Request for Proposals (RFP)

The 2007 International Future Energy Challenge (IFEC'07)

A student competition sponsored by the

Institute of Electrical and Electronics Engineers (IEEE) Power Electronics Society
&
others

Summary of Competition and Proposal Requirements

General Information

Competition Title: 2007 International Future Energy Challenge (IFEC) Student Competition

Topic Areas: (A) Universal Adapting Battery Charger and (B) Integrated Starter/Alternator-Motor Drive for Automotive Applications

Period of Competition: June 6, 2006 to August 24, 2007

Challenge Award: At least US$10,000 (and more based on sponsorship) will be awarded for the highest score among entries in each topic area meeting all minimum requirements as confirmed through reports and hardware tests.

Program Awards (actual number depends on availability): Best results in specific categories (such as design innovation, educational impact, technical reports, presentations, and others); expected levels are $1,000 to $5,000 each. The final amounts and award categories are subject to sponsor support and the recommendations of the judges.

Intellectual Property and Use of Prize Money:

The International Future Energy Challenge does not restrict the use or protection of inventions or other intellectual property produced by participating teams. There are no special licenses or rights required by the sponsors. However, the Final Test Events that begin August 20, 2007 will include public disclosure of each team's technology. Teams interested in securing protection for their inventions should be aware of this date when making arrangements.

The prizes provided to schools are intended to benefit the team members and student team design project activities. The Letter of Support (Attachment II) required for submission with the proposal should outline the plans of the school in the event that a prize is received.

Outside Support:

Individual schools should solicit project funding from companies, foundations, utilities, manufacturers, government agencies, or other sources. There is no limitation for the sources of project funding.

Eligibility Information:

- **Eligible schools must:** have an accredited or similarly officially recognized engineering program (through the Accreditation Board for Engineering Technology (ABET) or equivalent as appropriate for the school's location); be a college or university with engineering curricula leading to a full first degree or higher; have the support of the school's administration; establish a team of student engineers with an identified faculty advisor;

demonstrate the necessary faculty and financial support commitments; and demonstrate a strong commitment to undergraduate engineering education through their proposal.

- **School Eligibility Limit: <u>Each school is limited to one proposal in one topic area; each school can propose only one team.</u>** Consortia of schools are permitted on a single proposal.

To confirm eligibility, potential participating schools must submit a Letter of Support (Attachment II) together with a Preliminary Team Information Form (Attachment I) when they submit the proposal.

How to Participate: Participation is on a proposal basis. Those schools that are interested must submit a proposal no later than September 18, 2006. Proposals will be judged by a distinguished panel of volunteer experts from the IEEE and from industry. 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. The reports will be judged by a similar expert panel. By May 15, 2007, the 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. The team achieving the best overall results that meet all the requirements in each topic area will receive a Challenge Award of no less than US$10,000 (based on sponsorship levels). The best results in individual categories, such as design innovation, educational impact, technical reports, presentations, and other categories to be determined, will win special monetary prizes of approximately $1,000 to $5,000 each.

Please be aware that each of the two topic areas of the 2007 International Future Energy Challenge will be judged separately, against a separate specification set. Each team proposal must address a single topic area.

Judging Panels

Judges include volunteer experts from the IEEE Power Electronics Society, other sponsors, and representatives from manufacturers, national labs, independent test labs, utilities, and other recognized as experts in the respective topic areas.

Judging

Student team project results will be judged based on cost effectiveness, performance, quality of the prototype and other results, engineering reports, adherence to rules and deadlines, innovation, future promise, educational impact, and related criteria. Each aspect of judging will be scored according to a point list and test protocol.

