Lindemann, chapter chair, opened the IEEE Business session of the meeting in the conference center of Wetzlar. Among others he gave a short review of the chapters activities and publications in 2005. Prof. Wilfried Hofmann announced the next chapter meeting to be held in May 2006 at the Technical University of Chemnitz.

Subsequently all attendees of the meeting were invited by Lust Antriebstechnik GmbH to enjoy the outstanding skating show "Peter Pan on Ice" performed by members of Holiday on Ice. After the show dinner was served. The opportunity to meet colleagues and discuss all kinds of technical and further topics in a comfortable atmosphere was highly appreciated by the participants.

The second day, March 31st, the auditory was welcomed by Mr. Karl-Heinz Lust, the founder of Lust Antriebstechnik GmbH. Lust Antriebstechnik GmbH was founded in 1971. In that times the company produced electrical drives for vacuum pumps, especially frequency converter directly fed by the electric grid. Nowadays Lust Antriebstechnik produces servo drives and high speed drives. In 1993 the company started a new business namely the hybrid technology for microsystems. In 1998 a new company within the Lust Antriebstechnik group named Levitec was founded. This company's speciality is the electromagnetic bearing technology. In 1999 and 2002 the companies Sensitec and Lust DriveTronics were founded. Sensitec produces magneto-resistive components and sensors, which have even been used by NASA for its mission to Mars. In 2004 Naomi Technologies was founded by Mr. Karl-Heinz Lust. This company is active in the field of AMR and GMR technology.

After this introduction to the Lust Group, Dr. Stephan Beineke of Lust Antriebstechnik presented applications of direct-driven systems with linear permanent magnet motors. He gave an overview about five different control methods for current commutation, the application of a speed observer to extract the speed signal and a correction algorithm for the encoder signals.

Subsequently Dr. Andreas Bünte of Lust DriveTronics introduced the technologies used for the pitch systems of sea flow turbines. These concepts use the kinetic energy of the sea flow to generate elctrical power. The flow speed could be as high as 45 m/s. Dr. Bünte introduced the projects of SEAFLOW and SEAGEN. These two systems each generate 300 kW with a rotor diameter of 11 m. The shaft of these systems is located 15 m under the sea. The latest projects in the area of renewable energy from sea flow and sea waves are PELAMIS with 500 kW and Wave-Dragon with 600 kW. Lust DriveTronics has also experience in the area of electric pitch systems for wind turbines.

Next Dr. Christian Redemann of Levitec GmbH, also a company of Lust Group, reported about high-speed drives with active magnetic bearings. He explained the different types of active magnetic bearings especially a combined radial-axial magnetic bearing. These magnetic bearings use a hybrid exciation. The basic magnetic excitation is realized by NdFeB permanent magnets. Deviations from the desired air-gaps are controlled by small excitaion coils. Another speciality is the integration of magnetic bearings in stators of three phase permanent magnet synchronous machines. These high-speed elctrical machines have a maximum speed of 100.000 rpm with two pole pairs. The PWM frequency is about 64 kHz. The radial forces of the magnetic bearing take values up to 2000 N.

The last presentation was given by Joachim Achenbach of Sensitec GmbH and Dr. Jan Marien of Naomi Technologies, both belonging also to the Lust group, about the applications of XMR sensors. Mr. Achenbach gave an introduction about the

Levitec's magnetic bearing holding an iron ball.

magneto-resistive effect which was discovered by Kelvin in the 19th century. XMR sensors use the variation of the electrical resistance in the presence of magnetic fields. The deviation from nominal resistance is about three percent when using anisotropic materials. Applications of XMR sensors are high current sensors ranging from 200 A to 2000 A for use in hybrid automotive vehicles and low cost position encoders used in electrical drives.

Dr. Jan Marien reported about the different magneto-resistive effects namely Anisotropic MR (AMR) and Giant MR (GMR) and their production with micro-lithographic methods. He presented different applications in the area of medical systems to measure the magneto-cardiogram at 0.1 pT and the magneto-encephalogram at about 1 fT. Other applications are found in the area of magnetostatic printing devices to replace the standard blanket cylinder used in printing machines.

After the technically exciting presentations all participants were invited to a guided factory tour of Lust Antriebstechnik viewing the production of control units for electrical drives and magnetic bearings as explained before. In summary, the event, generously hosted by a highly innovative private company, was a great success, which has been underlined by the high number of some 70 participants: The manifold program comprised technical presentations and a technical tour focused on the area of activities of the chapter, further an outstanding social meeting and a session dedicated to IEEE Business. The chapter would like to cordially express its gratitude to the hosts.

For further information about the IEEE IAS/PELS/IES German Chapter and the next meetings please visit our homepage at http://www.ewh.ieee.org/r8/germany/ias-pels

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Welcome speech of Karl-Heinz Lust, founder of Lust Antriebstechnik GmbH.

"PELS president Prof. Rik De Doncker (second from left), RWTH Aachen, listen to the explanations of Dr. Josef Wiesing (first from left), head of R&D at Lust Antriebstechnik GmbH."

WIND ENERGY - The World's Fastest Growing Energy Source

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Wind Power Development Background

Present Status

The first electricity-generating wind turbines were invented in the late 1800s. In the early 1900s, as electricity became more widely available in towns and cities, many rural communities used small-scale wind turbines for their electricity supply, which were built on-site, using small generators, such as old car generators, and hand-carved rotor blades. But, except some remote areas, wind power has not really had any significant role to play in generating electricity until recently. In 1994, the installed capacity of wind turbines worldwide was about 3,500 MW. However, in the past 10 years, the global wind energy capacity has increased rapidly. According to the Brussels based Global Wind Energy Council (GWEC) (www.gwec.net) the global wind power industry installed 7,976 MW in 2004, an increase in total installed generating capacity of 20%. Installed global wind power capacity has grown to 47,317 MW. The countries with the highest total installed wind power capacity are:

1. Germany (16,629 MW)
2. Spain (8,263 MW)
3. United States (6,740 MW)
4. Denmark (3,117 MW)
5. India (3,000 MW)

A number of countries, including Italy, the Netherlands, Japan, and the UK, have above or near 1,000-MW installed capacity. Interest in wind power is also growing in many countries including China and Australia.

Europe continued to dominate the global market in 2004, accounting for 72.4% of new installations (5,774 MW). Asia had a 15.9% of installation share (1,269 MW), followed by North America (6.4%; 512 MW) and the Pacific Region (4.1%; 325 MW). Latin America + the Caribbean (49 MW) and Africa (47 MW) had a 0.6% market share, respectively.

Denmark is home to Vestas, the world's largest wind turbine manufacturer, and the wind energy industry is a giant contributor to the Danish economy. Denmark currently produces about 20% of its energy from wind sources and will increase the percentage of energy produced from wind to 25% by 2008 [1], and are aiming for a 50% wind share of energy production by 2025 [2].

Globally, wind power development is experiencing dramatic growth. The phenomenal growth of the wind industry can be attributed to supporting government policies associated with the environmental concerns, and research and development of innovative cost-reducing technologies.

Most electricity generated today uses non-renewable fuels such as coal, oil and gas. These contribute large quantities of carbon dioxide to the atmosphere, and cause an enhanced green house effect, leading to the Earth's atmosphere warming. Unlike the USA, Europe's response to the threat of global climate change has been to ratify the international Kyoto treaty on reducing greenhouse gas (GHG) emissions. Under the accord, 15 nations of the European Union will reduce their CO2 and other GHG emissions 8% below 1990 levels [3]. To achieve the targets under Kyoto, many European countries, have made the construction of land-based and offshore wind farms a top energy policy priority, because the advances in wind turbine technology over the past 30 years have made wind power more practical and efficient.

The advances in wind power technology are reducing the cost of wind power to a level that it is becoming competitive with many other energy sources. Today's largest commercial wind turbine has a blade diameter of 104 meters and produces up to 3.6 MW of electricity. One of the MW class wind turbines made by Vestas is shown in Fig. 1. In February 2005, Repower Systems of Germany switched on a demonstration turbine near Hamburg that produces 5 MW and has a blade diameter of 126 meters. Also General Electric is developing a design for a 70-meter blade, a total blade diameter 140 meters, a turbine of such size could produce as much as 7 MW. Modern large wind turbines use either asynchronous or synchronous variable speed generators with partly or fully rated power electronic conversion systems. The computers adjust blade angles in according to wind speed and direction to provide optimal operation, system control and protection. The technical advances have brought wind energy production costs down by 80% since 1980 to about $USD 0.05 per kWh or less [4] for utility scale wind turbines and created 20% growth in the industry per year worldwide.

Fig.1 V90-3.0 MW wind turbine (Reproduced by permission of Vestas Wind Systems A/S; www.vestas.com)

Offshore Development

Wind power, already the world's fastest-growing source of electricity, is still picking up more momentum. It is expected that 25% of the new electricity-generating capacity in the next decade will come from wind. However, it may not be easy to find suitable sites for land-based wind farms. Wind projects need a large area to achieve significant levels of energy production.

