Michigan State University
College of Engineering; Dept. of Electrical and Computer Eng.
ECE 480 Capstone Design Course Project Charter

Sponsoring Company/ Organization: Michigan State University

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Background Information:

Business Case:

- Electrical energy from large scale solar projects is attractive due to favorable economics and carbon emission avoidance. Operating large scale solar projects on micro-grids where the output of the solar array is a sizeable fraction of the micro-grid generation capability present some technical challenges. MSU is working with a company to install a large scale solar project and demonstrate leadership in operating such an array on the MSU micro-grid.
- Access to renewable energy has increased due to the falling prices of large scale solar projects. With favorable pricing, technical challenges remain for cost-optimizing the integration of renewable energy into traditional fossil fuel micro-grids.
- This product will be positioned to avoid the costs to import electrical power and avoid disruption to the micro-grid by temporarily suspending elective electrical loads to balance the available supply with the present demand.
- There are few competitive barriers to marketplace entry for the design of a micro-grid control system because each micro-grid is typically unique with its own set of fossil and renewable generation assets, demand characteristics, and costs to import power. This niche environment creates a low entry barrier for simple, cost-effective solutions that can be reliably adopted.

- Novel and demonstrated technology and low cost are the key factors for sustaining a competitive advantage for this system. Demonstrated reliability on a major research university campus is another competitive advantage.

Project Intellectual Property Considerations:

- A Non-Disclosure Agreement is not required.
- The design team may post their work on the course website.
- The student Design Team will not be working with technology contained in pending patents not yet granted, but may be generating patentable technology.
- The electronic design can be shown.

Opportunity Statement:

- What **clearly defined Customer Problem** you hope to solve with this project?
    - Solar energy output is expected to be variable depending on weather events. When production from a large scale solar array rapidly drops, as in the case of a rapidly approaching storm, the micro-grid that it is attached to it could potentially be disrupted until the fossil fuel powered generation is able to reach the production levels necessary to meet the demand. To avoid disruption, power can be imported from a connection from an adjacent utility. This imported power typically costs more than electricity generated within the micro-grid. A micro-grid control system is one solution that can work with both the solar electric array and fossil fuel generation system to balance production needs with demand.
    - The problem can be solved in 13 weeks with a team that has knowledge of interfacing directly with electrical control equipment, or implementing solutions that interface with existing control system software.
- Does this problem exist now, or in the future?
    - This problem exists now in the event of the loss of key fossil fuel generation equipment at the central plant so any solution can be verified and is beneficial even in advance of the construction of the large scale solar array.
    - The window of opportunity will remain open for as long as hardware and software remain at a level where high expense or complex changes to infrastructure are necessary to implement.
    - Many things can drive the window of opportunity closed. Some of those include lower costs to import power or better electrical energy storage technologies.
- Who is the customer?
    - A micro-grid operator typically makes the purchasing decision together with a recommendation from their engineering team.
    - The ECE 480 Design Team will deliver their project to a wide audience that includes key University administrators, campus utility engineers, and other subject matter experts.
    - The benefit to MSU of this project is leadership in demonstrating the operation of a large scale solar array to reduce carbon emissions,

maintain or increase the reliability of the campus micro-grid, and reduce the costs of University operation.

Deliverables:

- Describe what is to be delivered at the end of the semester.
    - MSU is looking for a technical solution to increase the reliability of the micro-grid and reduce total cost of utility operation. The solution space and therefore the deliverable takes the form of anything that abates or totally avoids the costs of on-peak capacity charges due to an imbalance between the present demand and the available generation on the micro-grid. This can be as simple as an analytical study that has been validated by a field experiment on the micro-grid to verify the recommended action(s) of the study. It can be as complex as a final product (hardware / software) that is tested on the actual micro-grid.

Goals:

- Describe what success will look like at the end of the semester.
- Goals should be SMART
    - **Specific** – A technically feasible solution to abate or totally avoid the costs of on-peak capacity charges due to an imbalance between the present demand and the available generation on the micro-grid
    - **Measurable** – The measurement system will be the total campus electrical demand vs. available generation capacity both of which are existing, well-developed measurement systems.
    - **Attainable** – This project is achievable to students with little or no industrial experience. Full access to experienced campus utility engineers is guaranteed.
    - **Relevant** – This is a real-world problem that exists at MSU and is expected to increase (if no solution is found) with the installation of a large scale solar array on the campus micro-grid.
    - **Time Bound** – This project will be intense yet achievable and is balanced with the reward of making a real difference and benefit to our campus in a 13 week period.

Scope:

- In scope:
    - Balancing the performance capabilities of the campus micro-grid generation assets to the campus electrical demand.
- Out of scope
    - Solar array output properties
    - Power plant internal properties (another project is doing this)

    - Campus electrical demand profiles (we cannot expect people to turn things off under non-automated control).
- Clearly list chipsets, software, equipment, test set-ups, working systems, etc. that will be supplied to the Design Team to facilitate their efforts and keep project cost reasonable.
    - Expected solar array output characteristics
    - Power plant supply properties (generation ramp rates)
    - Costs of importing power
    - Access to campus subject matter experts responsible for the design, maintenance, and operation of the campus micro-grid system.

Constraints:

- List all constraints on the project team.
    - Must learn details about the T.B. Simon Power Plant, MSU 10MW solar array, campus demand and electrical distribution with expert help from MSU campus utility engineers and other experts.
    - Must work with MSU campus engineers involved with utility generation and building codes.
    - Propose and validate (test) or implement a reliable, creative, and low-cost solution within critical infrastructure.

Project Team: (Completed once semester begins)

Name	Responsibility

Faculty Advisor: (Assigned by ECE Dept . based on project requirements)

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