Request for Proposals (RFP)

(Updated on July 13, 2020)

The 2020 International Future Energy Challenge (IFEC2020)

http://energychallenge.weebly.com/ifec-2020.html

A student competition sponsored by the
The Institute of Electrical and Electronics Engineers (IEEE)
November 9-12, 2020
Aalborg University, Denmark

IFEC2020 Organizing Committee and Time Schedule

Organizing Committee

General Chair:
Huai Wang, Aalborg University

General Co-chair:
Yongheng Yang, Aalborg University

Publicity Chairs:
Ariya Sangwongwanich, Aalborg University
Mads Graungaard Taul, Aalborg University

Finance Chair:
Ching-Jan Chen, National Taiwan University

Steering Committee

Steering Committee Chair:
Giri Venkataramanan, University of Wisconsin-Madison

Time Schedule

Sep. 30, 2019	IFEC2020 Information Session at ECCE2019
Nov. 11, 2019	Letter of intent deadline
Nov. 25, 2019	Proposals Due
Dec. 21, 2019	Schools informed of acceptance into the competition
Apr. 23-24, 2020	Online workshop 1. All accepted qualified teams must give a presentation. Up to 10 teams will be invited for the 2nd stage.
Aug. 23, 2020 By 23:39 (UTC+2)	**Project report due** (project report must include technical approach, design methodology, realized prototype with respect to the requirement, experimental results, and future plan. It is limited to 25 single-column double-spaced pages total, including all diagrams, attachments, and appendixes. The page size must be 8.5" x 11" or A4 and the font size must be 12-point, font type: Times New Roman. Margins should be at least 25 mm). **Video due** (up to 5 minutes to record relevant prototype and experimental testing)
Aug. 31, 2020	Online workshop 2. This workshop will select at least 4 teams to be invited for the final event at Aalborg.
Nov. 9-12, 2020	Final competition

IFEC Introduction

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 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, reduce the cost of dc-ac inverters, and interface systems for use in distributed generation systems. The objectives were to design elegant, manufactural 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.

To continue and expand the success of 2001 and other 11 IFECs along the years, the 2020 International Future Energy Challenge (IFEC) will be organized with the topic of “Power Supply for Nano Satellites”, the 1st time IFEC comes to Europe. In the 2020 IFEC, the students will be asked to design the power supply to be used in Nanosatellite application, where the size and weight become crucial.

Awards and Financial Support

There will be a Grand Prize of $10,000 and three additional awards granted at $1,000, $3000 and $5,000 each. The detailed technical specification of the 2020 competition is listed in the following page. A travel support of $1000 for teams with a distance less than 5000 km and $2000 for distance of 5000 km and above will be provided, which is applicable for the final competition.

