CAREER EPISODE 1

PV Solar Power Generation with MPPT Controller

A) Introduction

[CE 1.1]

Title: PV Solar Power Generation with MPPT Controller

Duration: [Date] – [Date]

Location: Hyderabad, India

Organization: Nagarjuna Construction Company, India

Position: Electrical Engineer

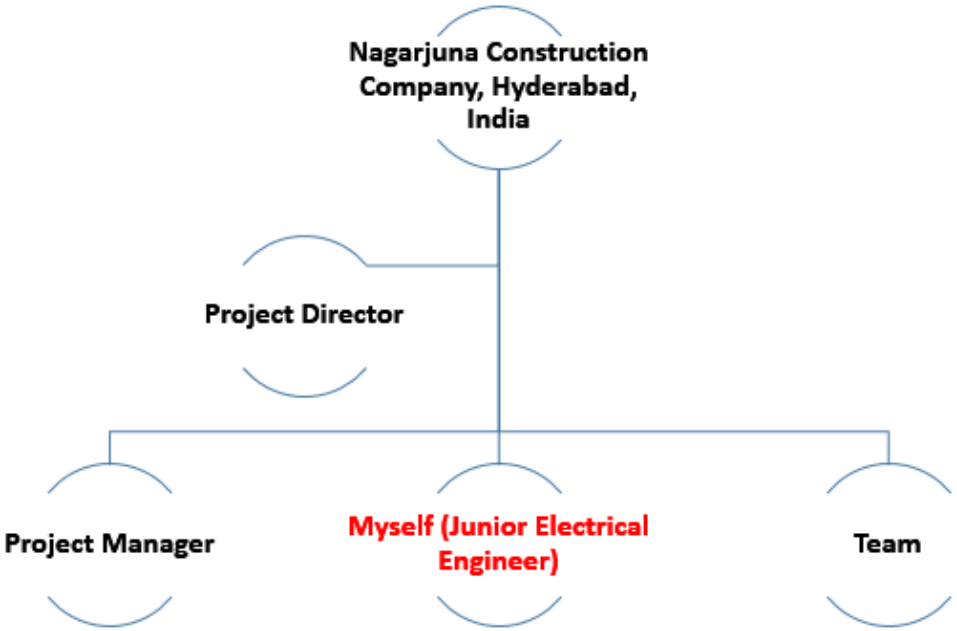
B) Background

[CE 1.2] For isolated loads or household purposes, the standalone-PV systems are generally used. The power demand increment in the utility end with lesser fluctuations and harmonics are the major issues. The energy conventional sources have the probability to last for a limited time but energy renewable sources such as solar energy are eco-friendly and infinite. With the power electronics devices enhanced efficiency, the utilization of solar energy can be done by providing power to the consumers. The solar energy only flaw is that the set-up needed is expensive.

[CE 1.3] The main aim was the MPPT control implementation of the standalone-PV system to supply power with battery to the loads. The battery worked as an energy storage element and it was utilized as a power source when PV was insufficient for the same. I executed the system which comprised of PV panel, a boost converter circuit, and a battery. I implemented the hardware and software design with the boost converter for tracking the maximum power point of the PV panel from duty cycle controlling. It worked as the boost converter gate pulse and the battery function was for maintaining a constant dc-link voltage.

[CE 1.4] I implemented the perturbation and observation technique which was utilized as the Maximum Power Point Tracking control algorithm. I created the standalone-PV system model which led towards verifying the output. I implemented the microcontroller which was the bigger circuit part for MPPT hardware implementation and it was the solar charge controller. The hardware circuit's main part was the solar charge controller and after simulation verification, the complete setup was designed in hardware along with testing which was executed according to the set parameters.

