Solar Power Parking Structure

INTRODUCTION AND PROJECT SCOPE

The purpose of this project is to provide Cal State East Bay with a green alternative parking structure that will allow students to shelter from the elements during rainy winters and extremely hot summers. At the same time, the solar panel parking structure will provide solar-powered electricity and solar-powered car chargers for Cal State East Bay facilities and students while reducing the school's carbon footprint. In addition to building the parking structure at Cal State East Bay, it must be built during summer break (a 4-month time frame) when students are not at school utilizing the parking lot to reduce conflicting traffic with students and potential accidents if sharing the parking lot with students.

The scope of this project includes the main 5 elements: Project Objective, Deliverable, Milestones, Technical requirements, and Limits and exclusions/ constraints. Starting with the project objective, we will build approximately 4,560 kW of Solar Power Parking Structures on the CSU East Bay Hayward campus (Lot H: 310,000 sqft) at a total cost of no more than $10,878,000. Our project will commence the following Monday after the completion of the Spring 2024 term with all construction and installation completed before the start of the Fall 2024 term. In other words, this will all need to be completed within the summertime when fewer students and school staff are on campus. Our deliverables will be to make sure that a 12ft high solar panel parking structure is installed on Lot H, that is fully functional, has all of its permits, passes all our final quality checks, and is capable of producing 4,560kW of Solar Power for Cal State East Bay School Facility.

For our milestones, we have identified 5 key points in our schedule to show the progress of our project (This will be shown clearly in the chart below) Figure 1. We identified work site audits and preliminary planning as the first stage. This is a critical foundation for our project as we need to review the construction site, estimate a budget, and start the initiation of applying for all the required permits. With these permits from the city, we cannot start our construction. Our next milestone is engineering and design. Once we get all the permits ready, we will begin looking into how we would build and position the parking structure on Lot H since the solar panels need to be in the correct position to take in optimal light. In parallel, we will also start on software development during this milestone. Once we have aligned on the design and confirmed how we would set up the solar panels, batteries, electrical wire, and charging station, we will start with material procurement and execution. This milestone is very straightforward, it is measured by all materials being purchased and physical building to the plan as designed. Once all the construction has been completed, we will review each solar panel construction to ensure that it is taking in power accordingly and confirming the output onto the power grid. Finally, for our final milestone, we will establish a maintenance plan for the school and train the appropriate school technician to maintain the solar panel parking structure. We will also make sure to provide documentation and other paperwork on instructions for troubleshooting and simple repairs.

Project Scope - Milestones

	Milestones	Description	Dates
1	Work Site Audit/ Preliminary Planning Review	• Project Initiation • Budget Estimation/ Schedule • Construction site review and alignment on location • Preparation in order to submit request for Solar Permits	4/23
2	Engineering & Designing	• Review proposed drawing for Solar Parking Structure installation for Lot H • Design Appropriate Solar Power System/ Electrical infrastructure plan • Software development to allow Solar Panel to Charge Correctly	6/18
3	Procurement/ Construction	• Material purchase PO are on track and placed • Construction starts on Site • Parking Structure is set up • Solar Panels installed and set up • Install batteries • All Software installed to run the Solar Panels	8/1
4	Test system and Final review	• Testing Solar Panels, making sure there is charge going to school power grid • QA and QC • User Acceptance Test	8/22
5	Hand over all technical documents/ Training	• Establish on going maintenance plan • Continuous monitor of system performance • Address any issues and repairs	8/29

Our scope also includes technical requirements that must be met. As mentioned before, because having all the permits is so critical for our project, we made it a key requirement in order to move on to the next milestone. Permits that are required as our technical requirements are Building permits, Electrical permits, and for our batteries, not an official permit but approval from the Fire Prevention Bureau (Thoubboron). Other than these permits, we require the parking structure to be at least 12 ft tall, be able to fit 80 cars in one row, and finally be able to meet seismic stability code as we are in a state prone to earthquakes (Thoubboron).

The final part of our scope is limits and Exclusions as well as constraints/risks we expect during our project. Our project scope will not include helping the new owner of the solar power parking structure with tax incentives from the federal or state government and we will not be liable for helping the new owner upgrade or add any additional power or solar-related equipment once the design has been approved and frozen.