Wind developers have begun focusing on the development of offshore wind resources to avoid conflicts of onshore sites. Also, wind turbine technology advances have made offshore wind farm increasingly attractive. The basic technical requirements for efficient offshore wind turbine deployment are now moderate wave heights, relatively shallow water, and “class 4 or 5” wind speeds, averaging 15.7 mph or higher [5]. Europe fortunately possesses all of those conditions in many offshore waters – making ideal offshore wind farm placement conditions.

Other advantage of moving turbines offshore is that wind speeds are more consistent and less turbulent over water, therefore more energy production and less wear and tear on turbines. Also offshore wind farms become more ubiquitous than that on land, so that placing wind farms offshore removes or at least minimizes the visual impact.

Offshore wind farms now account for about 2% of Europe's total wind capacity. One of the largest recent wind farm developments is at Horns Rev off the coast of Denmark, shown in Fig. 2. It is expected that offshore turbines could be supplying 10,000 MW throughout Europe within five years. Germany alone plans to have 3,500 MW of offshore wind farms by 2010.

The largest offshore wind farm planed is the Arklow Bank in the Irish Sea. In 2002 the Irish government gave the go-ahead to Eirtricity, an Irish company, for the construction and operation of the 200 turbine, 520 MW wind farm.

In the United States, a proposal to develop the nation's first offshore wind farm off the coast of Cape Cod is made to build 130 wind turbines within a 25 square-mile area called Horseshoe Shoal situated between Hyannis and Martha's Vineyard in Massachusetts [5]. The proposed wind farm would have an installed capacity of 420 MW and an average generating capacity of 170 MW. That would be enough electricity to offset up to 113 million gallons of imported oil a year.

Wind Energy Industry in Denmark

The most significant results that the last 25 years of Danish research into alternative forms of energy have produced are the design and construction of wind turbines [6]. Denmark is one of the leading producer of wind turbines in the world, with an almost 40% share of the total world wide production. With sales reaching 20 billion Danish kroner in 2003, the manufacturing of wind turbines has within a few years become the third largest export commodity. In Denmark, the 3,117 MW (in 2004) wind power is supplied by approximately 5,500 wind turbines. Individuals and cooperatives own around 80% of the capacity.

Denmark is investing in research projects in all relevant aspects of wind turbine technologies. One of the overall goals is to develop new designs that make the wind turbine technology more affordable and hence more competitive in the energy market. The research and technological development results from a fruitful cooperation between industry, research institutions and universities.

Rejsby Hede wind farm consists of 40 turbines from Bonus Energy each of 600 kW. The turbines were erected in 1995 near Tønder in southern Jutland. It was the largest wind farm in Denmark at the time. Today the largest onshore wind farm in Denmark is Syltholm on the southern island Lolland. The farm consists of 35 NEG Micon 750 kW turbines with a total capacity of 26.25 MW.

Offshore wind energy is a promising application of wind power, construction costs are higher at sea, but energy production is also higher. The Danish government expects 5500 MW wind energy in Denmark by year 2030 out of which 4000 MW is from offshore wind farms. These 4000 MW are expected to produce 13.5 TWh per year equivalent to 40% of the Danish electricity consumption.

Vindeby is the world's first offshore wind farm, which is located North of the island of Lolland in the Southern part of Denmark and was built by the utility company SEAS. Electricity production could be about 20 % higher than comparable sites on land. The most recent and largest offshore wind farms in Denmark are Horns Rev by the west coast of Jutland and Nysted close to Lolland. The Nysted Offshore Wind Farm at Rødsand has an annual electricity production of 600GWh, enough to supply 145,000 (Danish) households. The Horns Rev offshore wind farm shown in Fig. 2 can supply the equivalent of 150,000 (Danish) households. The larger production compared to Nysted is due to better wind conditions. Table 1 gives some information of some typical Danish offshore wind farms.

Danish power companies also participate in wind farm development internationally. For example, a leading Danish power company, Elsam, having more than 25 years of experience with wind energy projects, has erected an offshore wind farm consisting 30, 3MW wind turbines at the Kentish Flats, UK. The 30 turbines, starting on 10th September 2005, are the largest wind turbine installed in the UK, and the 90 MW rated wind farm is the largest wind farm in the UK so far.

Fig. 2 Horns Rev offshore wind farm (Reproduced by permission of Vestas Wind Systems A/S; www.vestas.com)

Table 1: Danish Offshore Wind Farms

name	Year	turbines	Distance from shore	notes
Vindeby	1991	11 Bonus 450 kW stall wind turbines	1.5 ~ 3 km North of the coast of the island of Lolland	The world's first offshore wind farm
Tunø Knob	1995	10 Vestas 500 kW pitch controlled	3 km from the island of Tunø, and 6 km off the coast of the Jutland peninsula.	The world's second offshore wind farm
Middelgrunden	2000	20 Bonus 2 MW	2 km off shore east of Copenhagen	the largest wind farm in the world based on cooperative ownership (2005)
Samsø	2003	10 Bonus 2,3 MW	3,5 km south of the island Samsø	Owned by local people, the island is fully supplied by renewable energy
Nysted	2003	72 Bonus 2,3 MW	10 km south of the town of Nysted on Lolland	The largest wind farm in Denmark in capacity (2005)
Horns Rev	2002	80 Vestas 2 MW	14-20 km off the coast of Jutland	The largest wind farm in Denmark in production (2005)

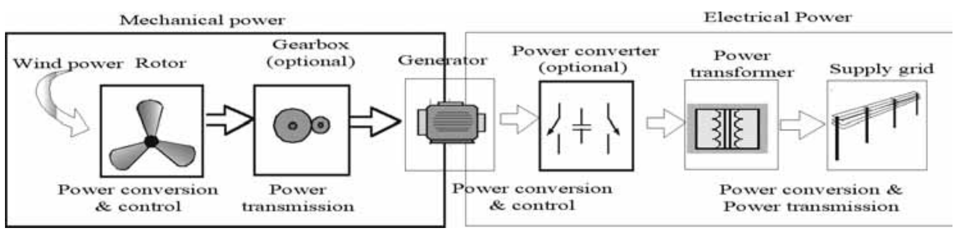


Fig. 3 Main components of a wind turbine system

The Modern Wind Power Conversion Systems

Wind technology has improved significantly over the past two decades to today's situation, some basic feature of modern wind generation systems are described in this section.

The main components of a wind turbine system are illustrated in Fig. 3, including the turbine rotor, gear box, generator, transformer and possible power electronics. Fig. 4 shows the power curves of a pitch controlled wind turbine, which is increasingly used for variable speed modern wind turbines.

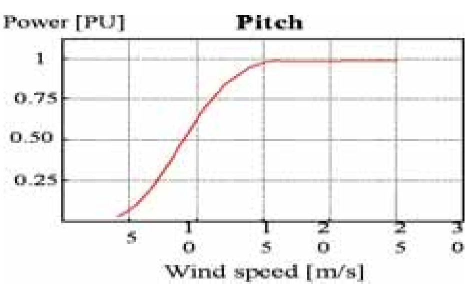


Fig. 4. Power characteristics of pitch controlled wind turbines

Two types of wind generators become increasingly popular in modern variable speed wind turbines, they are double fed induction generator (DFIG) and synchronous generator systems.

DFIG system using a medium scale power converter with a wounded rotor induction generator is shown in Fig. 5 [7]. The power converter connected to the rotor through slip rings controls the rotor currents. If the generator is running super-synchronously, the electrical power is delivered through both the rotor and the stator. If the generator is running sub-synchronously the electrical power is only delivered into the rotor from the grid. A speed variation around ±30% around synchronous speed may be obtained by the use of a power converter of 30% of nominal power.

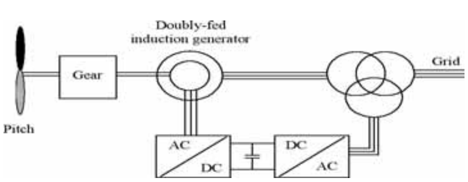
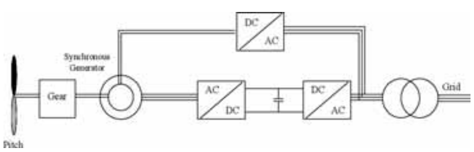


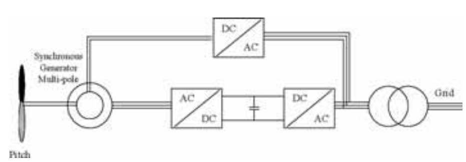
Fig. 5. Doubly-fed induction generator wind turbine topologies

The other category is synchronous generators which require a full-scale power electronic conversion between the generator and grid, but will gain the added technical performance. Fig. 6 shows three possible synchronous generator solutions with full-scale power converters.