[CE 1.5]



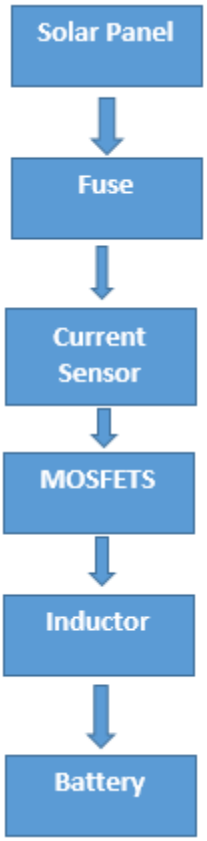
[CE 1.6] Core responsibilities in the project were:

- I did snubber circuit consideration which was required when an inductor was present in the design.
- I did ceramic capacitors utilization mainly for higher frequency spikes removal.
- I executed the hardware and software design implementation for the boost converter for obtaining the work results using electrical engineering expertise.
- I carried out three LEDs connection with the microcontroller for noting the output values associated with the design.
- I utilized the sensor specifically for current sensing from the solar panel which was typically fed to the Arduino analog pin.

C) Personal Engineering Activity

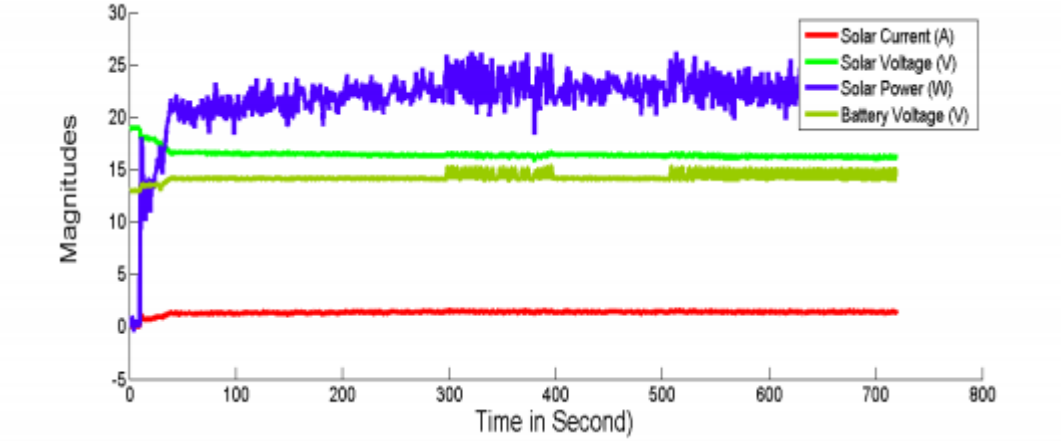
[CE 1.7] I connected the terminals of the solar panels to the two screw terminals. I used the third connector for the load connection. I used two safety fuses of 5A each. I implemented the synchronous buck converter which comprised of two MOSFETs along with inductor and capacitors which worked as energy storage elements. The inductor functioned for smoothening the switching current and the capacitor was for smoothening the output voltage. There were the capacitive elements added which acted as a snubber network. I considered the snubber circuit which was needed when an inductor was present. It was utilized for reducing the voltage ringing in the inductor. I used the PWM signal from the Arduino which sent to the MOSFET driver and the IR2104 typically shut down with the control signal from the Arduino.

[CE 1.8] I executed the decoding which was done in a manner that kept the PWM duty cycle record and never allowed MOSFETS to be 100% ON. I implemented two voltage divider circuits and the solar panel voltage and battery voltage were reduced to a smaller value of 2-3V. I sent the signals to the microcontroller and it was adequate as it was required to be in the 0-5V range. It was fed to analog pin-0 and pin-2. I utilized ceramic capacitors which were for removing higher frequency spikes and the diodes were transient voltage suppression diodes mainly utilized for over-voltage protection from the load side and solar panel side. I used the sensor for sensing the current from the solar panel and it was fed to the Arduino analog pin. I connected the three LEDs to the microcontroller digital pins which were then utilized for showing the battery charge state.



[CE 1.9]I implemented the solar charge controller in which LED was used to display the solar panel parameters along with battery parameters. There were three LEDs in the LED display and if the green LED glowed, it resulted to indicate that the battery was highly charged up to the fully charged state. In case if there was an orange LED displayed, it showed that the battery was having a nominal voltage, and the yellow LED indicated that the battery was discharged.