IFEC2020 Topic: Power Supply for Nano Satellites

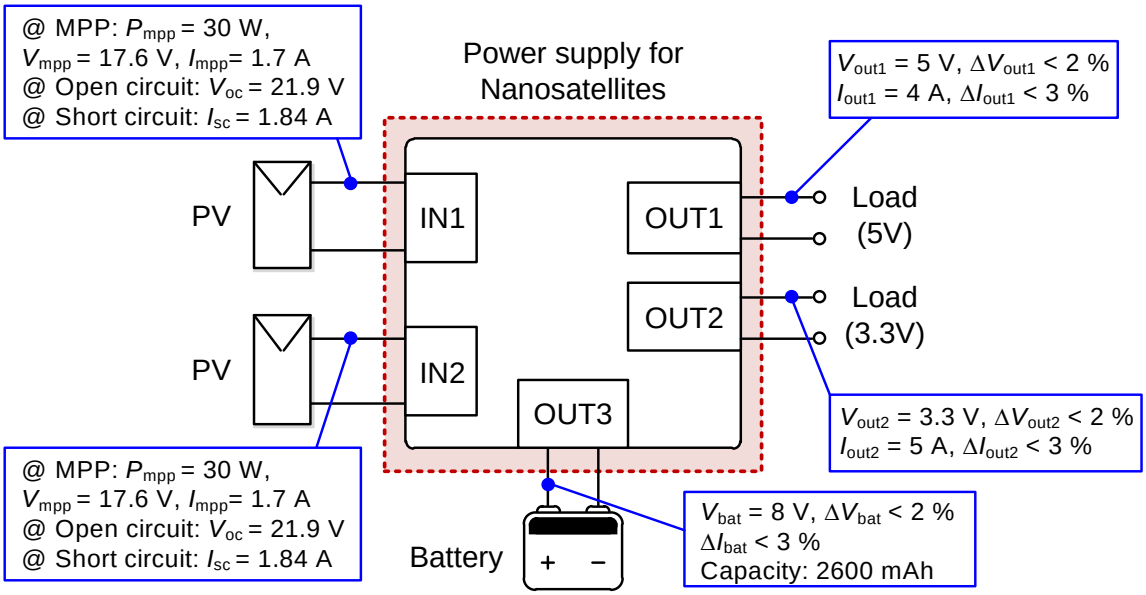
Background of the Topic

Nanosatellites are one of the fast-growing satellite industry segments in recent years. According to Nanosats.eu, more than 1000 small- and nanosatellites have been launched as of the January of 2019 with an estimated market value over US$7 billion. As the costs are going further down and the production period is continuously shortening, the market of nanosatellites is still growing at a fast pace. The applications of nanosatellites are also very broad, covering global tracking, internet of things, remote sensing, defense and security, electronic equipment testing, etc.

Typically, nanosatellites have a wet mass between 1-10 kg (i.e., 2.2 – 22.0 lb). In this case, the design of nanosatellites requires much more dedications, especially the electronics, which is the core of the nanosatellites power systems. In general, the power electronics systems have to withstand the harsh operating environment, where the temperature is low and the equipment is exposed strong radiations. Additionally, the power conversions should be highly efficient and highly reliable to condition the power from solar photovoltaic (PV) panels, in which the power management is essential. The voltage levels at the PV should be regulated to be compatible with the load demands, e.g., battery storage systems and on-board loads. Those involve extensive direct current (DC) to DC power conversions, unidirectional and bidirectional. Notably, the space (volume and weight) is also a limiting factor when designing the power systems.

With the above considerations and background, IFEC 2020 is calling for proposals to design power supplies for nanosatellites applications. The power supplies include power sources from multiple solar PV panels (two) mounted on the surfaces of the nanosatellites. Batteries are used as the energy storage system, which are charged through the solar PV panels and discharged to supply loads when necessary. Different types of loads are considered. Thus, the power converters include unidirectional DC-DC converters and a bidirectional DC-DC converter for the batteries. The designed power supplies should perform the basic functions – extract the maximum power from solar PV modules; charge and discharge the batteries. Detailed specifications and requirements are listed as follows.

Specification of Power Supply for Nano Satellites



IN1, IN2 - Solar PV Modules (for each input):

- Maximum power P_{mpp}: 30 W
- Open circuit voltage V_{oc}: 21.9 V
- Short circuit current I_{sc}: 1.84 A
- Voltage at the maximum power point V_{mpp}: 17.6 V
- Current at the maximum power point I_{mpp}: 1.7 A
- Maximum power point tracking (also under partial shading)
- Ref: https://docs-emea.rs-online.com/webdocs/171c/0900766b8171c20b.pdf

OUT1 – 5V DC Loads:

- V_{out1} = + 5V @ I_{out1} = 4 A
- Voltage ripples at the load side ΔV_{out1} < 2% @ 100% load
- Current ripple at the load side ΔI_{out1} < 3% @ 100% load

OUT2 – 3.3V DC Loads:

- V_{out2} = + 3.3V @ I_{out2} = 5 A
- Voltage ripples at the load side ΔV_{out2} < 2% @ 100% load
- Current ripple at the load side ΔI_{out2} < 3% @ 100% load

OUT3 - Batteries:

- Capacity: 2600 mAh
- Battery voltage: V_{bat} = 8 V
- Under voltage detection: 1600 µs
- Over current detection: 580 µs (max 1400 µs)

- Voltage ripple at the batteries during discharging $\Delta V_{bat} < 2\%$ @ 100% load
- Current ripple at the batteries side during charging $\Delta I_{bat} < 3\%$ @ 100% load