With our project needing to be completed before school starts some constraint and risk, we expect are time constraints, material constraints, students during summer school, and finally the hot weather. Time constraints will be the biggest challenge as we need to make sure our plan is executed flawlessly. Material constraints might be our biggest concern as we currently only have one source for our solar panels and batteries. Even though our project is taking place over the summer, we do expect a low density of students to go to summer school, with this we need to be careful to gate off construction zones appropriately. Finally, working in the heat will be a challenge on its own, we will have carefully scheduled breaks, plenty of water, as well as a shaded area for our team to rest during work time (Kleiner).

COST ANALYSIS

Assumptions

As per the scope of our project, we have been hired to complete the described 310,000 sqft solar project at a cost of no more than $10,878,000 dollars. We work under the assumption that CSU East Bay conducted a fair and competitive RFP of which our proposal was selected. However, we will not assume the exact reasons or circumstances surrounding the selection of our firm to undertake this project. The only assumption we will make is that CSU East Bay has issued a fixed Purchase Order (PO) in the amount of $10,878,000 and that the school is unlikely to approve change orders should the project cost exceed this amount. Additionally, we have made the assumption that CSU East Bay has or will not require assistance with obtaining the tax incentives associated with the project and our only role in that is to ensure our project meets all requirements necessary for the school to obtain those tax credits (all costs are reflected based on billable work and materials).

Regarding payment terms, CSU East Bay has agreed to weekly invoicing with NET 30 day terms and have adequate cash reserves, meaning we do not expect to have issues with cashflow including: paying our employees, paying our contractors, or sourcing materials needed to complete the project. The following analysis reflects how we arrived at the overall project cost of $10,878,000.

Analysis

Many solar projects often have their cost broken down per kilowatt (kW), which is the approach we used as well. However, because solar construction is still a growing industry with strong tax incentives, the estimates of solar canopy construction projects vary widely.

With CSU East Bay selecting Lot H as the site of the project, they provided information regarding the size of the parking lot. However, we also did our own rough estimate and found Lot H to be roughly 310,000 sqft. According to Solar Power Phoenix, a 68,000 sqft parking lot can support 1,000 kW of solar installation at $1,332,800 which provided the base for our cost structure. Using these figures, we determined Lot H could support 4,560 kW (68 kW per sqft) of solar installation at an average cost of $19.60 per sqft (before mark-up). This analysis found the base cost of performing the work amounted to $6,076,000. See outlined map of Lot H and cost per sqft calculation below.

SunPower Est.		Cost/SQFT	kW/SQFT
Cost	$ 1,332,800		
SQFT	68,000	$ 19.6	
Size (kW)	1,000		68
	SQFT	Cost	kW
Lot H	310,000	$ 6,076,000	4,559

Solar Panels & Canopy Structures

One of the major costs involved in servicing this project relates to procurement of the 4,560 kW of solar panels required. After researching potential options through Solar Electric Supply, we concluded that we could procure the number of solar panels needed at a direct cost of $1,400 per kW. Additional research, including a paper from the Clean Energy States Alliance, cited a similar figure that we believed could be lowered through a volume based discount with a vendor.. We procured these panels at an average direct cost of $1,400 per kW, totaling $6,382,353. The mark-up for the procurement was built into the Admin labor mark-up of the RFP.

In addition, we are also required to procure and plan the construction of the canopy structure meant to hold the solar panels. According to TIME Magazine, solar canopy structures can increase the cost of a solar installation as much as $800 per kW compared to a rooftop installation. Our Solar Engineers believe, with the flat terrain characteristics of the site, we can procure the materials needed to build these structures at a cost of $525 per kW, totaling $2,393,382.

Permitting

While this project does not require us to assist CSU East Bay in acquiring the tax credits for this project, our team will assist with acquiring the necessary permits from the city and county. Based on an estimate from Solar Permit Fees, reviewing plans and admin processing by the county can cost over $100 for an average sized project and an additional $105 for inspection. Given the repeating nature and close proximity of the individual structures, we believe permitting through the county can be done at an average cost $150 per kW, totaling $683,824. The mark-up for assistance with this process was built into the Admin labor mark-up of the RFP.