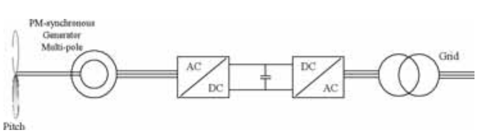
A synchronous generator with a gear is shown in Fig. 6(a), a small power converter may be used for field excitation. Multi-pole generator systems without a gear are shown in Fig. 6(b) and Fig. 6(c). Permanent magnets are used for the system shown in Fig. 6(c). Various power electronic interfaces may be used with permanent magnet wind power generators [7, 8]. All the synchronous generator systems have the almost same controllable characteristics. The power converter to the grid enables a fast control of active and reactive power since the generator is decoupled from the grid by a dc-link. By introducing power electronics many of the wind turbine systems behavior like a power plant [9]. In respect to control performance they are faster but the real power depends on the available wind.



(a) Synchronous generator with gear



(b) Multi-pole synchronous generator with field control



(c) Multi-pole permanent magnet synchronous generator

Fig. 6. Wind turbine systems with full-scale power converters

Research and Developments

Wind energy will become a major source of energy. Innovative technologies related with wind energy are still under active research and development to achieve a low cost, high efficiency industry. Some of the R&D activities are described in this section.

Wind Energy Conversion Systems

Work on developing lower cost drive trains are being conducted to produce a drivetrain that is lighter and more efficient than conventional drivetrains. New types of gears, such as multi-stage planetary and helical stages gearbox, are being developed to achieve high mechanical efficiency and power. The torque values and increased rotational speeds are optimally converted for the higher speed generators.

New types of generators, including multiple poles and axial flux configuration, are being developed for further reducing generator mass while improving overall generator efficiency.

A key area in improvements is power conversion through advanced power electronic components to reduce costs and increase efficiency. New power electronic devices are in study to explore the potential of replacing silicon with silicon carbide, which have the advantage of handling higher voltages and currents and surviving in higher temperature environments. This could reduce power converter size and improve performance. Also the use of medium voltage components, higher than the voltage level currently in use, is studied to reduce the overall cost of converter systems for larger wind turbines. Various topologies for multi-MW power electronic converters, including multi-level converters and ac-link technology, are developed to provide a power conversion with the features of cost-effective, high reliability and clean-power.

Research work is conducted to design and fabricate blades that incorporate advanced lighter-weight materials. Some new materials for blades are being developed, including carbon fiber and carbon/glass hybrid composites. Although carbon fibers are more expensive than traditional fiberglass materials, but much stronger and weigh less than traditional materials. New blade manufacturing processes are also being developed.

Some work related to turbine tower is being carried out, including the use of hybrid steel/concrete towers for the much taller towers of multi-MW turbines, and the method to form and fabricate towers on site to reduce fabrication and transportation costs.

The sites of offshore wind farms could move from relatively shallow waters into deeper waters. For offshore turbines in shallow water (less than 30 m), wind turbine manufacturers have adopted conventional land-based turbine designs and placed them on concrete bases or steel monopiles and anchored them to the seabed. An offshore substation increases the voltage, and a buried undersea cable carries the power to grid on shore for transmission to the loads. However, some countries, such as USA, a large amount of offshore resources are in deep waters (30 m and greater), and monopile foundations are unsuitable. To achieve cost-effective wind energy production in deep water, new technologies must be developed for example, the floating support structures.

In order to fully use the wind resource, the technologies of utilizing wind energy at lower wind speed areas are also being developed. In USA, a Low Wind Speed Technologies (LWST) project was launched to develop wind turbines for both utility-scale and small, distributed wind applications for low wind speed areas [10]. The design goal is to reduce the cost of energy (COE) at low wind sites by increasing energy capture, reducing initial costs, increasing reliability, and lowering maintenance costs.

Wind Energy Integration and Applications

As the percentage of wind energy in the generation capacity grows, it becomes increasingly important to forecast the wind speed so as to estimate the amount of generation from the wind farms, which will be used to predict the value of the electricity produced by the wind farms; to help with the required planning and scheduling to meet system loads and contractual agreements. Accurate models can ensure the success of a development and enable to maximize profits and minimize risks.

The possible primary barriers to the use of wind technology would be from system integration issues, including transmission system constraints, operational policies, and a lack of understanding of the impacts of wind energy on utility grids. The standards that are expected to facilitate the interconnection and economic operation of large wind generating plants are being proposed. The rapidly increased wind injection into power grid presents great challenge to the power system operators. Wind farms' productivity fluctuates with the weather, while the electrical grid must maintain a constant balance of supply and demand. The effects of fluctuating wind power on system regulation and stability are being studied in order that the system operators and planners can feel confident about increasing the amount of wind energy in power systems. One way of providing a stable supply of electricity to the grid is the combination of wind and hydropower. Research concerning the generation, transmission, and economics of integrating wind and hydropower systems is being carried on.

Other applications of wind energy are also being explored to open new markets, for example, the use of wind energy to provide desalination solutions and to produce hydrogen. These applications would open up opportunities for providing low-cost, clean energy in other sectors including transportation, at the same time, these applications present significant new challenges to the wind community.

It is envisioned that the wind energy industry will still grow rapidly, new technologies are being actively exploited through research and development activities, also the applications of wind energy are expanding into wider areas.

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Authors Biographies

Zhe Chen (M'95-SM'98) received the B.Eng. and M.Sc. degrees from Northeast China Institute of Electric Power Engineering, Jilin City, China, and the Ph.D. degree from The University of Durham, Durham, U.K. He was a Lecturer and then a Senior Lecturer with De Montfort University, U.K. Since 2002, Dr. Chen has been a Research Professor with the Institute of Energy Technology (IET), Aalborg University, Aalborg, Denmark. He is the coordinator of the Wind Turbine Research Program at IET. His main research areas are renewable energy and distributed generation, power electronics, power systems and protection. He has more than 100 publications in his field. Dr. Chen is an Associate Editor of the IEEE Transactions on Power Electronics, a member of the Institution of Electrical Engineers (London, U.K.), and is a Chartered Engineer in the U.K.

Frede Blaabjerg (S'86-M'88-SM'97-F'03) received the M.Sc.EE. from Aalborg University, Denmark in 1987, and the PhD. degree from the Institute of Energy Technology, Aalborg University, in 1995. He was employed at ABB-Scandia, Randers, from 1987-1988. During 1988-1992 he was a PhD. student at Aalborg University. He became an Assistant Professor in 1992 at Aalborg University, in 1996 Associate Professor and in 1998 full professor in power electronics and drives the same place. His research areas are in power electronics, static power converters, ac drives, switched reluctance drives, modeling, characterization of power semiconductor devices and simulation, wind turbines and green power inverter. He is the author or co-author of more than 300 publications in his research fields including the book 'Control in Power Electronics' (Eds. M.P. Kazmierkowski, R. Krishnan, F. Blaabjerg) 2002, Academic Press. During the last years he has held a number of chairman positions in research policy and research funding bodies in Denmark. He is associated editor of the IEEE Transactions on Industry Applications, IEEE Transactions on Power Electronics, Journal of Power Electronics and of the Danish journal Elteknik. He received the 1995 Angelos Award for his contribution in modulation technique and control of electric drives, and an Annual Teacher prize at Aalborg University, also 1995. In 1998 he received the Outstanding Young Power Electronics Engineer Award from the IEEE Power Electronics Society. He has received five IEEE Prize paper awards during the last six years. He received the C.Y. O'Connor fellowship 2002 from Perth, Australia, the Statoil-prize in 2003 for his contributions in power electronics and the Grundfos-prize in 2004 for his contributions in power electronics and drives.

Induction Generators for Small Wind Energy Systems

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Introduction

Background

The use of induction generators can be traced back to the beginning of the 20th century until they were almost disappeared in the 1960s [1]. The dramatic increase in gas prices during the 1970s, created the favorable situation for the revival of the induction generator. With such high energy costs, rational use and conservation implemented by many processes of heat recovery and other similar forms became important goals. By the end of the 1980s, wider distribution of population over the planet, with improved transportation and communication that enabled people to move away from large urban concentrations, and growing concerns with the environment led to demand by many isolated communities for their own power plants. The general consciousness of finite and limited sources of energy on earth and international disputes over the environment, global safety, and the quality of life have created an opportunity for new, more efficient, less polluting power plants with advanced technologies of control, robustness, and modularity. In this new millennium of 21st century, the induction generator, with its lower maintenance demands and simplified controls, appears to be a good solution for such applications [1]. For its simplicity, robustness, and small size per generated kW, the induction generator is favored for small hydro and wind power plants. More recently, with the widespread use of power electronics, computers and electronic microcontrollers, it has become easier to use these generators with increased efficiency for the power generation up to 500 kW. The induction generator is always associated with alternative sources of energy as for the small power plants, it has a great economic appeal. Standing alone, its maximum power does not go much beyond 15 kW. Alternatively, if an induction generator is connected to the grid or to other sources or storage, it can easily approach 100 kW [1]. Very specialized and custom-made wound-rotor schemes enable even higher power. More recently, power electronics and microcontroller technologies have given a decisive boost to induction generators for wind energy generation because they enable very advanced and inexpensive types of control, new techniques of reactive power supplements, and asynchronous injection of power into the grid.