[CE 1.10]I obtained the solar voltage, current, power, and battery voltage output with respect to time. The PV rated voltage was closer to 20V and the MPPT was tracked when it settled down to 17V. The solar current was 1-2A and the load utilized was 12V battery which needed 20-24W power. It was observed that when the battery was charging, there was more current drawn from PV and the current increased till the battery was in its fully charged state. It was 14V and as soon as the battery reached 14V, the current drawing from PV was also reduced. Thus, I tracked the MPP voltage from the MPPT tracker. The MPP power tracked was 22W for the load utilized, which was the battery.



[CE 1.11]I obtained MOSFET gate pulse testing in which a 5V supply was provided to the microcontroller ATMEGA 328. I provided the microcontroller output to the gate pulse to MOSFETs but this voltage was not adequate for providing the MOSFET triggering. Thus, the MOSFET driver was used for further operation. I used two MOSFETs in the circuit which was based on the synchronous buck converter configuration. I used the inductor and capacitor for obtaining the smooth output across the converter. The activities were split into various sections and technical discussions with the project manager were made for obtaining the specified work results.

D) Summary

[CE 1.12]I modeled a stand-alone PV system with the MPPT system. I designed the system hardware components for real proposed system creation which was for testing the results and ensuring that hardware and software worked in tandem. I executed the mathematical models along with control schemes which contained MPPT control and it was provided for the boost converter. I employed the control methods and verified it accordingly for the specified model optimum working operation. I obtained the results which indicated that the boost converter tracked the maximum port point of the panel and the battery was charged fully. I achieved the MPPT control from microcontroller for the hardware implementation. All the assigned work duties were achieved with the consistent electrical engineering expertise applied in the project.

[CE 1.13] I used extra components that worked in addition to the simulation. I implemented the boost converter for tracking the MPPT and the solar charge controller assisted in not only in obtaining MPPT but also maintaining the battery charge. There was the requirement of the microcontroller for maintaining the maximum power point and it led towards generating the PWM signal. There were two roles played from the battery and one acted as a load while others acted as an energy storage element. I took 900 cells in series and 8 cells in parallel which were feasible in executing the operation. Thus, I used one PV cell of 100W and the obtained results ensured an optimum and efficient model for high quality and reliable stand-alone PV systems.

CAREER EPISODE 2

Electrical Power System Analysis

A) Introduction

[CE 2.1]

Project: Electrical Power System Analysis

Duration: [Date] – [Date]

Location: [location]