Admin and Onsite Labor

Using the Organizational Breakdown Structure (OBS), our RFP included the following positions with the following estimated hourly rates and estimated annual salaries:

	Hourly Rate	Annual Salary
General Admin	$ 35.00	$ 72,800.00
Procurement Officer (Admin)	$ 50.00	$ 104,000.00
Solar Engineer	$ 45.00	$ 93,600.00
Electrical Engineer	$ 85.00	$ 176,800.00
Construction Supervisor	$ 40.00	$ 83,200.00
Construction Crew	$ 35.00	$ 72,800.00
Safety Officer	$ 35.00	$ 72,800.00
IT Specialist	$ 125.00	$ 260,000.00
Quality Control Inspector	$ 35.00	$ 72,800.00
Project Manager	$ 55.00	$ 114,400.00

After applying these hourly rates to the Work Breakdown Structure (WBS), we were able to calculate an estimated labor cost of $709,280. We then assumed a 100% mark-up for all Admin and Onsite Labor associated with the project and determined the billable labor total of $1,418,560.

Assuming General Admin and Procurement Office are considered the only Admin expenses, the billable labor is $324,800 or $71 per kW. The project's remaining billable labor (onsite labor) is $1,093,760 or 240 per kW.

	Count/Unit	Hourly Rate	Days Needed	Hours/Day	Est Cost	Mark-up (100%)
General Admin	6	$ 35.00	80	8.00	$ 134,400.00	$ 268,800.00
Procurement Officer (Admin)	2	$ 50.00	35	8.00	$ 28,000.00	$ 56,000.00
Solar Engineer	2	$ 45.00	70	8.00	$ 50,400.00	$ 100,800.00
Electrical Engineer	2	$ 85.00	70	8.00	$ 95,200.00	$ 190,400.00
Construction Supervisor	3	$ 40.00	27	8.00	$ 25,920.00	$ 51,840.00
Construction Crew	36	$ 35.00	27	8.00	$ 272,160.00	$ 544,320.00
Safety Officer	2	$ 35.00	27	8.00	$ 15,120.00	$ 30,240.00
IT Specialist	1	$ 125.00	26	8.00	$ 26,000.00	$ 52,000.00
Quality Control Inspector	1	$ 35.00	30	8.00	$ 8,400.00	$ 16,800.00
Project Manager	1	$ 55.00	122	8.00	$ 53,680.00	$ 107,360.00
					$ 709,280.00	$ 1,418,560.00

Using these figures, we can calculate the total billed work and compare it to our direct costs. This project is expected to leave us with a profit of $4,802,119 (44.1% profit margin).

	SQFT	Cost	kW	Billed/kW	
Lot H	310,000	$ 6,076,000	4,559		
Solar Panels				$ 6,382,353	$ 1,400
Materials				$ 2,393,382	$ 525
Permitting				$ 683,824	$ 150
Admin				$ 324,800	$ 71
Labor				$ 1,093,760	$ 240
				$ 10,878,119	**$ 2,386**
				6,076,000	= Direct Cost
				4,802,119	= Profit

PROJECT PLANNING

The project scope entails the following key components:

- Preliminary Planning:
    - Initiation of the project, including the definition of objectives and scope.
    - Identification of funding sources and estimation of the preliminary budget.
    - Procurement of necessary permits and approvals.
- Design and Engineering Phase:
    - Design of the solar panel system and associated infrastructure.

- Development of the electrical infrastructure plan.
    - Architectural design for the construction of the charging station structure.
    - Development of the software platform.
- Procurement:
    - Procurement of materials and equipment.
    - Negotiation of contracts with subcontractors for specialized tasks.
- Construction and Installation:
    - Preparation of the project site.
    - Installation of the solar panel system.
    - Construction of the charging station structure.
    - Installation of the electrical systems.
    - Setup of the network and software platform.
- Testing and Commissioning:
    - Conducting performance tests on the solar panels and charging stations.
    - Implementation of quality assurance checks.
    - User acceptance testing to ensure functionality.
- Operations and Maintenance:
    - Establishment of a comprehensive maintenance plan.
    - Ongoing monitoring of system performance.
    - Prompt addressing of any issues or necessary repairs.