Generator Selection for Wind Energy

An important step for installation of wind energy system is to select the turbine rating, the generator, and the distribution system. In general, the output characteristics of the wind turbine power do not follow exactly those of the generator power; so they have to be matched in the most reasonable way possible. Based on the maximum speed expected for the turbine and taking into account the cubic relationship between the wind speed and the generated power, the designer must select the generator and the gearbox so as to match these limits. The most sensitive point here is the correct selection of the rated speed for the generator. If it is too low, the high speed of the primary source wind will be wasted; if it is too high, the power factor will be harmed. The characteristics of the commercially available turbines and generators must be matched to the requirements of the project with regard to cost, efficiency, and maximum generated power in an iterative design process [1].

Several types of generators can be coupled to the rotating wind power turbines: dc and ac types, parallel and compound dc generators, with permanent magnets or electrical field excitation, synchronous or nonsynchronous, and, especially, induction generators. The dc machines are not usually employed because of their high cost, bulky size, and maintenance needs. The right choice of generator depends on a wide range of factors related to the primary source, the type of load, and the speed of the turbine, among others [1]. Besides, systems differ with respect to their applications, whether they are stand-alone or connected to the grid, their degree of interruptibility, and the quality and cost of their output. Because of the way it works as a motor or generator, the possibility of variable speed operation, and its low cost compared to other generators, the induction machine offers advantages for rotating power plants, like the wind power, in both standalone and interconnected applications [1].

Induction Generator

Typically, small renewable energy power plants rely mostly on induction machines, because they are widely and commercially available and very inexpensive. It is also very easy to operate them in parallel with large power systems, because the utility grid controls voltage and frequency while static and reactive compensating capacitors can be used for correction of the power factor and harmonic reduction [2], [4], [5]. Although the induction generator is mostly suitable for hydro and wind power plants, it can be efficiently used with prime movers driven by diesel, biogas, natural gas, gasoline and alcohol motors. Induction generators have outstanding operation as either motor or generator; they have very robust construction features, providing natural protection against short-circuits, and have the lowest cost with respect to other generators. Abrupt speed changes due to load or primary source changes, as usually expected in small power plants, are easily absorbed by its solid rotor, and any current surge is damped by the magnetization path of its iron core without fear of demagnetization, as opposed to permanent magnet based generators [2], [6].

The induction generator has the very same construction as the induction motors with some possible improvements in efficiency. There is an important operating difference; the rotor speed is faster with respect to the stator magnetic field rotation. In quantitative terms [2], if n_s is the synchronous mechanical speed in rpm at the synchronous frequency f_s in Hz, the resulting output power comes from the induced voltage proportional to the relative speed difference between the electrical synchronous rotation and the mechanical rotation within a speed slip factor range given by:

$$S = (n_s - n_r)/n_s \qquad (1)$$

where; S is the slip, n_r is the rotor speed in rpm.

Self-Excited Induction Generator

For its operation, the induction generator needs a reasonable amount of reactive power which must be fed externally to establish the magnetic field necessary to convert the mechanical power from its shaft into electrical power [1]. Therefore, the external reactive source must remain permanently connected to the stator windings responsible for the output voltage control. In interconnected applications, the synchronous grid supplies such reactive power. In stand-alone applications, the reactive power must be supplied by the load itself, or by a bank of capacitors connected across its terminals, or by an electronic inverter. When capacitors are connected to induction generator, the system is usually called a SEIG (a self-excited induction generator) [1], [2], as shown in Figure 1(a). When the shaft is rotated externally, such movement interacts with a residual magnetic field and induces a voltage across the external capacitor, resulting in a current in the parallel circuit which, in turn, reinforces the magnetic field and the system builds up an increasing excitation. Due to high cost of capacitors and maintenance needs, self-excitation of the induction generator is economically recommended only for small power plants [7], [8].

When several SEIGs operate interconnected, each induction machine requires a certain capacitance bank depending on the primary energy, the magnetization curve of the core and the instantaneous load. So, the interaction among the operational state of the primary source of energy with the induction generator, the self excitation parameters and the load, will define the overall performance of the power plant [9], [10], [11]. The performance is greatly affected by the variance of some of the parameters related to the availability of primary energy and load variations.

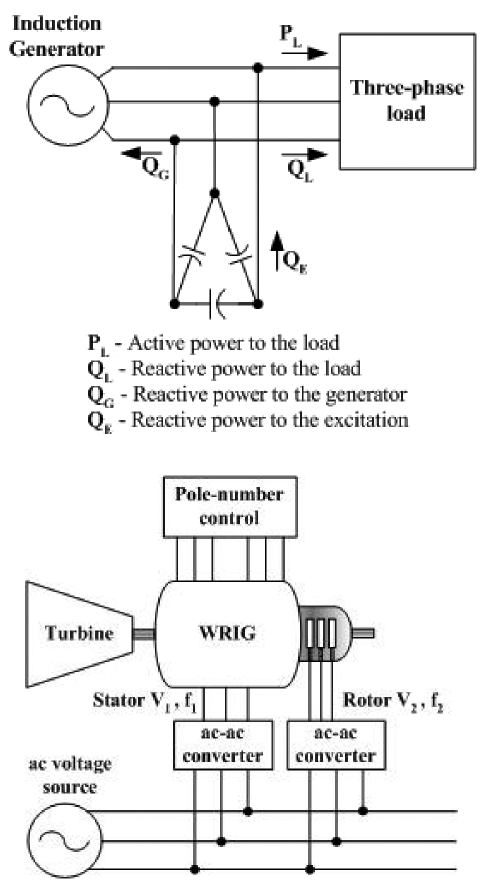

Figure 1. (a) Capacitor self-excited induction generator, (b) DFIG-overall stator and rotor parameter control

Doubly Fed Induction Generator

A very important machine, typically used for high power applications, is the doubly fed induction generator (DFIG). The DFIG is a wound rotor machine where the rotor circuit is connected to an external variable voltage and frequency source via slip rings and the stator is connected to the grid network [2], as illustrated in Figure 1(b). There is also a possibility of altering the rotor reactance by effectively modulating some inductors in series with the original rotor reactance. Adjusting the frequency of the external rotor source of current controls the speed of the doubly fed induction generator, which is usually limited to a 2:1 range. Doubly fed machines were not very popular in the past due to the maintenance required for the slip rings. More recently, with the development of new materials, powerful digital controllers and power electronics, the doubly fed induction generator became a solution in power generation for up to several hundreds of kW ratings [2]. Power converters usually make up the need for a variable frequency source for the rotor.

As it is said above, the control of doubly fed induction generators can be exerted either through the stator or rotor variables. The controllable stator variables are number of poles, voltage and frequency [2]. The rotor variables for squirrel cage rotors can be design resistance, design reactance and speed. The doubly fed induction generator is affected by the second power of the grid voltage and the controllable variables are current, voltage, frequency, and voltage phase shift with respect to the stator voltage angle. An experimental set up [2], to implement and monitor changes in the stator and rotor characteristics, is depicted in Figure 1(b). Obviously, in most applications, this setup can be simplified. If, for example, there is no interest in stator frequency or voltage changes, the stator power converter is not required in practice.

Interconnected and Stand-Alone Operation

When directly interconnected with the distribution network, an induction machine must change its speed (increased up to or above the synchronous speed). The absorbed mechanical power at the synchronous speed is right enough to withstand the mechanical friction and resistance of the air. In case the speed is increased just above the synchronous speed, a regenerative action happens, yet without supplying energy to the distribution network. This will happen only when the de-magnetizing effect current of the rotor is balanced by a stator component capable of supplying its own iron losses and, above that, supplying power to the external load. When considering interconnection with or disconnection from the electric distribution network, it should be observed that there is a rotation interval above the synchronous speed in which the efficiency is very low. This effect is caused by the fixed losses related to the low level of generated power and torque in these low speeds [12].

Another relevant aspect is the maximum rotation. At this point, disconnection from the distribution network should occur, so that a control system will act as a brake for the turbine under speed controlled operation. The disconnection should be performed for electric safety of the generator in the case of a faliure in the control brake, and for the safety of the local electric power company maintenance teams when the generator should be disconnected from the distribution network.

Connection of induction generators to the distribution network is quite simple process, as long as the interconnection and protection guidelines by the local utilities are followed. Technically, the rotor is put to rotation in the same direction in which the magnetic field is rotating, as close as possible to the synchronous speed to avoid unnecessary speed and voltage mismatches [2]. A phenomenon similar to the connection of motors or transformers to the distribution network will happen resulting in a transient exchange of active and reactive power between generator and load. The load here considered can be any ordinary electrical load or a power inverter for interconnection with the distribution network or any ac load.

The active power supplied by an induction generator to the load, similar to what happens with the synchronous generators, can be controlled by speed change which is related to controlling the mechanical primary power. For the case of stand-alone operation, the magnetizing current is to be obtained from the self-excitation process. The mechanical energy of rotation can only influence the active component of the current with no effect on the reactive component.