Position: Electrical Engineer

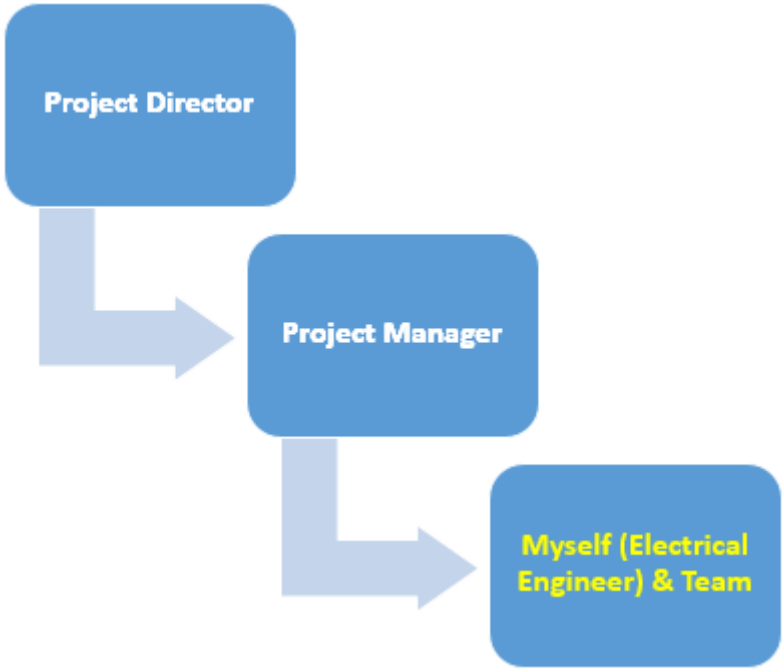
B) Background

[CE 2.2]Electrical power supply disturbances can have serious issues for everyday life as well as for national security. The power outage can typically be started from adverse weather, natural disasters, human errors, the act of war, and other factors. The system vulnerability was defined as threats and hazards sensitivity and was measured from P(Q9(t) >q). It worked as the probability of at least one disturbance with negative societal consequences. It was specifically during the period (0, t). The work aim was based on presenting techniques for quantitative vulnerability analysis of electric power delivery networks for enabling the techniques specifically related to mitigation, response, prevention, and recovery.

[CE 2.3]The project objective was presenting techniques for electric power quantitative vulnerability analysis for enabling the effective prevention, mitigation, response, and recovery strategies. I contributed towards the rational approaches development for resource allocation analysis. It was specifically for assisting policy and decision-makers for the evaluation of strategies and measures for critical infrastructure protection. Numerous concept vulnerability definitions were linked with no general definition. I formalized vulnerability which acted as a theoretical concept and utilized in quantitative analysis for power delivery networks.

[CE 2.4] The nature of work was based on power systems implication. The system was treated as an abstract network and various severe events were considered based on the look-upon power systems. I focused on power outages and extreme operational conditions. There were minor operational disturbances considered as an exception. Also, the power-engineering techniques were implemented for analyzing and controlling the power systems under normal conditions. Furthermore, I diffused the infrastructure issues like market and financial risks along with political and institutional risks.

[CE 2.5]



[CE 2.6] Assigned responsibilities were:

- I carried out technical systems traditional risk analysis specifically based on the technical failures.
- I carried out an existing system analysis which was for checking the status along with the changes executed appropriately in the project.
- I analyzed the responses which mainly linked to the possible crises responses development.
- I did three principal methods implementation for the probability estimation occurrence of an event.

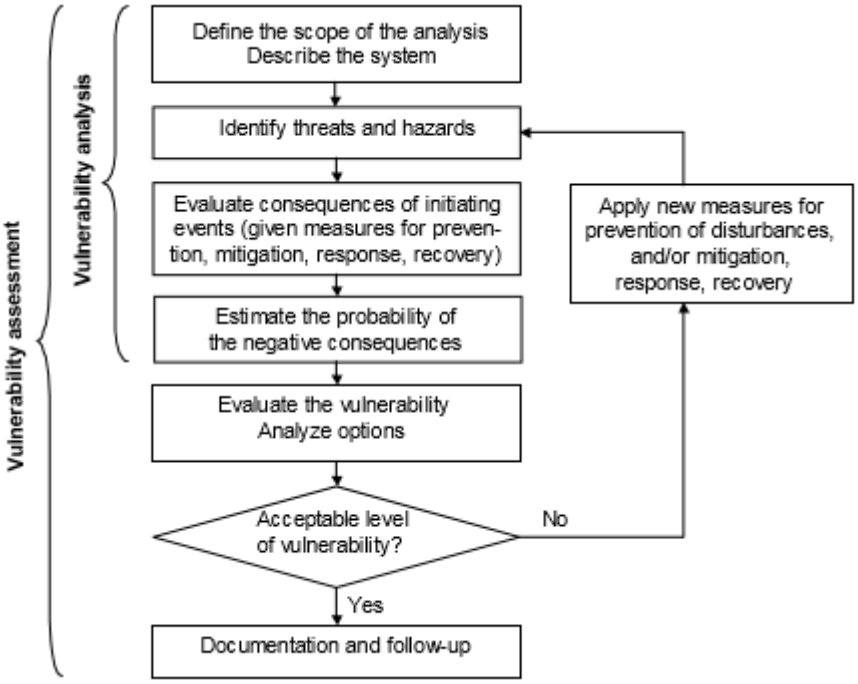
C) Personal Engineering Activity

[CE 2.7]I evaluated the vulnerability analysis focal point which was based on system survival and the associated disturbances. There were two parts present in the total probability which consisted of initial even occurring and the probability which occurred with the chain of events. It typically led towards the consequences which were Q>q. It was as:

$$P(Q > q) = P(A_i) \cdot P(Q > q \mid A_i).$$

There was societal crisis management considered for various phases which included response, recovery, prevent, mitigate, and learn. It was more appropriate for concentrating over resources for aborting an ongoing disturbance. It was in a place of utilizing the resources for preventing that the disturbance took place. I obtained an important difference among the vulnerability and risk analysis which was that the former focused on the complete disturbance process. I conducted7

the traditional risk analysis of technical systems which was specifically on technical failures, and other hazards. I carried out vulnerability analysis which was for identifying events that typically led to critical situations and research was conducted of the system function needed to be restored. I conducted existing system analysis which included checking its status along with following up changes. I executed the analysis which facilitated the development of the response for possible crises. It was found that the prioritization was dependent on various alternatives for improving system performance. I conducted the vulnerability assessment which included an evaluation of the vulnerability level and analysis for the options that were done for incrementing the system robustness. I assessed creating risk awareness and vulnerability management in the organization.



[CE 2.8]I implemented the principal vulnerability analysis approaches in which I focused on two vulnerability concepts dimensions which were consequences analysis and probability estimation. I faced the situation when analyzing the vulnerability of the technical system which was that there were few accident data with severe consequences. Thus, it was adequate to utilize statistical techniques for vulnerability estimation. Also, I obtained information which was from incidents. There were no incidents that occurred at the site when there were new technologies installed. I executed the three principal methods for the occurrence probability estimation of an event. The initial one was an ordinary statistical analysis of the empirical accident. I did system mathematical modeling which was combined with components empirical failure data. I followed the expert judgments which were collected from the formalized techniques and Bayesian statistical tools were employed for combining expert judgment with empirical data.

[CE 2.9]I worked on the power system which acted as a lossless network. I applied modular methodology which was for employing a refined electrical power systems model. I utilized the

power system analysis toolbox for consequences evaluation of removing elements in the network. Also, I considered a refined attacker model and considered the utility function which was the appropriate model in the project. I kept the game model simple for not obscuring the general idea. I utilized three different statistical techniques for obtaining a ranking of the defined strategies. I noted the problem with the approach which was linked with the attack scenario likelihood. Also, I carried out the relevant calculations using electrical engineering skills.

[CE 2.10]I implemented the concepts and models mainly obtained from the game theory which was specifically for finding out the optimal ways for defending an electrical power network against antagonistic attacks. There was an interaction among the system among the defender and attacker. I measured to apply the power grid defect which affected the course of action and was mainly for attacking the defense. I researched the different defense strategies' performance against attack scenarios. Specifically, I researched the dominant defense strategy along with optimum resource allocation among the network elements protection.

[CE 2.11]Numerous factors in the project were evaluated and discussed the impacts with the project team members. I applied technical knowledge in each project stage and fully used my electrical engineering expertise for getting the desired work results.

D) Summary

[CE 2.12]In this project, I worked on subjecting the quantitative vulnerability analysis of infrastructure systems, particularly electric power networks. I executed the traditional risk analysis framework which was rooted in system analysis, and classical decision theory was implemented. I provided the framework that mainly discussed numerous quantitative vulnerability analysis aspects of electrical power systems. I demonstrated the aspects which were dependent on various approaches and it included numerical modeling, empirical disturbance data analysis, and analytical modeling.