Project Organization and Resources:

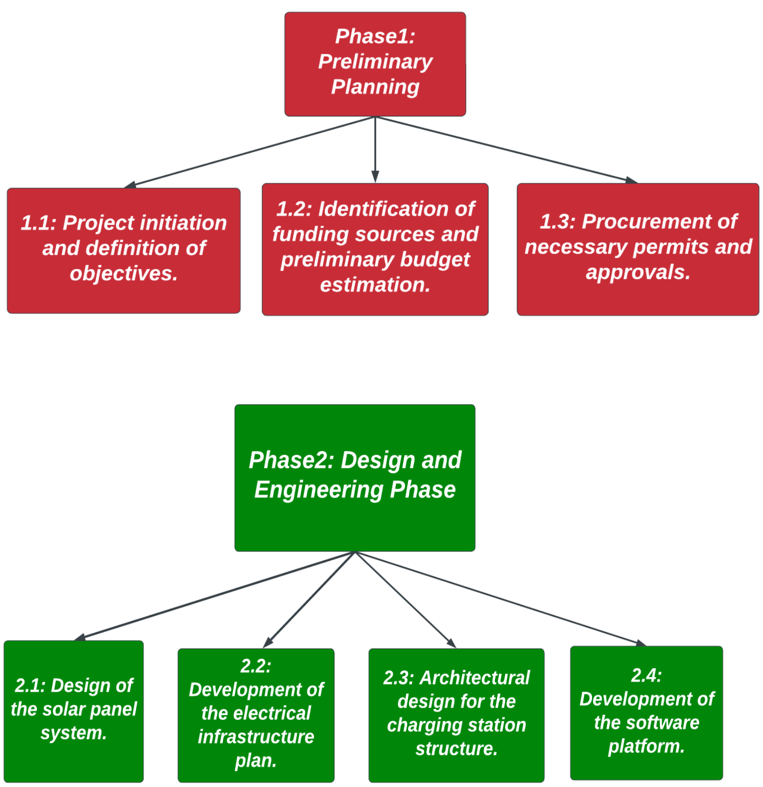
The project will be executed by a dedicated team with the following roles:

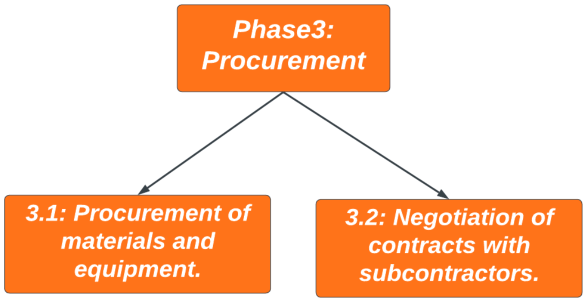
1. **Project Manager:** Responsible for overall project coordination, budget management, and adherence to the project timeline.
2. **Solar Engineer:** Tasked with designing and implementing the solar tree structure.
3. **Electrical Engineer:** Responsible for ensuring the proper setup of the electrical infrastructure for the charging stations.
4. **Construction Supervisor:** Overseeing the construction and installation processes on-site.

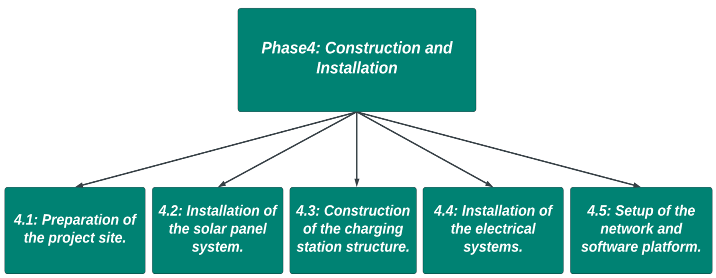
5. **Procurement Officer:** Managing the procurement of materials and equipment required for the project.
6. **Environmental Specialist:** Ensuring compliance with environmental regulations and sustainability objectives.
7. **IT Specialist:** Managing the development and maintenance of the software platform and network infrastructure.
8. **Quality Control Inspector:** Ensuring that the project meets predefined quality standards.
9. **Safety Officer:** Ensuring a safe working environment during construction.
10. **Public Relations Officer:** Managing community relations and communication related to the project.

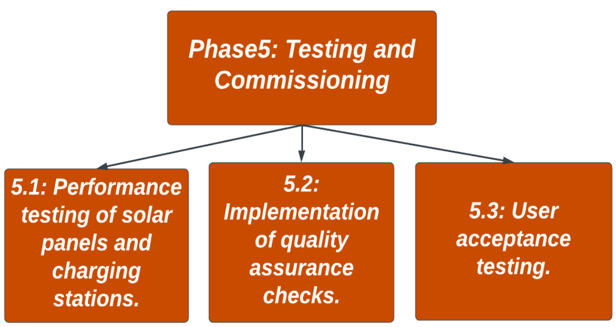
WBS (Work Breakdown Structure) Design:

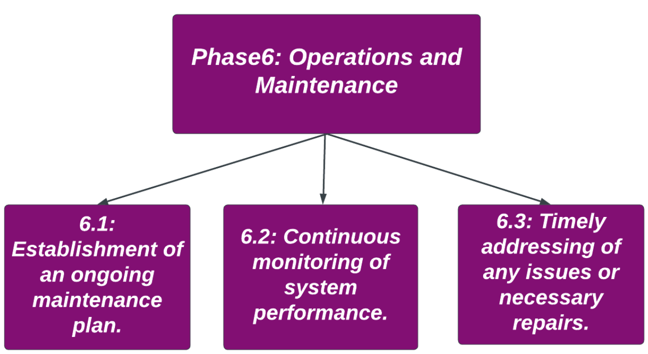
The Work Breakdown Structure (WBS) for this project includes:




Phase3: Procurement
3.1: Procurement of materials and equipment.
3.2: Negotiation of contracts with subcontractors.


Phase4: Construction and Installation
4.1: Preparation of the project site.
4.2: Installation of the solar panel system.
4.3: Construction of the charging station structure.
4.4: Installation of the electrical systems.
4.5: Setup of the network and software platform.


Phase5: Testing and Commissioning
5.1: Performance testing of solar panels and charging stations.
5.2: Implementation of quality assurance checks.
5.3: User acceptance testing.


Phase6: Operations and Maintenance
6.1: Establishment of an ongoing maintenance plan.
6.2: Continuous monitoring of system performance.
6.3: Timely addressing of any issues or necessary repairs.

The Organizational Breakdown Structure (OBS) is structured as follows:

- Project Manager
  - Solar Engineer
  - Electrical Engineer
  - Construction Supervisor
    - ➢ Construction crew(Civil, Mechanical, Electrical & Instrumentation)
  - Procurement Officer
  - Environmental Specialist
  - IT Specialist
  - Quality Control Inspector
  - Safety Officer
  - Public Relations Officer

Resource Allocation

There are various resources to be considered for a project to be completed successfully:

1. Human resources (manpower)
2. Facilities and Equipment resources
3. Material resource
4. Time allocation
5. Financial resources

Human Resource:
Human resource refers to a project team. The project manager, associates, and other departments directly involved in the project are considered to be the project team.

1. Project Manager: takes responsibility for planning, scheduling, and executing the project with the help of associates.
2. Training and Development: trains the team to improvise their working techniques for the project. This training involves operations and maintenance, technical training, and assessments after training.
3. Engineers and expertise: Engineers will install the solar power panels with their area of expertise and best safety measures. After installing the solar panels, they connect them to the electrical grid.
4. Site Manager/Supervisor: Making sure that the installation is carried out in accordance with the plan as well as maintaining the project site's safety and compliance with local safety requirements

Material Resource:
All the physical items and materials needed to build, maintain, and achieve the project are considered material resources. It is very important to manage the material resources in order to finish on time, within budget, and with the utmost efficiency.
And here are materials, including

1. Solar Panels: These are the main components of the project that are used to convert light energy into electricity.
2. Mounting Structure: Mounting structures are used to place the solar panels firmly and for optimal exposure to sunlight. And also to help withstand the weather conditions.
3. Wiring and cables: These are used to connect the solar panels to electric grid and other electrical appliances, if used.
4. Batteries: These batteries store the extra electricity produced during the day and can be used at night when there is no light.
5. Circuit Breakers and Fuses: This can be used to break the circuit when there is an excess flow of electricity through the circuit and also to prevent any accidents caused by circuit failures.
6. Charge Controllers: Used to prevent the batteries from overcharging.
7. Electrical Tape: Used to insulate the electrical cables at their joints.

Facilities and Equipment Resources:
Facilities and Equipment resources are needed to operate, repair, inspect, and monitor the installed and running operating solar panels and other machinery.
This includes:

1. Transport Equipment: Vehicles are used to transport equipment and machinery from one place to another.
2. Repairing Tools: Tools are used to repair if there is any problem occurring during the work.
3. Lab Facilities: Labs are being provided to examine any equipment during it's repair work.
4. Monitoring Equipment: All the equipment is being monitored to keep everything posted.
5. Safety Tools: Tools are required to stay safe while working, i.e., gloves, goggles, safety coats, etc

Time Resource:
Time resources are all about the estimated time to finish the project.
If any of the above resources gets delayed, it's going to affect the time allocation, and then The allotted time for tasks needs to be adjusted again based on the availability of resources. Apart from these, there are a few more things that need to be taken care of. They are

1. Work Breakdown Structure: It's best to create smaller tasks in order to finish the work without any complexities.
2. Buffer Time: There is a need for buffer time during/after the completion of the project to check if everything is working fine.
3. Analyzing Critical Path: Critical Path Analysis needs to be done just to avoid possible delays in the project.
4. Monitoring: Each and every task should be monitored to make sure that the task will be completed within the allotted time.