In the case of an induction generator in parallel with a synchronous machine, the excitation depends on the relative speed between them, so the short circuit current supplied depends on the voltage drop produced across the terminals of the synchronous generator. If the voltage across the terminals goes to zero, the steady state short circuit current is zero. The induction generator dampens oscillations, as long it does not have to run at the synchronous speed. All the load variation is followed by a speed variation and small phase displacement, much the same with the synchronous generator [2].

Wind Power Integration by Induction Generator

Integration of alternative sources of energy into the network for Distributed Generation (DG) requires small-scale power generation technologies located close to the loads served. The move toward onsite distributed power generation has been accelerated because of deregulation and restructuring of the utility industry and the viability of alternative energy sources. DG technologies can improve power quality, boost system reliability, reduce energy costs, and defray utility capital investment [2].

The integration of renewable sources of energy, such as wind energy, poses a challenge because their output is intermittent and variable and must be stored for use when there is demand. If only one renewable energy source is considered, the electric power system is simple where the source can be connected to a storage system. In the grid-connected application, the grid acts as energy storage. However, if multiple renewable energy sources are used, the electric power system can be rather complex and needs detailed analysis.

Wind Energy – SEIG System for Remote Users

An induction generator (IG) requires reactive power whether it is running as a machine or a generator. As mentioned previously, the reactive power needs of the IG in remote user cannot be supplied from the grid and other sources must be used. One possible source might be a three-phase capacitor connected in parallel with the machine, which enables the machine to operate self-excited. Another source may come from a capacitor connected to the dc bus of an inverter. This scheme is able to start the machine as long as there is an initial voltage on the capacitor. However, a more reliable method of starting the machine is to use a battery on the dc bus that can supply voltage until enough voltage is being generated by the machine to power the dc bus [3].

After the machine has started generating voltage, there are several methods for using the power generated by the machine. An ac load can be attached directly to the machine terminals. However, the voltage and frequency of the electrical power on the terminals of the machine depend on the speed. In renewable energy applications such as wind or hydro power generation, the speed of the machine is not constant and consequently poses a problem. A dc load can also be connected on the dc bus of the inverter. However, a controller must be used to regulate the voltage on the dc bus. If the voltage on the dc bus drops too much, the voltage supplied by the machine will collapse and will no longer be able to supply power to the loads [3].

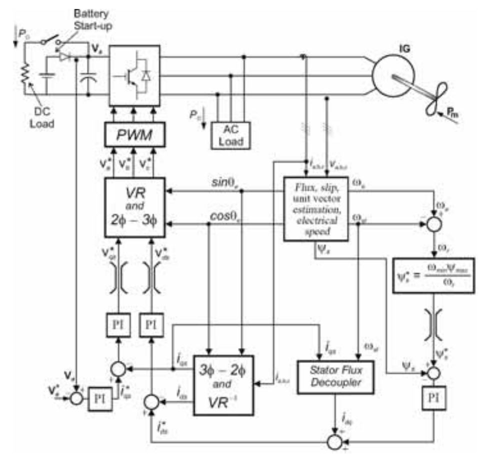

Figure 2. Induction generator with a remote wind energy system

An experimental system with wind energy and induction generator is shown in Figure 2. The system is started by a battery connected to the dc bus, when the voltage on the bus increases above the voltage on the battery, the diode shuts off and the bus is powered from the machine only [3]. In addition to keeping the voltage on the bus constant, the generator also supplies both ac and dc loads. To supply the ac load with power, the controller regulates the voltage on the terminals of the machine. The controller attempts to keep the voltage on the dc bus constant, but also tries to regulate the voltage on the terminals of the machine to supply the ac load with a constant voltage.

The voltage on the ac bus can be controlled indirectly by programming the machine stator flux such as indicated by Equation (2):

$$E \propto \omega_r \Psi \qquad (2)$$

where, E is the no-load voltage, and Ψ is the machine air-gap or stator flux.

This means that the voltage on the terminals is proportional to the rotor speed times the flux. To keep the voltage on the terminals constant, the product of the speed and the flux must remain constant. However, this assumption has limits based on the machine parameters [13]-[15]. The maximum speed is limited by the mechanical rating of the machine. The machine should not be operated above this speed, so this value corresponds to the minimum flux limit. The maximum flux in the machine is limited by saturation effects within the machine. There is a value corresponding to a minimum speed limit that the machine can run while maintaining constant voltage.

The rotor speed is known either from actual measurements or by estimation. Therefore, the following equation can be used to calculate the reference flux for the controller:

$$\psi^* = \frac{\omega_{r,min}}{\omega_r}\psi \tag{3}$$

All the equations to implement the control system are based on stator flux orientation as explained in [3]. The results from running the simulation are shown in Figure 3 and 4.

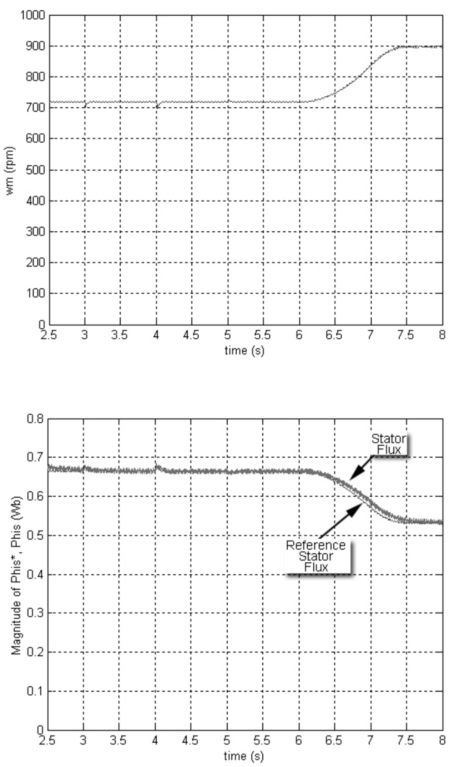

Figure 3. Induction generator operation (a) estimated rotor speed, (b) reference and actual flux

To show the effectiveness of the voltage regulation, consider the voltage waveforms in Figure 4(b). The controller with constant flux varies from 77.0 Vrms to 28.6 Vrms (62.8% drop), while the controller with variable flux varies from 65.2 Vrms to 57.3 Vrms (12.1% drop).

Investment Considerations

In induction generator based renewable energy systems the energy source is typically a low-speed prime mover such as hydropower or wind power. The investments required for such power plants are basically for three areas: (1) a power generation section, consisting of the turbine, gear box, generator and all structural elements to support them, (2) a protective and control operational center capable of withstanding environmental and operational hazards and (3) a utility power interface section, tailoring the power output to the requirements of the electrical grid [1].

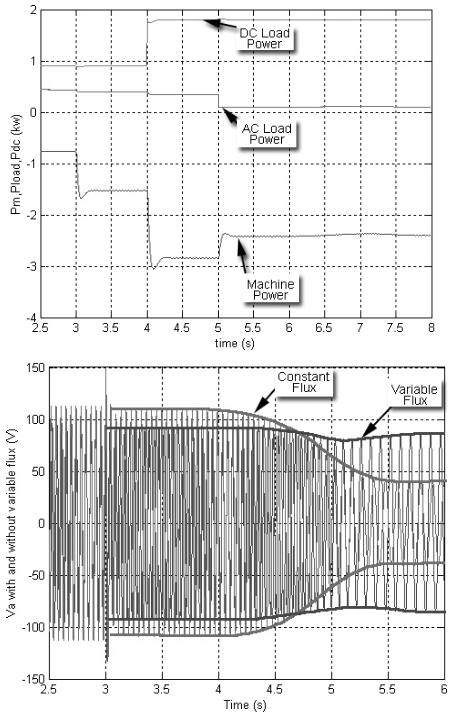

Figure 4. (a) Load powers and machine power, (b) voltage waveforms with and without variable flux

One important economic concept that is used to support capital investment analysis is the capacity factor (CF). The capacity factor measures the operational hours, seasonal constraints, and source and demand fluctuations that limit the full utilization of the installed power plant by dividing the actual energy produced during a specified time period by the amount of the energy that would have been produced under full power [1].

$$CF = \frac{ActualEnergy}{EnergyatFullUse} \tag{4}$$

A wind turbine rated at 100 kW would produce 87600 kWh of electricity per year if operating 100% of time. However, wind velocity fluctuation, maintenance down time and the demand matching will constrain the annual output power to a lower value. For average production, the average input must be computed, and the given average shaft velocity would determine a gearbox that optimizes the power transfer. But the operational generator speed would oscillate about this optimum point, and the electronic system must compensate for such deviation. Therefore, there is a typical cost of energy generated by the system that must be taken into consideration for the amortization of the cost of capital, operation, and maintenance [1].

Since wind power systems do not require fuel for operation, the following equation expresses the cost of energy, neglecting taxes, surcharges, and insurance [16]:

$$C = \left[\frac{r(l+r)^n}{r(l+r^n-1} + m\right]\frac{P}{87.6(CF)} \tag{5}$$

where, C is generation cost in U.S. cents per kilowatt hour; CF is capacity factor; m is the fraction of the capital costs needed per year for operation and maintenance of the unit; n is the amortization period in years; P is the capital cost in US dollars per kW; and r is the annual interest rate per unit.