Performance Targets

- Overall maximum power consumption by the converters: < 5 W
- Weight: < 200 g without PV panels and batteries
- Dimension: < 90 × 96 × 25 mm (PC104 Standard) without PV panels and batteries
- **NO** forced-air cooling and **NO** liquid cooling

Control Functions

- **Mode I:** The battery is in the inactive state (i.e., no charging or discharging). The power extraction of the PV panels has to be regulated equal to the load demands (e.g., non-MPPT operation). The loads are supplied by the PV panels only.
- **Mode II:** The battery is in the active state. The power extraction of the PV panels has to be kept at the maximum available power, i.e., MPPT operation.
    - If the PV power is higher than the load demand, the battery is charged with the excessed power.
    - If the PV power is lower than the load demand, the battery is discharged to supply the load together with the PV panels.
- **Mode III:** The battery is in the active state. The PV panels are in the inactive state (i.e., no power available). The loads are only supplied by the battery only.

Mode	PV panels	Battery	Loads
I	Active	Inactive	Active
II	Active	Active	Active
III	Inactive	Active	Active

Protection

- At point of connection to the power supply and load (i.e., IN1, IN2, OUT1, OUT2, and OUT3), over current and over voltage protection will be provided by the power supply (e.g., PV simulator and battery simulator).

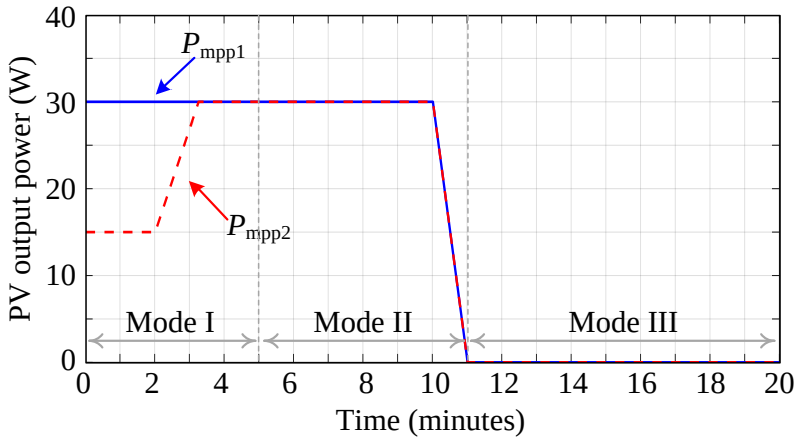
Safety

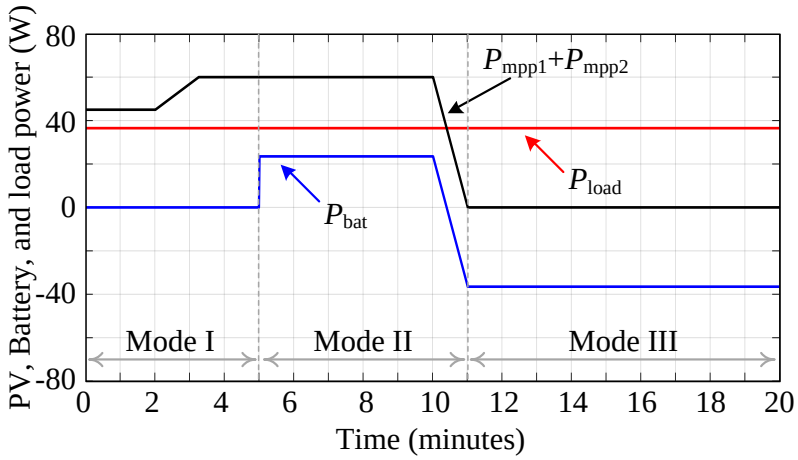
- No live electrical elements are to be exposed when the unit is fully configured. The system is intended for safe, routine use by non-technical customers.