Proposals

Proposals will be judged on the quality of plans, the likelihood that a team will be successful in meeting the International Future Energy Challenge objectives, technical and production feasibility, and degree of innovation. Other key criteria are evidence of the school's

commitment, capability, experience, and resources to implement their design over the one-year span of the competition. Commitment to excellence in undergraduate education is important, and acceptable proposals will involve undergraduate students as the primary team members. Interdisciplinary teams are encouraged. Graduate students are not excluded, but the impact on undergraduate education is a critical judging criterion. **Proposals are limited to 12 double-spaced pages total, including all diagrams, attachments, and appendixes.** Schools that are invited to participate in 2007 International Future Energy Challenge are expected to adhere to the basic plans described in their proposals. Approval of the competition organizers must be sought for significant changes in plans or engineering designs. **Only one proposal will be considered from each school. Electronic copies of the proposals in PDF format are due, to be received by September 18, 2006, at the address provided below.**

A. Proposal Objectives

Respondents should express their ideas and plans relevant to their interested topic area. The project plan should include the construction and operation of a complete hardware prototype. The proposal must address both technical and organizational issues for each phase of the prototype's development and testing. It must contain a realistic project budget, along with a plan to secure the necessary funding. The educational goals, including any course credit provided for work related to the 2007 International Future Energy Challenge, and how the project relates to other efforts within the school and at the regional or national level should be addressed. A Letter of Support from an official of the school confirming a commitment to participate in the competition, and stating types and level of support for the team's participation in the competition, must be attached, and is not counted toward the 12-page limit. Refer to the attachments at the end of this document for a sample.

B. Administrative Considerations and Limitations

This section describes the limitations placed on the proposal. Compliance is mandatory.

Language	Proposals must be written in English.
Length and Format	Proposals are limited to 12 single-sided double-spaced pages of text, figures, references, and appendices. The page size must be 8.5" x 11" or A4 and the font size must be no smaller than 10 point. Text margins should be at least 25 mm. The first page should begin with the title, name of school, authors, the topic area, and an abstract. The Preliminary Team Information Form (Attachment I in this RFP) and Support Letter(s) (Attachment II in this RFP) from the school, government entities, or private sector organizations will not count in the proposal length.
Authors	Proposals are to be prepared by the student team in collaboration with the faculty advisors.

Signatures

Proposals must be signed by all authors of the proposal (or the student team leader) and the faculty advisor.

Letter of Support

Proposals must be accompanied by a letter of support from an appropriate Dean, Department Chair, or other authorized school official. The letter must confirm the school's commitment to participate. It must also state the types and value of support from the institution. Matching support from the school for the value of cash and in-kind support from the team's principal sponsors is encouraged and will strengthen the proposal. The letter should also indicate plans with respect to any potential award funds received as a result of the competition. Letters of support from other team sponsors are optional. A sample letter is provided as Attachment II.

Preliminary Team Data

Submit one copy of the Preliminary Team Information Form (Attachment I) with the proposal, then an updated copy with the progress reports to the address below. This form does not count in the 12-page limit.

Due Date

All proposals must be received at the address below by close of business on September 18, 2006 for full consideration.

Proposal Submission

An electronic copy of the proposal in PDF format must be sent to the competition administrator. Email is the preferred medium. If necessary, the electronic version can be delivered on floppy disk (IBM format), Zip disk (IBM format), CD, or USB memory stick.

Competition Administrator:
Ms. Lee Myers
Secretary, 2007 IFEC
IEEE Power Electronics Society, Executive Office
799 North Beverly Glen
Los Angeles, CA 90077, USA
Phone: +1-310-446-8280
Fax: +1-310-446-8390
E-mail: Lee.myers@ieee.org

Information

The volunteer Organizing Committee for the 2007 International Future Energy Challenge maintains a web site at http://www.energychallenge.org/. The site will include the most recent schedule and rule updates, frequency-asked questions, details about judging and scoring, and other team information. It should be checked regularly. The committee chair is Prof. Ali Emadi, Illinois Institute of Technology, Chicago, Illinois, USA (E-mail: emadi@iit.edu).