Optimization of Control Actions

General approaches of optimization utilize linear, nonlinear, dynamic, and stochastic techniques, while in control, the calculus of variations and optimal control theory are important. Operations research is the specific branch of mathematics concerned with techniques for finding optimal solutions to decision-making problems. However, these mathematical methods are, to a large degree, theoretically oriented and thus very distant from the backgrounds of the decision makers and management personnel in industry. Recently, practical applications of heuristic techniques like hill climbing and fuzzy logic have been able to bridge this gap, thereby creating the possibility of applying practical optimization to industrial applications. One field that has proven to be attractive for optimization is the generation and control of electric power from alternative and renewable energy resources like wind energy [17], [18]. For such generation systems, where the installation costs are very high, while the availability of alternative power is by its nature intermittent, which tends to constrain efficiency. It is therefore of vital importance to optimize the efficiency of electric power transfer, even for the sake of relatively small incremental gains, in order to amortize the installation costs within the shortest possible time. The following characteristics of induction-generator based control motivate the use of heuristic optimization [1]:

- Parameter variation that can be compensated for by design judgment.
- Processes that can be modeled linguistically but not mathematically.
- Dependence on operator skills and attention.

- Process parameters affect one another.
- Effects cannot be attained by separate PID control.
- Data intensive modeling.

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Authors Biographies

M. Godoy Simões (S'89–M'95–SM'98) received the B.S. and M.Sc. degrees in electrical engineering from the University of São Paulo, São Paulo, Brazil, in 1985 and 1990, respectively, the Ph.D. degree in electrical engineering from the University of Tennessee, Knoxville, in 1995, and the Livre-Docencia (D.Sc.) degree in mechanical engineering from the University of São Paulo, in 1998. He joined the faculty of Colorado School of Mines, Golden, in 2000 and has been working to establish research and education activities in the development of intelligent control for high-power electronics applications in renewable and distributed energy systems. Dr. Simões authored the book "Renewable Energy Systems: Design and Analysis with Induction Generators," by CRC Press, and the book "Integration of Alternative Sources of Energy," by John Wiley and Sons.

Dr. Simões is a recipient of a NSF - Faculty Early Career Development (CAREER) in 2002, the NSF's most prestigious award for new faculty members. He served as the Program Chair for the Power Electronics Specialists Conference 2005, as well as the General Chair of the Power Electronics Education Workshop 2005. He is serving as the Chair of the IEEE Power Electronics Chapter of the Denver Section, IEEE Power Electronics Society Intersociety Chairman, and also as the Associate-Editor for IEEE Transactions on Power Electronics.

Sudipta Chakraborty (S'02) was born in Kolkata, India, in 1979. He received the B.E. degree in Electrical Engineering from Bengal Engineering College (now Bengal Engineering and Science University) in 2001. He joined Colorado School of Mines in spring 2002 to pursue PhD degree in Engineering Systems, Electrical Specialty. He is currently working on intelligent integration of renewable sources in the Microgrid so that the power quality and power flow issues can be resolved. His research interests include renewable energy, control systems, power electronics, intelligent control and power systems. Mr. Chakraborty was recipient of several awards and scholarships from the Government of India for his scholastic achievements. In USA he was enlisted in 2002-2003 edition of the National Deans List. A student member of IEEE, he received Myron Zuker Travel Grant from IEEE to attend 38th Annual Meeting of the IEEE Industrial Applications Society held in Saltlake City, UT in 2003. Recently, he was awarded with the IEEE Industrial Electronics Society scholarship to attend and present his paper in IECON 2005 held in Raleigh, North Carolina.

Robert Wood is a member of the Power Components Branch, U. S. Army Research Laboratory, Adelphi, MD, where he is currently the lead for improving DC to AC designs for three phase motor drive inverters through simulations and experimental tests. In addition to inverter design, he also designed and built several DC to DC converters, and programmed several micro-controllers to run various tasks. Preceding his work at ARL, Mr. Wood did research at the Colorado School of Mines on three phase inverters. He simulated and implemented a three phase vector controller designed to generate power from a variable speed shaft. The controller was tested on a three phase inverter running a small induction machine driven by a DC machine. Mr. Wood received his B.S.E.E. and M.S.E.E degrees from the Colorado School of Mines, Golden, Colorado in 2002 and 2004 respectively. Mr. Wood has authored 2 papers and co-authored 2 papers.

The Sixth IEEE International Conference on Power Electronics and Drive Systems (PEDS 05)

by Mahindra Vilathgamuwa

The Sixth IEEE International Conference on Power Electronics and Drive Systems (PEDS 05) was held from 28 Nov to 1 Dec 2005 at Renaissance Kuala Lumpur Hotel, Malaysia. The PEDS conference series is held in various Region 10 countries and this time Malaysia had the honour to organize this prestigious event. The conference is biennial, and since 1995 the PEDS Central Committee, Singapore in collaboration with overseas organizing committees have successfully organized five conferences (PEDS-95 Singapore, PEDS-97 Singapore, PEDS-99 Hong Kong and PEDS-01 Bali, PEDS-03 Singapore). All the PEDS conferences were held in technical co-sponsorship with the IEEE Power Electronics Society and IEEE Industry Applications Society. The aim of the Conference is to provide a forum for delegates from the industry and academia to exchange ideas and present their research results. In addition it is an ideal venue for interaction and establish the all-important networking with each other.

This time, the conference included a set of half-day tutorials conducted by Prof B T Ooi, Prof Leo Lorenz, Prof V Agelidis and Prof M F Rahman in the afternoon of Monday, 27th November 2005. The opening ceremony was held in the morning of the 28th November. The key note and plenary speeches were delivered by Prof D Patterson, Prof B T Ooi, Prof M A Rahman, Prof P Tenti and Prof J Holtz. The opening ceremony was followed by three days of technical paper presentations until the 1st December. The poster session was conducted on in the afternoon of 30th November. With over 500 abstracts received, the Technical Program Committee had an overwhelming task of selecting papers of outstanding quality and diversity. Finally, 297 papers were selected, involving authors from 34 different countries.

Besides the technical program, delegates have managed to explore the many exciting tourist attractions within the Capital Kuala Lumpur as well as in Malaysia.

Conference organizing committee, plenary and key-note speakers (Front row from left: N Mariun, P Tenti, Zainal Salam, B T Ooi, J Holtz, D Patterson, D M Vilathgamuwa, A H M Yatim, A K Khambadkone, L Lorenz, S K Panda and Y C Liang) along with conference participants.

Conference organizing committee, plenary and key-note speakers (Front row from left: N Mariun, D M Vilathgamuwa, A H M Yatim, J Holtz, D Patterson, A Darus, M A Rahman, P Tenti, B T Ooi: Back row from left: N R N Idris, Gobbi Ramasamy, D V Battul, Y C Liang, S K Panda, Zainal Salam, A K Khambadkone, Awang Jusoh, Mohd Rodhi Sahid, Nik Din Muhammad, Shahrin Bin Md Ayob and Naziha Ahmad Azli)

(a)

(b)

Professors (a) D Patterson and (b) M A Rahman presenting their papers during plenary session. Reported by D Mahinda Vilathgamuwa, General Co-chair PEDS05.

Book Review

Kenneth L. KAISER, Kettering Univ., Flint, Michigan, USA

Electromagnetic Compatibility Handbook

CRC Press, Taylor and Francis Group, end Sept. 2004

2600pp B5, 2300 tb and figs., $150. ISBN : 0-8493-2087-9

The size of the book authored by K.L. Kaiser is impressive. Given the size, one looks at the content to see the contributors, and finds out that the whole book is written by one single person. How much time the author needed to achieve it ?! And what a wide view, knowledge and references ! There are more and more electrical devices in use, hence grow the challenges of ensuring the electromagnetic compatibility (EMC) of products and systems.

The book is useful for all the designers of electronic equipments: electrical and electronics engineers, technicians, professors, teachers.

The content covers much more than EMC. The title should be "All you should know to really master EMC". It is an Encyclopaedia of Radio Engineering.

It mentions basic theory, then takes shortcuts to reach last practical consequences; a typically American approach. The presentation is compact, useful in all applications, with many figures, tables and graphics, no design examples and only short explanations. It is ideal for quick reference, more than as a textbook for courses. The author has either derived from basic principles or obtained and verified from their original sources all of the expressions in the tables. Mathcad was used to generate most plots and solve many equations. The author includes the Mathcad programs for many of these, so users can clearly see the variable assignments and assumptions.

Thin "Bible" paper makes the book appropriate for personal use, not for libraries. Hence, it has been also published by CRC Press, Taylor and Francis Group, in Sept 2005, split in three volumes, as to be harder and on narrower domains:

Transmission lines, matching and crosstalk
448pp. B5, $90. ISBN : 0-8493-6362-4

Electromagnetic Shielding
336pp. B5, $90. ISBN : 0-8493-6372-1

Electrostatic Discharge
344pp. B5, $90. ISBN : 0-8493-7188-0

The Electromagnetic Compatibility Handbook is a wide compilation of many approximations, guidelines, models, and rules-of-thumb used in EMC analyses, with their sources and their limitations. The book presents them in an efficient question-and-answer mode that leads straight to the core of each topic.