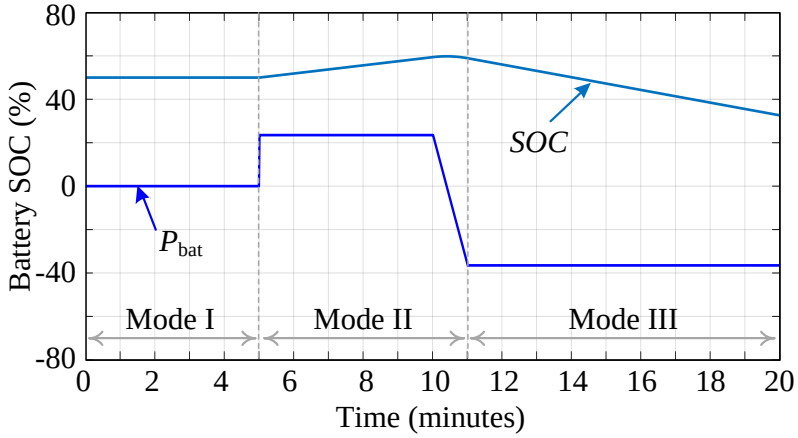
Test Profile

- The following test profile will be used during the final testing of the prototype.
- The power supply (i.e., prototype) is not allowed to be disconnected/stopped during the entire testing process.

- The testing time is 20 minutes, which is divided into three operation modes.
    - Mode I: 5 minutes
    - Mode II: 6 minutes
    - Mode III: 9 minutes



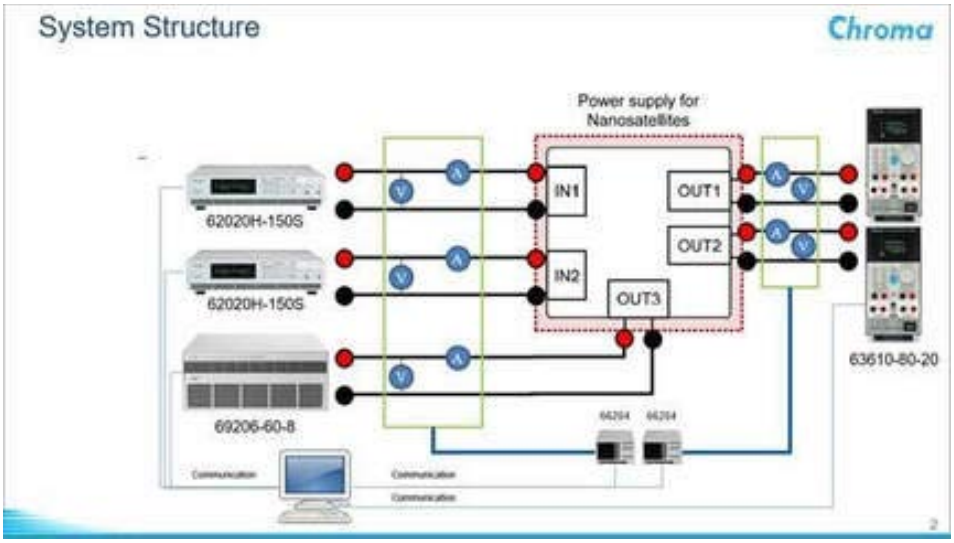




Note: P_{mpp1} and P_{mpp2} are the maximum available power of the 1st and 2nd PV panel, respectively.

Testing configurations

62020H-150S: Solar Array Simulator
17020 (69206-60-8): Battery emulator
63610-80-20: Load emulator (in current mode setting at 4A and 5A, respectively)
66204: Measurement of voltage, current, and power



Configuration of the Testing Setup for the Final Test.

Competition and Proposal Requirements

Competition Title

The 2020 International Future Energy Challenge (IFEC2020) Student Competition

Topic

Power Supply for Nano Satellites

Period of Competition

September 29, 2019 to November 12, 2020

Challenge Program Awards

A Grand Prize of $10,000 and three additional awards granted at $1,000, $3000 and $5,000 each.

Prize Requirements

US$10,000 will be awarded as Grand Prize for the highest score among entries in each topic area meeting all minimum requirements as confirmed through reports and hardware tests. The remaining prizes will be awarded to the teams according to the highest scores in other aspects/categories, e.g., Best Hardware Design and Best Technical Report.

Intellectual Property and Use of Prize Money

The International Future Energy Challenge (IFEC) 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 in November 2020 will include public disclosure of each team's technology. Teams interested in securing protection for their inventions should be aware of this date when planning.