Coordinator for Topic (A) Universal Adapting Battery Charger:

Prof. Philip Krein
University of Illinois at Urbana-Champaign
Department of Electrical and Computer Engineering
341 William L. Everitt Laboratory
1406 West Green Street
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Phone: +1-217-333-4732
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Coordinator for Topic (B) Integrated Starter/Alternator-Motor Drive for Automotive Applications:

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University of Texas at Arlington
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E-mail: fahimi@uta.edu

2007 International Future Energy Challenge Organizing Committee

Chair: Dr. Ali Emadi – Illinois Institute of Technology
Secretary: Ms. Lee Myers – IEEE PELS Executive Office
Topic A Coordinator: Dr. Philip Krein – University of Illinois at Urbana-Champaign
Topic B Coordinator: Dr. Babak Fahimi – University of Texas at Arlington
Future Planning: Dr. Philip Krein – University of Illinois at Urbana-Champaign
Webmaster: Dr. Antonello Monti – University of South Carolina
European Liaison: Dr. Francesco Profumo – Politecnico di Torino
Asia Liaison: Dr. Prasad Enjeti, Texas A&M University
Australia Liaison: Dr. Grahame Holmes – Monash University
South America Liaison: Dr. Marcelo G. Simoes – Colorado School of Mines
IEEE Inter-Society Associate: Robert Myers – IEEE

Time Schedule

June 6, 2006:	Request for proposals (RFP) posted
September 18, 2006:	Proposals due
October 1, 2006:	Schools informed of acceptance into the competition
February 19, 2007:	Mid-progress reports due (Mid-progress reports are limited to 10 double-spaced, single-column pages total, including all diagrams, attachments, and appendixes.)
February 25-March 1, 2007:	IFEC Workshop at the 2007 IEEE Applied Power Electronics Conference (APEC) in Anaheim, California, USA (http://www.apec-conf.org/). Participating teams are expected to present their progress at this workshop. At least one member of each team should attend this workshop and present.
May 1, 2007:	Final progress reports due (Final progress reports must include preliminary experimental results; final progress reports are limited to 25 single-column pages total, including all diagrams, attachments, and appendixes.)
May 15, 2007:	Finalists notified (Selection is based upon likelihood of deliverable hardware, quality of design, and likelihood of success in meeting all the challenge objectives.)
August 20, 2007:	Final reports and working units due (Final reports are limited to 50 single-column pages total, including all diagrams, attachments, and appendixes.)
August 20-24, 2007:	Final competition
February 24-28, 2008:	2007 IFEC Awards Recognition at the 2008 IEEE Applied Power Electronics Conference (APEC) in Austin, Texas, USA.

Competition Description

Scope: 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. Participation is on a proposal basis.

Introduction: In 2001, the U.S. Department of Energy (DOE), in partnership with the National Association of State Energy Officials (NASEO), the Institute of Electrical and Electronics Engineers (IEEE), the U. S. Department of Defense (DOD), and other sponsors, organized the first Future Energy Challenge competition. The objective was to build prototype, low-cost inverters to support fuel cell power systems. This competition was originally open to schools in North America with accredited engineering programs. The 2001 Future Energy Challenge focused on the emerging field of distributed electricity generation systems, seeking to dramatically improve the design and reduce the cost of dc-ac inverters and interface systems for use in distributed generation systems. The objectives were to design elegant, manufacturable systems that would reduce the costs of commercial interface systems by at least 50% and, thereby, accelerate the deployment of distributed generation systems in homes and buildings. Final events were conducted at the National Energy Technology Laboratory (NETL) in Morgantown, WV, USA. Speakers from IEEE, DOE, and DOD introduced the competition and interacted with students during the event week. Hardware was tested with an experimental fuel cell at the NETL site. The 2001 Challenge was a success, and represented the first in a biannual series of energy-based student team design competitions.

To continue and expand the 2001 success, the 2003 International Future Energy Challenge (IFEC) was organized as a worldwide student competition. The 2003 IFEC had two topics, a revised topic on fuel cell power conditioning, and a topic for high-efficiency motor drive systems suitable for home appliances. Major sponsors included three IEEE societies, DOE, and DOD. Fuel cell inverter events were again held at NETL. Motor system events were held at Advanced Energy in Raleigh, NC, USA.