[CE 2.13] I executed various possibilities for technique refinement and there was the adequate potential obtained for further research. I pointed out a few promising areas and cascading failures were obtained in transmission grids. Various methodologies were analyzed for researching the power systems cascading failures and the engineering model along with the analytical model was analyzed using electrical engineering skills. I noted that the approaches provided adequate knowledge which assisted in relationship understanding advancement among the complex network vulnerability and dynamics. I executed the mathematical network analysis which assisted adequately in enhancing computational power. Also, I successfully conducted the analytical model's analysis with consistent electrical engineering skills implementation.

CAREER EPISODE 3

Lighting Load Control using GSM

A) Introduction

[CE 3.1]

Title: Lighting Load Control using GSM

Duration: [Date] – [Date]

Location: [Location]

Position: Electrical Engineer

B) Background

[CE 3.2]

In a building, Plug and process loads include all plug-in and hardwired loads that are not associated with ventilating, heating, and air-conditioning (HVAC), water heating, lighting, and other major equipment for appropriate building operation. There are process loads including for commercial equipment within a building shell, like vertical transportation or equipment such as industrial washing machines present in hotels. There are building end uses diversity obtained and equipment widely vary with building method, individual preference, and organizational mission.

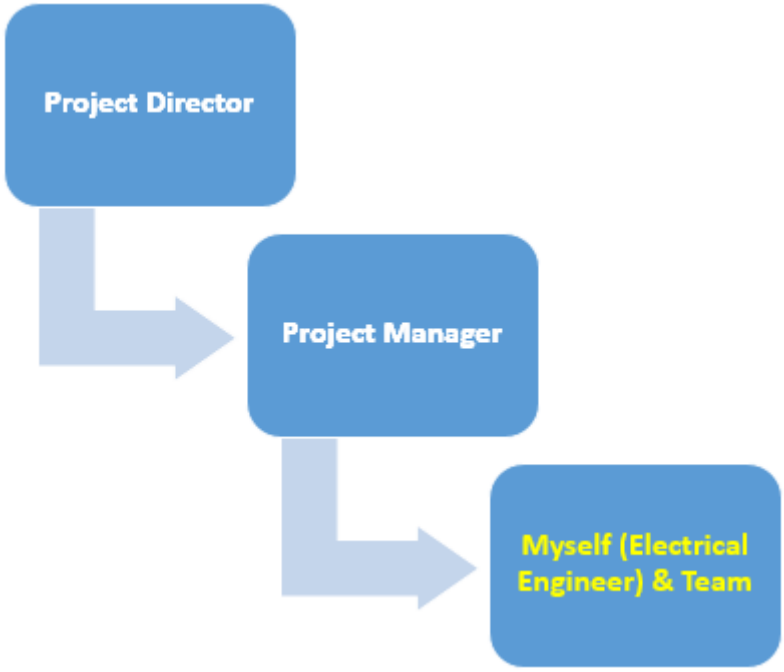
[CE 3.3]

The work aim was specifically for improving the BAS and EMIS platforms' integration of PPLs. I set the stage for identifying the synthesis and it included highlighting the areas for DOE appropriate points. I directly connected the DOE's core research areas and carried out the smart building technology integration with the grid-interactive efficient buildings. I did PPL data integration into EMIS platforms and PPL data interoperability with other building end-use data. I executed the testing and development of the automatic PPL controls.

[CE 3.4]

The project was investigating the anticipated savings and cost linked with integrated PPL data into EMIS platforms. I worked as an Electrical Engineer and carried out setup, operation, potential energy savings, and maintenance costs along with payback periods for making optimum decisions. The associated project objectives were predefined in the project and each work activity was specified with the thorough skills applied in the electrical engineering domain.

[CE 3.5]



[CE 3.6] The work duties were:

- I researched and set recommendations for impactful data collection from building end usage.
- I researched appropriately for PPL controls algorithms implementation which was linked with the end-use building data specifically for complete building-energy consumptions.
- I executed the dynamic and automatic load detection capabilities with integration and data management.
- I applied electrical engineering skills for researching numerous outlet products which were particularly for tag piece identification.