This book covers all the key topics involved in EMC:

- decibel expressions, fast Bode magnitude and phase plotting, transient behavior in the time and frequency domains, spectra of periodic and aperiodic signals,
- non-ideal R L C, magnetic coupling and transformers, magnetic materials, baluns and balanced circuits, passive electric filters, electrical equivalent length, transmission lines and matching, wire impedance, cable modeling, skin effect, cable shielding and crosstalk,
- EMI sources, radiated and conducted emissions and susceptibility, antennas, test chambers, electrostatic discharge, air breakdown, plane wave shielding, electric and magnetic field shielding, grounding, circuit board layout for EMC.

Including basics but also discussions and derivations never published before in book form guarantees that the book will be useful for many years ahead, even for these fast-evolution domains, as electronics and aerospace technology.

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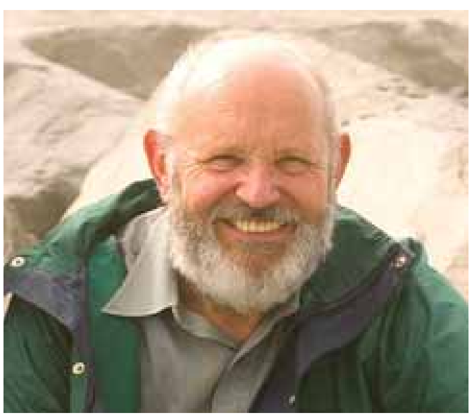
Obituary: Alan K. Wallace

November 29th, 1942 – June 7th, 2006

(Editor's Note: Excerpted from Eulogy by Prof. Annette von Jouanne)

Dr. Alan Wallace was born in Sheffield, England on November 29th, 1942. He had a wonderful childhood there with his parents, and he was an only child. He received his B.Eng. in 1963 and his Ph.D. degree in 1966 in electrical power engineering, both from the University of Sheffield, England.

From 1966 to 1967 he worked with ICI (Imperial Chemical Industries) on the application of digital computers to process control – and remember, this was 1966! Alan has not only always been working in the state-of-the-art, but right at the edge-of-the-art, even from the beginning of his career!



Then in 1967 he joined the University of Nottingham, England, and taught electrical machine design and power system analysis.

From 1974 to 1984 Alan was engaged in the design and development of advanced propulsion systems in the mass-transit industry in Canada (in other words, Alan was designing the motors and power distribution systems for high speed trains). He worked with Spar Aerospace of Toronto and Canadair Services and was manager of Power Distribution for the Urban Transportation Development Corporation in Kingston, Canada.

During those 10 years working on high-speed trains, Alan was instrumental in taking the linear induction motor (LIM) from a laboratory curiosity to the rapid-mass-transit systems in Vancouver, B.C., Toronto, Ontario, and Detroit, MI (these trains are currently carrying up to 15,000 passengers per hour, per direction!). Similar systems have been installed in several other cities worldwide. Currently more than 1,000 LIMs of Alan's design are in daily transit system service! In fact, Alan's high speed train LIM system was the first to become widely commercially applicable in the world!!

Alan was absolutely gifted with incredible creative problem solving skills, and thus OSU was very fortunate when in 1984 Alan joined the Department of Electrical and Computer Engineering at Oregon State University as a professor in Energy Systems. Alan was able to secure the necessary funding from the Electric Power Research Institute (EPRI), the Bonneville Power Administration (BPA), and the U.S. Department of Energy to design and build the Motor Systems Resource Facility (MSRF) in the basement of Dearborn Hall. I was very fortunate in that I joined Alan at OSU in 1995, in the midst of the lab construction phase, and we became fully operational in 1996. The development of this lab enabled us to work on some pretty exciting research such as the Navy all-electric ship, the hybrid electric vehicle generator in the Ford Escape Sport Utility Vehicle, the LCAC, and our joint passion for Wave Energy! In addition, the lab has become a significant asset for our students as they transition into the workforce as "work ready" graduates – Alan's vision to serve our students and industry will have very lasting impacts.

Alan and his work are so highly regarded. He has authored more than 140 research papers including prize papers in IEEE and IEE, and he received the highest honor of IEEE Fellow for extraordinary accomplishments. With all of Alan's accomplishments, he felt his greatest accomplishments were within his family.

Meetings of Interest

COMPEL'06, Tenth IEEE COMPEL Workshop, to be held at Rensselaer Polytechnic Institute, Troy, New York, on 16-19 July 2006. The workshop will focus on digital control of HF converters. General chair, Prof. Jian Sun, Dept. of ECSE, RPI, jsun@rpi.edu. For more information visit the COMPEL'06 webpage at http://www.ecse.rpi.edu/compel06.

EPE-PEMC 2006, the 12th International Power Electronics and Motion Control Conference, will be held 30 August - 1 September 2006 at the Congress Centre Bernardin Portoroz, Slovenia. EPE-PEMC 2006 is technical co-sponsored by IEEE Power Electronics Society and Industrial Electronics Society. Visit http://www.ro.feri-uni.mb.si/epe-pemc2006 for more details. Prof. Dr. Karel Jezernik, University of Maribor is EPE-PEMC2006 General Chair and may be contacted at: karel.jezernik@uni-mb.si

The 41st International Universities Power Engineering Conference (UPEC 2006) will be organized by the School of Computing Engineering and Information Sciences, Northumbria University, Newcastle-upon-Tyne, September 6-8, 2006. UPEC2006 is co-sponsored by PEL's. Abstracts are due 10 February 2006. For more information visit the web site at: (http://www.upec2006.org/ and also see the announcement in this issue.

International Telecommunications Energy Conference, INTELEC® 2006, will be held at the Rhode Island Convention Center on 10-14 Sept. 2006 in Providence, RI. Sponsored by IEEE PEL's. Contact: INTELEC@pcmisandiego.com, or visit the website: www.intelec.org.

VPPC2006, Vehicle Power and Propulsion Conference, will be held 6-8 September 2006 at Windsor, England, UK. VPPC2006 is co-sponsored by IEEE Power Electronics Society and IEEE Vehicular Technology Society. For more information visit www.vppc2006.com or contact Prof. John T. Economou at J.T.Economou@cranfield.ac.uk

41st IEEE Industry Applications Society Annual Meeting, IAS2006, will be held 8-12 October, 2006 at Marriott Waterside Hotel, Tampa, Florida. This is a new facility that is attuned to IEEE convention and business activities. IAS General Chair, Mark Halpin, m.halpin@ieee.org. For more details visit the IAS website at: www.ieee.org/ias2006.

CIEP 2006, International Power Electronics Congress, to be held 16-18 October 2006 in Puebla, Mexico with venue Universidad de las Americas Puebla. CIEP is co-sponsored by IEEE Power Electronics Society. For more information visit the website at www.udlap.mx/electronica/ciep2006/ or contact Dr. Pedro Banuelos-Sanchez at pbanuelo@mail.udlap.mx for more information.

The 22nd Annual IEEE Applied Power Electronics Conference, APEC2007, is scheduled for 25 Feb. through 1 March, 2007 at the Disneyland Hotel, Anaheim, CA. Co-sponsored by IEEE PEL's, IEEE IAS and Power Sources Manufacturers Association. Deadline for abstract and digest submission is 25 July 2006. For more information visit the website at: www.apec-conf.org.

4th Power Conversion Conference, PCC2007 will be held 2-5 April 2007 at the Nagoya Congress Center, Nagoya, Japan. Important dates: submission of summary 12 September 2006, author's notice of acceptance 30 November 2006, and final paper due 31 January 2007. For more information please visit the PCC'07 website: http://www.ics-inc.co.jp/pcc/