The 2005 IFEC had two topics. The inverter topic was revised to incorporate photovoltaic sources and grid interaction, while the motor topic was revised only slightly. Major sponsors included three IEEE societies and DOD, with more modest sponsorship from DOE. Inverter events were held at the National Renewable Energy Laboratory (NREL) in Golden, CO, USA. Motor events were held at MPC Products in Skokie, IL, USA.

2007 Topics and Descriptions: The 2007 competition addresses two broad topic areas: (A) Universal Adapting Battery Charger and (B) Integrated Starter/Alternator-Motor Drive for Automotive Applications.

Detailed specifications, system requirements, and test procedures for each of the two topics will be updated through August 2006 through the IFEC Web page.

Topic A
Universal Adapting Battery Charger

The objective of this topic is to develop 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 or office from several to as few as one.

Minimum requirements:

- Devices must operate without degradation or derating for input supplies ranging from 48 Hz to 440 Hz and 95 V to 270 V RMS.
- Devices must adapt and successfully charge any of the following battery combinations without external settings, switches, or other user intervention. Tests of these combinations will use readily available commercial cells.
    - Lead-acid cells, single or series combinations up to nine cells.
    - Nickel-cadmium cells, series combinations of two to fifteen cells.
    - Nickel-metal-hydride cells, series combination of two to fifteen cells.
    - Lithium-ion cells, single or series combinations up to five cells.
- Charging currents up to 1 A must be possible at all voltages.
- The charger must address the specific needs of each battery configuration, including but not limited to: no overcharge of lithium cells, appropriate end-of-charge action for each chemistry, etc.
- External indication of "charging" and "charge complete" conditions.
- Polarity-insensitive design. Batteries can be charged without trouble regardless of the connection polarity.
- Protection against open-circuit and short-circuit conditions.
- Device draws no more than 0.25 W when no battery is connected.
- After battery charge is complete, devices draws no more than 0.25 W plus twice any power required for maintaining battery "float charge" if needed for a given chemistry.
- Power drawn during charging not to exceed 0.5 W plus double the power delivered to the battery terminals.
- Input power factor not less than 0.7 under any circumstances, and not less than 0.8 during any battery charging condition under which the charging current exceeds 0.5 A. Details of power factor and power quality requirements will be posted on the web site.
- The charging methods should meet manufacturers' recommendations for each cell type.
- Batteries can be connected whether or not power is available without damage (i.e. fully hot pluggable with no requirements for a particular connection sequence)
- Delivered with adapter connectors for barrel-type dc power plugs as are provided on many small portable devices.
- Manufacturing cost in high-volume production (>1 M units/year) not to exceed US$10.

Optional (bonus points awarded for any provided minimum requirements are met):

- Operation from a vehicle dc outlet (12-15 V typical)
- Minimum power factor 0.85
- Device draws no more than 0.1 W when no battery is connected.
- Charging currents up to 2 A.
- Operation to nominal battery voltages up to 24 V (12 lead-acid cells, 20 nickel cells, 6 lithium cells)
- Ability to support rechargeable alkaline cell combinations of two to four or more cells in series.
- Size less than 15 cm x 6 cm x 3 cm, not including cords. Mass less than 0.4 kg.
- Switch setting converts the unit into a fixed 12 V power supply at up to 1 A. Reverts to charging mode automatically when batteries are then connected.
- Display indicates battery configuration and state of charge.
- Efficiency above 75%, not including up to 0.1 W quiescent power.

Entries are judged based on meeting the required specifications, based on lowest energy consumption during a specific test sequence to be defined in the rules, lowest cost for all aspects of the solution, smallest size and weight, most innovative design approaches, optional aspects met by the team, and other factors.