C) Personal Engineering Activity

[CE 3.7] I did the wireless smart outlet technologies integration testing with the EMIS platform in a defined setting which proved the concept and worked out any issues which arose in the system. I carried out the testing which provided an opportunity for researching how data streams from PPLs and other building end utilized an integrated approach with the coordination and optimization of the building energy control. Also, I obtained the recommendations for more streamlined and impactful data collection from building end-use. The incorporation was done from the EMIS which varied building end-use data specifically utilized in the research.I conducted the field testing which

was specifically for testing the data flows among the EMIS and PPL platforms. It assisted in determining ways to better coordinate PPL data and other building end-use data like HVAC and lighting. I obtained the fault detection diagnostics data from EMIS platforms which were for detecting and diagnosing faults and it potentially wasted energy. I conducted the working in the area which included the whole-building AFDD and it utilized physics-based models along with the machine learning algorithm implementation. I evaluated the analytics behind the AFDD technologies which specifically crossing over to building end-use systems like PPLs for greatly improving and automating PPL controls. Also, there was decent research needed to identify the optimum approach for AFDD models implementation associated with the PPL data. The research included how the data from PPLs provided an optimum calculation for internal gains in the whole building energy models and it in turn utilized in AFDD for HVAC. I carried out the research which included devices power modes.

[CE 3.8]I researched the PPL interoperability which was sub-metered data with other building system data and EMIS data management. It included control integration and interoperability with the building automation platform broad spectrum. This was specifically associated with the other networked building end uses. I obtained the standardized data collection specifications and taxonomies helped to move the market towards the goals. I improved the action plan with the obtained data specifications. I conducted the research regarding the development of data specifications and taxonomies for connected PPL control devices and it streamlined data collection practices along with complying existing DOE data tools like building energy data exchange specifications. The research supported existing specifications for strengthening the offerings and data specifications along with taxonomies were utilized for categorizing and characterizing the PPL. The loads were addressed from similar control schemes with electrical engineering skills.

[CE 3.9] I implemented the machine learning algorithms which were developed for recognizing the PPL use patterns. It automatically suggested the schedule-based controls to facility managers. I determined the scheduled-based controls for equipment individual pieces. I researched incorporating algorithms for PPL controls with other building end-use data for assisting control and complete-building energy consumptions. I evaluated the automatic and dynamic load detection capabilities with data and integration management. I carried out the electrical system installation and there was regular maintenance needed for individual equipment identification and ensuring that the equipment did not remove or plug into the wrong socket. I monitored the data over time for checking energy-saving opportunities with the alerts or data inconsistencies. I executed the tasks which required additional operation by setting the time and budget. I then sub-metered the PPL for BAS platform integration and it needed to access various platforms for understanding the building performance. I noted that the process was time consuming specifically for ensuring optimal system and whole-building performance.

[CE 3.10] I researched the various outlet products which were specifically for identifying and tag each piece of plug-in equipment for facilitating communication, controlling, and data logging via smart outlet system. I implemented the process which was manual and placed for rapidly executing the system operation. I carried out the automation process which streamlines PPL's

interconnection with the cost reduction and making the system more flexible. It resulted in EMIS to be more reliable with the appropriate electrical engineering skills applied in the work.

[CE 3.11] When analyzing and implementing the project activities, there was appropriate and thorough discussion was made with the project manager as well as with team members regarding various aspects. I analyzed each work aspect and obtained the defined work results using Electrical Engineering skills in the project.

D) Summary

[CE 3.12]I understood the PPLs important in building energy management which rapidly enhanced as new products proliferate and other building systems became more efficient. The technologies were emerging for measuring and controlling the devices and efforts which underwent for integration into whole building EMIS platforms. It provided building-wide energy management with optimization, DR, and AFDD capabilities. But, there was a research question faced for fulfilling the EMIS platform vision which integrated PPLs, specifically in systems integration, automatic, dynamic, and interoperability with the dynamic load controlling and detection. I managed the building systems as isolated silos and system configuration was done accordingly with the consistent monitoring and analysis from building automation system process. The system configuration and data analysis along with controlling was done in the project.