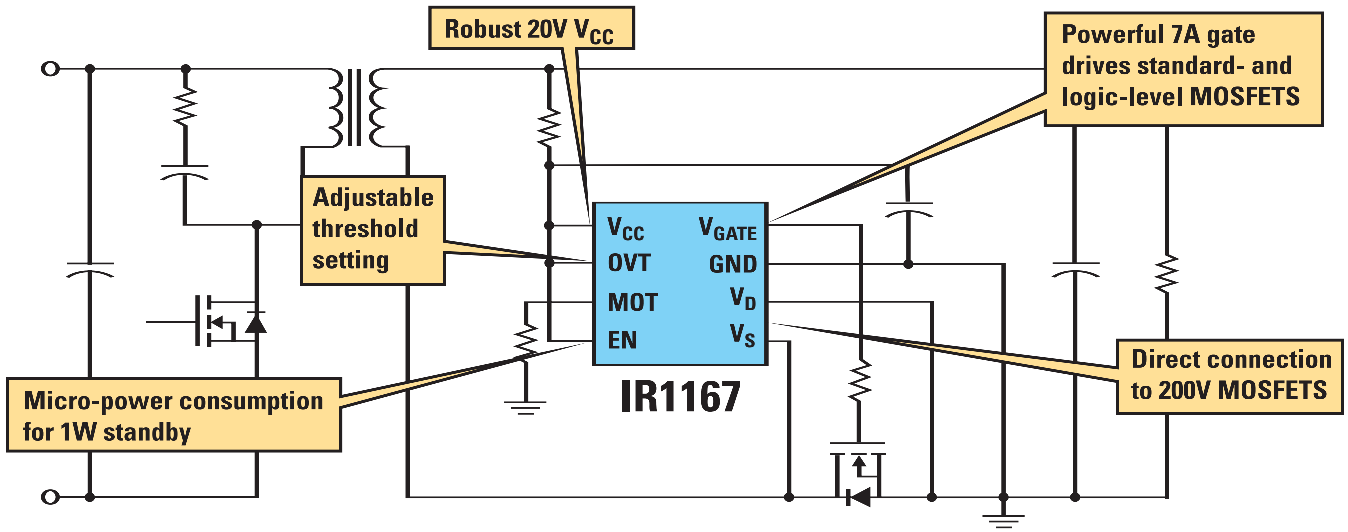
International Electric Machines and Drives Conference, IEMDC 2007, is scheduled for 3-5 May 2007 in Antalya, Turkey. IEMDC 2007 is jointly sponsored by the IEEE Power Electronics Society. For more information, please visit the conference website http://www.iemdc07.org/ or contact the General Chair, Okyay Kaynak kaynak@boun.edu.tr or the Technical Chair, Herb Hess, hhess@ieee.org

The 38th IEEE Power Electronics Specialists Conference, PESC'07, is scheduled for 17-21 June, 2007 at the Hilton in the Walt Disney World® Resort, Orlando, FL. PESC'07 is sponsored by IEEE PEL's. Deadline for abstract and digest submission is 10 Nov. 2006. General Chair is Prof. Issa Batarseh, batarseh@mail.ucf.edu and technical program chair Prof. John Shen, johnshen@mail.ucf.edu. For more information visit the website at www.pesc-conf.org.

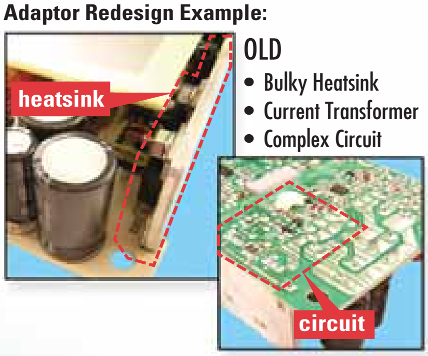
12th European Conference on Power Electronics and Applications, EPE2007, is scheduled for 2-5 Sept. 2007 in Aalborg, Denmark. Intending authors should note these deadlines: receipt of synopses by 1 Nov.1, 2006, notification of acceptance March 1, 2007, final review May 15, 2007. Further information can be found at http://www.epe2007.com/

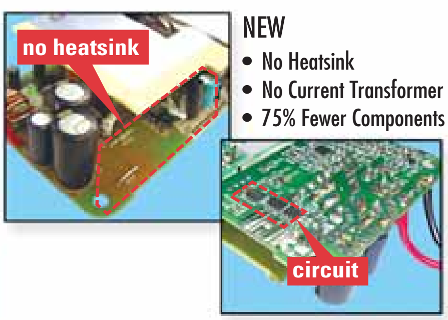
SYNCHRONOUS RECTIFICATION: NO HEATSINK, ONLY 6 COMPONENTS

New SmartRectifier™ IC Reduces Part Count by 75% and Boosts System Efficiency by 1%



Adaptor Redesign Example:





International Rectifier's new IR1167 SmartRectifier IC for 100W to 300W AC-DC power converters dramatically simplifies design and improves efficiency in secondary synchronous rectification (SR) flyback and resonant half-bridge circuits, enabling a "no heatsink required" design.

Features

- Increases system efficiency by 1% vs. current transformer
- Reduces component count from 22 to 6 in typical system
- Reduces MOSFET temperature by 10°C
- Works independently from primary-side control
- No current transformer required
- Industry-leading high voltage IC technology

Specifications

Part Number	Package	V_{CC} (V)	V_{FET} (V)	Sw. Freq. Max. (kHz)	Gate Drive +/- (A)	V_{GATE} Clamp (V)	Sleep Current Max. (µA)
IR1167A/S	DIP-8/SO-8	20	<=200	500	+2/-7	10.7	200
IR1167B/S	DIP-8/SO-8	20	<=200	500	+2/-7	14.5	200

MOSFETS to use with the IR1167 SmartRectifier as a total chipset solution:

Part Number	V_{DSS} (V)	$R_{DS(on)}$ max @ 10V (mΩ)	Package
IRFB4110	100	4.5	TO-220
IRF7853	100	18	SO-8
IRFB4227	200	24	TO-220

Design Tools

A data sheet, application notes, technical papers and online design software are now available on IR's myPower™ site (http://www.irf.com/design-center/mypower/).

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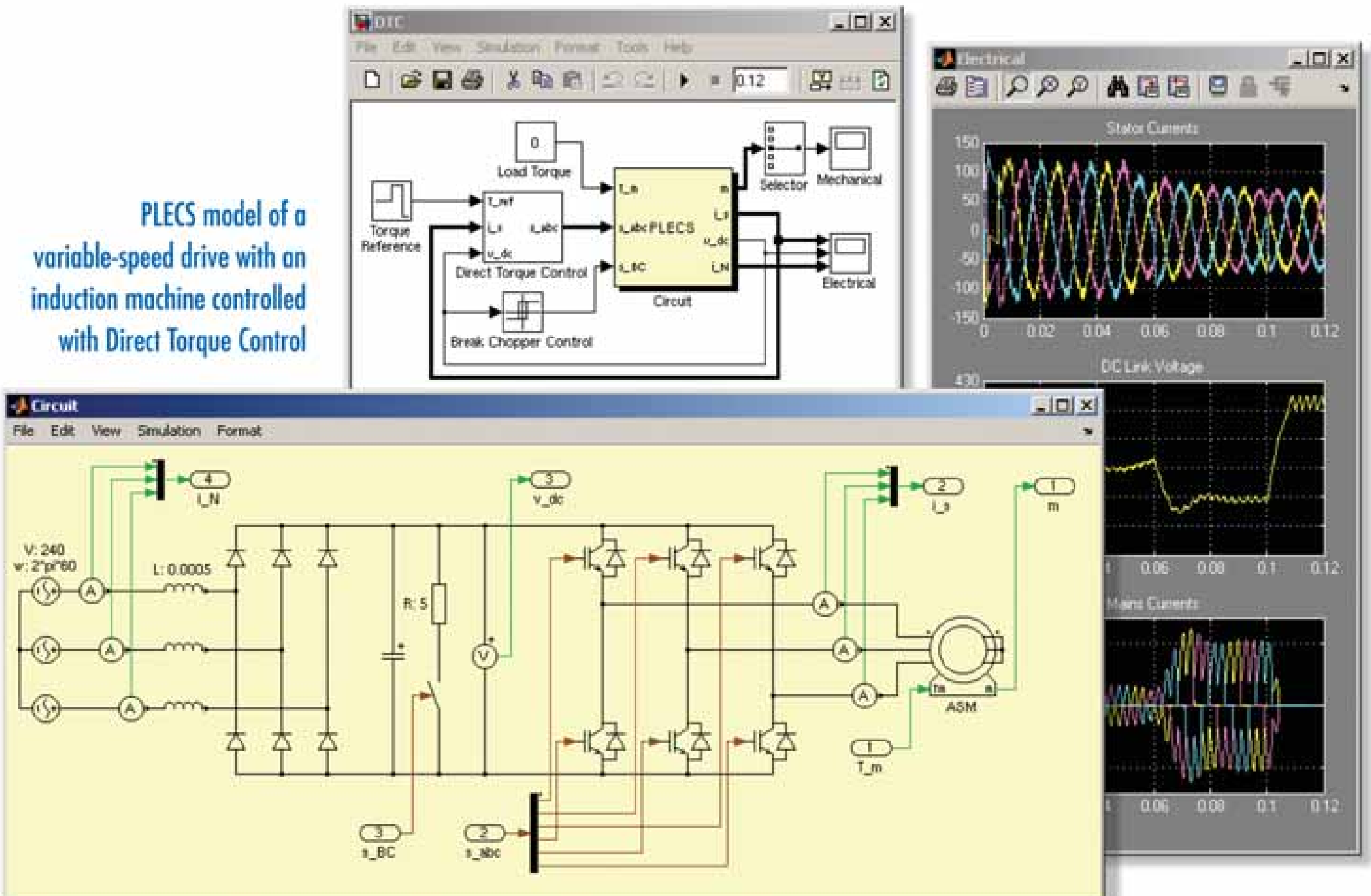

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