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

External 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); 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.
- University Eligibility Limit: **Each university campus is limited to support only one team**.
  To confirm eligibility, potential participating schools must submit a **Letter of Intention** (Attachment I) by November 11, 2019, to ifec2020@et.aau.dk; and submit a **Letter of Support** (Attachment II) with the project proposal by November 25, 2019, to ifec2020@et.aau.dk.
- For each team, the minimum undergraduate student number is three to qualify for the competition. Graduate students can only participate as graduate advisors. Up to two graduate students are allowed per team.

How to Participate

Participation is on a proposal basis. Interested universities must submit a proposal before the proposal deadline. Proposals will be judged by a distinguished panel of volunteer experts from the IEEE and the industry. Schools with successful proposals will be notified two months after the proposal deadline. Student teams will then carry out the work and prepare hardware prototypes and reports. Deadline for the qualification reports are also listed in the attachment and will be posted on the IFEC website. The reports will be judged by a similar expert panel. The panel will select a group of teams as Finalists based on the qualifying reports. These teams are invited to present their progress during the Online workshop 1. Afterwards, feedback will be given to the team to improve the system. Then, up to 10 project teams will be invited to the 2nd stage, where the Online workshop 2 will be held in September to select at least 4 project teams to the final event at Aalborg in November 2020. A Final Report will be due at the competition event.

Judging Panels

Experts from IEEE Power Electronics Society (and others to be announced) and representatives from manufacturers, national labs, independent test labs, utilities, and R&D engineers.

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, 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 IFEC2020 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. For each team, the minimum undergraduate student number is three to qualify for the competition. Interdisciplinary teams are encouraged. Graduate students are not excluded but are limited to graduate advisor role in the team. The upper limit of graduate student participants is two for each team.

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 the IFEC2020 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 for each school. Proposals must be submitted electronically in PDF format.

Proposal Objectives

Respondents should express their ideas and plans relevant to the competition topic area. The project 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 2020 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 the type(s) and level of support for the team's participation in the competition should be attached, and is not counted toward the 12-page limit.

Administrative Considerations and Limitations

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

Language	Proposals must be written in English.
Length	Proposals are limited to 12 single-sided double-spaced pages of text, figures, and appendixes. The page size must be 8.5" x 11" or A4 and the font size must be no smaller than 10 point. Margins should be at least 25 mm. The Preliminary Team Information Form (Attachment I in this RFP), Support Letter (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 type(s) and value of support from the institution. School support should match the value of cash and in-kind support from the team's principal sponsors. Additional 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 by close of business on Nov 25, 2019 for full consideration.
Proposal Submission	The electronic copy of the proposal in PDF format must be sent to ifec2020@et.aau.dk by e-mail, with a copy to the IFEC2020 chairs. General Chair: Huai Wang Department of Energy Technology Aalborg University Pontoppidanstraede 111, Aalborg 9220, Denmark Email: hwa@et.aau.dk General Co-Chair: Yongheng Yang Department of Energy Technology Aalborg University Pontoppidanstraede 111, Aalborg 9220, Denmark Email: yoy@et.aau.dk
Information	The Organizing Committee of IFEC2020 maintains the website at http://energychallenge.weebly.com/. The site will include the recent schedule and rule updates, frequency-asked questions, details about judging and scoring, and other teams' information. It should be checked regularly.
Contact email	ifec2020@et.aau.dk

ATTACHMENT I

2020 INTERNATIONAL FUTURE ENERGY CHALLENGE
LETTER OF INTENTION

To be submitted by 11 November 2019 to ifec2020@et.aau.dk

NAME OF UNIVERSITY:

CORRESPONDING ADDRESS (PLEASE INCLUDE 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

To be submitted by 25 November 2019 to ifec2020@et.aau.dk

[The letter below is an example, which should not be simply copied. Please send a letter with similar content on your university letterhead.]

Huai Wang, Professor
Department of Energy Technology
Aalborg University
Pontoppidanstraede 111
9220 Aalborg, Denmark

Dear IFEC2020 General Chair,

Our university has organized a student team to participate in the 2020 International Future Energy Challenge. Our proposal 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 December 21, 2020. 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 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 advisor 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 2020 International Future Energy Challenge.

Sincerely,

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