Financial Resources:

1. Project Budgeting: It's the estimation of the cost related to each and every activity, which includes human
 resource, equipment resource, material resource, etc.
2. Monitoring: It's keeping track of each and every financial activity.
3. Cost of resources: is calculating the cost for each resource and allotting budget to the resource according to their requirement
4. Maintaining Transparency: Audits are being conducted to ensure transparency between each and every transaction.

Project Scheduling

	Task Mode	Task Name	Duration	Start	Finish	Predecess
0		**Solar-Project-Normal-Fixed**	**107 days**	**Wed 4/3/24**	**Thu 8/29/24**	
1		**1 1 Preliminary planning**	**15 days**	**Wed 4/3/24**	**Tue 4/23/24**	
2		1.1 Porject initiattion and definition of objectives	5 days	Wed 4/3/24	Tue 4/9/24	
3		1.2 Identification of funding sources and preliminary budget estimation.	5 days	Wed 4/3/24	Tue 4/9/24	
4		1.3 Procurement of necessary permits and approvals	10 days	Wed 4/10/24	Tue 4/23/24	3
5		**2 2. Design and Engineering Phase**	**40 days**	**Wed 4/24/24**	**Tue 6/18/24**	
6		2.1 Design of the solar panel system.	7 days	Wed 4/24/24	Thu 5/2/24	4
7		2.2 Development of the electrical infrastructure plan	13 days	Fri 5/3/24	Tue 5/21/24	6
8		2.3 Architectural design for the charging station struc	6 days	Wed 5/22/24	Wed 5/29/24	7
9		2.4 Development of the software platform.	14 days	Thu 5/30/24	Tue 6/18/24	8
10		**3 3. Procurement and parallel construction**	**20 days**	**Wed 6/19/24**	**Tue 7/16/24**	
11		3.1 Procurement of materials and equipment.	10 days	Wed 6/19/24	Tue 7/2/24	9
12		3.2 Negotiation of contracts with subcontractors.	10 days	Wed 6/19/24	Tue 7/2/24	
13		**4 4. Construction and Installation**	**32 days**	**Wed 6/19/24**	**Thu 8/1/24**	
14		4.1 Preparation of the project site.	3 days	Wed 6/19/24	Fri 6/21/24	9
15		4.2 Installation of the solar panel system	5 days	Wed 7/3/24	Tue 7/9/24	14,11
16		4.3 Construction of the charging station structure.	10 days	Wed 7/10/24	Tue 7/23/24	15,11
17		4.4 Installation of the electrical systems.	2 days	Wed 7/3/24	Thu 7/4/24	11
18		4.5 Setup of the network and software platform.	7 days	Wed 7/24/24	Thu 8/1/24	16,15,17
19		**5 5. Testing and Commissioning**	**15 days**	**Fri 8/2/24**	**Thu 8/22/24**	
20		5.1 Performance testing of solar panels and charging :	4 days	Fri 8/2/24	Wed 8/7/24	18
21		5.2 Implementation of quality assurance checks.	6 days	Thu 8/8/24	Thu 8/15/24	20
22		5.3 User acceptance testing.	5 days	Fri 8/16/24	Thu 8/22/24	21
23		**6 6. Operations and Maintenance**	**5 days**	**Fri 8/23/24**	**Thu 8/29/24**	
24		6.1 Establishment of an ongoing maintenance plan.	5 days	Fri 8/23/24	Thu 8/29/24	22
25		6.2 Continuous monitoring of system performance.	5 days	Fri 8/23/24	Thu 8/29/24	22
26		6.3 Timely addressing of any issues or necessary repai	5 days	Fri 8/23/24	Thu 8/29/24	22

GANTT CHART

Gantt Chart:

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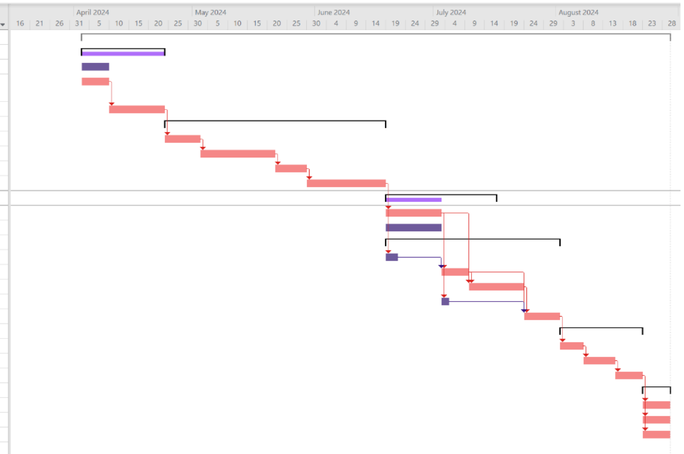


Our project's success depends not only on the time management but also on the effective utilization of the resources.

When we consider preliminary planning, which we have scheduled for 15 days, this phase requires thorough research, brainstorming and decision making. We have allotted this timeframe to ensure that we have the necessary manpower and financial resources to explore all options and make well informed decisions.

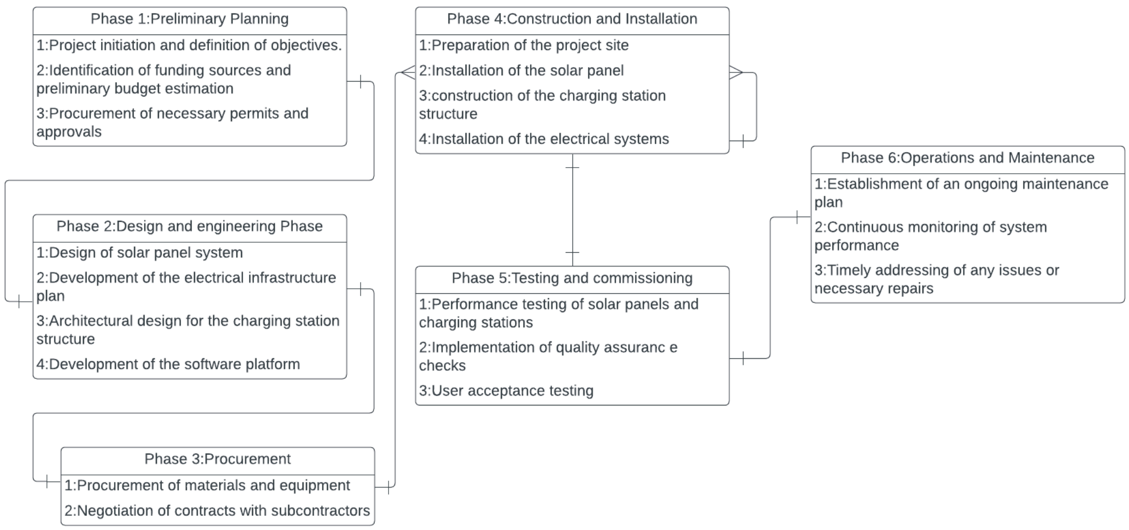
Design and Engineering, with its 40 days, involves the use of specialized equipment and facilities. We have allowed for this extended duration to accommodate the careful planning and procedure required for this phase.

Procurement within 20 days involves coordinating, material resources and financial resources efficiently. We have allotted time for negotiations, order processing and inspection to prevent delays caused by resource constraints. In the construction phase scheduled for 32 days, the availability of manpower, facilities,equipment and material is crucial.

Rushing through the construction could lead to costly mistakes, So we have given ample time to manage these resources effectively. Finally testing requires the right equipment and material to verify the project quality and performance. Our project schedule is delicate between time and resources. We Have allotted specific duration to ensure we have necessary resources at each stage. By adding so , we not only aim for timely completion but also prioritize quality and efficiency.

PROJECT EXECUTION

Description



Issue/Challenge Faced: Batteries and Solar Panel shipment delay by one week due to geopolitical issues between US and China

To fully comprehend the problem and find out if there are any feasible solutions or alternate sources for the components, we can get in touch with our suppliers or manufacturers. We can consider how the delay may affect our projects or business operations and change schedules and deadlines as needed. It's essential to inform all relevant parties of any modifications.