[CE 3.13] I defined the smart PLL technologies trend and the gaps which were needed to filling to better integrate PPLs into BAS and EMIS platforms. I carried out the field research which enclosed gaps and it rapidly advanced the fully integrated EMIS systems data. Specifically, recommendations were made for high priority research on PPL controls integration into EMIS platforms. It included automatic and dynamic load detection with the interoperability. My activities in the Electrical Engineering field were rapidly enhanced with the accomplished work activities.

PROFESSIONAL ENGINEER
Summary Statement

These are the competency Units and Elements. These elements must be addressed in the Summary Statement (see Section C). If you are applying for assessment as a Professional Engineer, you will need to download this page, complete it and lodge it with your application.

Competency Element	A brief summary of how you have applied the element	Paragraph number in the career episode(s) where the element is addressed
PE1 KNOWLEDGE AND SKILL BASE		
PE1.1 Comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	The three projects implemented in the Electrical Engineering domain are: • PV Solar Power Generation with MPPT controller • Electrical Power System Analysis • Lighting Load Control using GSM	CE 1.1, CE 2.1, CE 3.1
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics and computer and information sciences which underpin the engineering discipline	The executed work activities assisted adequately for obtaining the desired results with electrical engineering skills usage.	CE 1.8, CE 2.9, CE 3.10
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	An adequate work skills were applied with the appropriate technical skills implemented in the electrical engineering field.	CE 1.9, CE 2.8, CE 3.10
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	I executed the work objectives with the electrical engineering skills applied appropriately for obtaining the targeted work results.	CE 1.10, CE 2.11, CE 3.12
PE1.5 Knowledge of contextual factors impacting the engineering discipline	There were contextual factors evaluated throughout the project for obtaining the desired results.	CE 1.7, CE 2.10, CE 3.8
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline	I addressed the appropriate concerns in the work and achieved the desired work results using electrical engineering skills.	CE 1.6, CE 2.7, CE 3.6
PE2 ENGINEERING APPLICATION ABILITY		
PE2.1 Application of established engineering methods to complex engineering problem solving	Various technical issues were sorted in the work tenure for obtaining the desired work results.	CE 1.9, CE 2.11, CE 3.8
PE2.2 Fluent application of engineering techniques, tools and resources	There were appropriate resources and tools utilized throughout the work tenure for getting the targeted project results.	CE 1.11, CE 2.10, CE 3.9
PE2.3 Application of systematic engineering synthesis and design processes	Appropriate technical skills in the work were analyzed for obtaining the desired work results and electrical engineering technical skills were executed accordingly.	CE 1.12, CE 2.11, CE 3.8
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	There was systematic conduct in the entire project tenure were evaluated for getting the targeted work results.	CE 1.8, CE 2.12, CE 3.10
PE3 PROFESSIONAL AND PERSONAL ATTRIBUTES		
PE3.1 Ethical conduct and professional accountability	I approached the objectives in an ethical manner for obtaining the desired results.	CE 1.8, CE 2.10, CE 3.9

PE3.2 Effective oral and written communication in professional and lay domains	An effective oral and written communication skills were followed in the entire work tenure for obtaining the results.	CE 1.9, CE 2.9, CE 3.10
PE3.3 Creative innovative and proactive demeanour	There was proactive demeanour activities followed in the entire tenure for getting the desired results.	CE 1.10, CE 2.11, CE 3.11
PE3.4 Professional use and management of information	An appropriate information management skills in the work were evaluated throughout the tenure.	CE 1.11, CE 2.8, CE 3.8
PE3.5 Orderly management of self, and professional conduct	In the project tenure, an orderly conduct was maintained for obtaining the results.	CE 1.12, CE 2.12, CE 3.12
PE3.6 Effective team membership and team leadership	I managed the work activities with the effective leadership skills applied in the entire work tenure.	CE 1.11, CE 2.10, CE 3.10