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. The motor shall start under an initial load of 70 N-m and reach the speed of 3500 rpm within 3 to 5 seconds. Design should assume the existence of an adequate 42 Volts dc link. Following the startup process, the electromechanical energy converter should quickly and safely become an alternator, charging a set of batteries at cruising speed of 3500 rpm. The desired controller should receive and monitor an stream of data (in analog or digital format) which includes the mode of operation (motoring/generating) along with the desired level of power. The motoring action is assumed as an adjustable speed option ranging from standstill to the cruising velocity. The main objectives are:

- Cost. A target cost of $200/complete setup (including electric machine and controller) is considered.
- Safety and fault tolerance. Development of fallback strategies in the event of failures in machine, converter, and sensors are highly encouraged.
- Efficiency. A target efficiency of not less than 75% during motoring and generating (not starting) modes of operation is required.
- Packaging. Details of the standard packaging and mounting will be furnished in near future.
- Smoothness in transition from motoring to generating and visa verse. This will be gauged in terms of quickness of the process, absence of mechanical bumps and irregular electromechanical transients.
- Innovativeness in magnetic design and power electronic-based controller.

An adequate dynamometer will be used to apply the necessary torque profiles to the shaft of the machine.

ATTACHMENT I

2007 INTERNATIONAL FUTURE ENERGY CHALLENGE
PRELIMINARY TEAM INFORMATION FORM
Submit with Proposal

TOPIC AREA:

NAME OF UNIVERSITY:

CORRESPONDING ADDRESS (PLEASE INCLUDE PRIMARY CONTACT NAME):

TELPHONE:
FAX:
EMAIL:

FACULTY ADVISOR(S):

Name	Department	E-Mail
_____	_____	_____
_____	_____	_____

PRELIMINARY TEAM MEMBERS:

Name	Major Field of Study	Degree and Expected Graduation Date
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

ATTACHMENT II
LETTER OF SUPPORT
Submit with Proposal

[The letter below is a typical sample and should not simply be copied. Please send a letter with similar content on your university letterhead.]

To: Ms. Lee Myers
Secretary, 2007 IFEC
IEEE Power Electronics Society, Executive Office
799 North Beverly Glen
Los Angeles, CA 90077, USA
Phone: +1-310-446-8280
Fax: +1-310-446-8390
E-mail: Lee.myers@ieee.org

Dear International Future Energy Challenge Organizers,

Our university has organized a student team to participate in the 2007 International Future Energy Challenge. Our proposal for the topic (X) is enclosed. A Preliminary Team Participation Form is attached, listing our contact person, the faculty advisor(s), and some of the students who plan to be involved. The team will keep an eye on the Energy Challenge web site for detailed rules and other information. We understand that we will be notified whether we have been accepted to participate by October 1, 2006. If we are accepted, we agree to have our student team perform the design tasks and prepare the reports and hardware prototypes required for the competition. Our school is prepared to support the team with the following resources:

- A final year project course, XXX, has been authorized to provide engineering students and others across several disciplines with the opportunity to include this project in their curricula. Laboratory space has been arranged for this course.
- A faculty advisor, Prof. XXX, has been identified, and has been formally assigned to teach the project course and to advise the student team as a portion of his/her regular duties.
- A graduate student assistant has been identified to help manage the student team and to supervise direct laboratory activity. This student is supported with a Teaching Assistantship, which represents a funding commitment of our university of approximately $X.
- The student team will be provided with an appropriate level of technician and machine shop support to assist them with package preparation and assembly. This assistance represents a funding commitment of approximately $X, and we consider this as a matching commitment for any in-kind support received from external sponsors.
- In addition, we will provide limited funds to help secure special parts and equipment, with a total commitment of up to $X.
- The student team will be encouraged to secure outside sponsorship. Our university strongly supports all these efforts, and will match any outside cash support 1:1 up to an additional total of $X.

In the event that our school receives prizes from the competition, we are committed to using approximately X% of this money for scholarships for the student team members. The remainder of the funds will be added to our Team Design Program fund, which supports this and similar projects through sponsorship matching, travel funds for participation in competition events, and other direct costs of large team design projects. In the event that our team creates new inventions in the topic area, our university also provides the possibility of assisting with organization of a start-up company.

We understand the importance of student team projects in the engineering curriculum and look forward to our participation in the 2007 International Future Energy Challenge.

Sincerely,

(Head of Department, Dean of Engineering or similar authorized school official)