UQIDAR: The University of Queensland - IIT Delhi Academy of Research

Joint PhD Project Proposal Template

1. Project Title:	**Assessment and Comparison of Performance of Thermal and Electrical Battery for Renewable Energy Applications**
Project ID	**UQIDAR-00134**

2. Supervision Team

Please visit the IITD website www.iitd.ac.in and UQ Website http://researchers.uq.edu.au/ to highlight potential collaborators that would be best suited for the proposed project. Complete where possible – advise if you'd like assistance establishing contacts.

	University of Queensland	***IIT Delhi***	***External/Industry (if applicable)***
Supervisor Name	*Professor Hal Gurgenci*	*Professor Dibakar Rakshit*	*Not applicable*
School or Department (or company, if applicable)	*School of Mechanical and Mining Engineering*	*Centre for Energy Studies*	
Phone Number	*+61 7 336 53607*	*+91 2659 7313*	
Email-ID	*h.gurgenci@uq.edu.au*	*dibakar@iitd.ac.in,*	
URL for more info	*https://energy.uq.edu.au/profile/78/hal-gurgenci*	*http://web.iitd.ac.in/~dibakar/*	

3. Other Supervisor Details

Please include other associate supervisors below:

Full Name and Title(s): *Professor K. Ravi Kumar*
School/Department/Company details: *Centre for Energy Studies, IIT Delhi*
Phone/Email/URL: *+91-11-26591252; krk@ces.iitd.ac.in; http://ces.iitd.ac.in/?page=krk*

Full Name and Title(s): *Dr. Anand Veeraragavan*
School/Department/Company details: *School of Mechanical & Mining Engineering, The University of Queensland*
Phone/Email/URL: *+61 7 33654069; anandv@uq.edu.au , W: UQ Researchers: Anand V*

2. Field of Research CODES:

(Specify up to four four-digit FOR codes for your project – see **here** for more detail on FoR codes)

0913	091307
091305	Nil

3. Keywords: *(this will assist in classifying project and presenting projects to students on the applications portal)*

Choose up to 4 keywords for your project.

Eg: nanotechnology, data science, novel batteries, etc

1 Energy generation,	3 High Temperature Energy storage
2 Energy conversion	4 Electricity spillage

4. Discipline Background of Candidate: *(this will assist in presenting projects to applicants on the apps portal)*

Ideally this project requires students with a background in...

Eg: organic chemistry, physiology, topology, CFD, etc

1 Renewable Energy	3 Computational Fluid Dynamics
2 Heat Transfer	

5. Project description

Summary of the proposed project, including aims and methodology. (max. 300 words)

The project targets to harness the excess electricity (or electricity spillage) generated by solar PV and wind power plants which will be converted into thermal energy, and in turn will be stored in a thermal energy storage system (Thermal battery). The thermal battery is envisaged to store heat at high temperatures (≥900°C) and act as heat source for subsequent cogeneration applications.

Conventional electrical batteries can store electricity for future usage but their low energy storage capacity and less durability pave way for the recent contender in the area viz. thermal battery. Electrical energy can be efficiently converted into heat and multiple options are available to store it. An overview of the high temperature thermal energy storage (HTTES) is presented below.

Alkali-metal carbonate salts can be used for sensible heat storage at high temperature. There are following three systems available for the purpose viz. Raft thermocline, two tank and two media thermocline systems.

Latent heat storage is a lucrative HTTES option. Several metals such as Copper (1084°C), Ductile Iron (1149°C) and their alloys, e.g., Yellow Brass (930°C) have melting points in the target temperature range. Several common salts such as NaF (995°C), BaCl2 (962°C) etc. can also be utilized for HTTES.

Excess electricity can also be stored by thermochemical process consisting of a pair of reversible redox reactions. In the charging cycle, excess electricity converted into heat is utilized in an endothermic reaction. The excess heat can thus be stored in the products of reaction for a long duration without any energy loss issue. When required, the stored energy can be recovered by initiating the exothermic reaction between the products of the previous reaction.

This project will investigate the above options of HTTES and find the most suitable one from performance and economic aspects to substitute electrical batteries for energy storage.

6. Project deliverables/outcomes

Highlight the expected outcomes of the project

Successful completion of the project will deliver the following:

1. Evaluation of the thermal performance of various HTTES media.
2. Techno-economic analysis of development and functioning of thermal battery.
3. Comparison (Performance, economics, safety and durability) between thermal battery and electrical battery.
4. CFD analysis of critical components for performance improvements.
5. Holistic optimization study of the overall plant to determine optimum operating parameters.

7. Research Impact Themes:

Highlight which Research Impact Theme(s) this project will address?

(*Feel free to nominate more than one. For more information, see http://www.uq.edu.au/research/impact/)*

5. Transforming Societies

8. Type of Student

This project is best suited for an:

i-student	**i**
a-student	
i- or a-student	

Note that an i-student will be expected to spend year-1 at IIT-D, year-2 at UQ and the remaining time at IIT-D.
An a-student will spend year-1 at UQ, year-2 at IIT-D and the remaining time at UQ.
All students will be required to complete some amount of coursework in their first year.

9. Student capabilities and qualifications

List the ideal set of capabilities (at least 2 essential and 2 desirable) that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities. Add specific skill sets here…

Essential Capabilities: Strong fundamentals in thermodynamics, heat transfer and power plant engineering, Knowledge of CFD tools and Matlab, Knowledge of system design software

Desirable Capabilities: Experimental acumen

Expected qualifications (Courses/Degrees etc): Masters in Mechanical/ Chemical/ Aerospace engineering