Diversifying our supply chain by obtaining components from several sources or locations can help lessen the effects of upcoming geopolitical conflicts or supply chain disruptions. We should keep abreast of any changes to the geopolitical environment that may have an impact on our supply chain and be ready to modify our plans as the circumstances change.

To reduce dependency on overseas shipments, we can look into domestic or local alternatives for batteries and solar panels, depending on our location. Creating backup suppliers or other contingency preparations for future disruptions, such as stockpiling essential components, is also advisable.

If the delay is due to trade restrictions or international disputes, we can think about collaborating with appropriate trade groups or government organizations to promote solutions that will benefit us in the fast setup.

Resources and Cost Impact

We ran into material delay challenges because of the geopolitical issues between the US and China. Our material, solar panels and batteries were delayed by one week due to tougher shipping requirements. This was not acceptable as the project needs to be completed before the classes started after summer break. Other activities are fine but the working crew should be all done and out of the area. To solve the issue, the project team brainstormed options and chose to go with crashing activities or resource allocation.

The disruptions caused by shipping and transportation delays when importing materials from China had a significant impact on project resources and costs. Here's how the delay affected both aspects:

1. Resource Allocation:

Labor Costs: Extended project timelines due to delays lead to increased labor costs. More Construction workers and Construction Supervisors are hired to get the job done as per the original scope of the project, resulting in higher labor expenses.

2. Resource Reallocation:

Human Resources: Project team members diverted their attention and efforts to deal with the challenges posed by delays, affecting their ability to focus on other critical project tasks.

Management Attention: Senior management needed to allocate more time and attention to resolving issues related to shipping and transportation delays, potentially diverting their focus from other strategic initiatives.

3. Opportunity Costs:

Lost Revenue Opportunities: Because of the increased workers onsite, it has led to lost revenue.

Impact on Other Projects: Resource and cost overruns on one project due to delays can affect the allocation of resources and budgets for other concurrent or future projects, potentially creating a cascading effect.

As per the project expected schedule the material arrival was July 2, 2024, the project completion date was August 29, 2024 as in the screenshot from project scheduling above. As shown in schedule the working crew is out with the completion of testing by August 16, 2024. The project completion shifted to be completed on August 29th to September 29, 2024.

After Change:

	Task Mode	Task Name	Duration	Start	Finish	Predecessors
0		**Solar-Project-Change-Revised-Final**	**114 days**	**Wed 4/3/2**	**Mon 9/9/24**	
1		**1 1 Preliminary planning**	**15 days**	**Wed 4/3/2**	**Tue 4/23/24**	
2		1.1 Porject initiattion and definition of objectives	5 days	Wed 4/3/2	Tue 4/9/24	
3		1.2 Identification of funding sources and preliminary budget estimation.	5 days	Wed 4/3/24	Tue 4/9/24	
4		1.3 Procurement of necessary permits and approvals	10 days	Wed 4/10/	Tue 4/23/24	3
5		**2 2. Design and Engineering Phase**	**40 days**	**Wed 4/24/**	**Tue 6/18/24**	
6		2.1 Design of the solar panel system.	7 days	Wed 4/24/	Thu 5/2/24	4
7		2.2 Development of the electrical infrastructure plan	13 days	Fri 5/3/24	Tue 5/21/24	6
8		2.3 Architectural design for the charging station struc	6 days	Wed 5/22/	Wed 5/29/24	7
9		2.4 Development of the software platform.	14 days	Thu 5/30/2	Tue 6/18/24	8
10		**3 3. Procurement and parallel construction**	**20 days**	**Wed 6/19/**	**Tue 7/16/24**	
11		3.1 Procurement of materials and equipment.	17 days	Wed 6/19/	Thu 7/11/24	9
12		3.2 Negotiation of contracts with subcontractors.	10 days	Wed 6/19/	Tue 7/2/24	
13		**4 4. Construction and Installation**	**39 days**	**Wed 6/19/**	**Mon 8/12/24**	
14		4.1 Preparation of the project site.	3 days	Wed 6/19/	Fri 6/21/24	9
15		4.2 Installation of the solar panel system	5 days	Fri 7/12/24	Thu 7/18/24	14,11
16		4.3 Construction of the charging station structure.	10 days	Fri 7/19/24	Thu 8/1/24	15,11
17		4.4 Installation of the electrical systems.	2 days	Fri 7/12/24	Mon 7/15/24	11
18		4.5 Setup of the network and software platform.	7 days	Fri 8/2/24	Mon 8/12/24	16,15,17
19		**5 5. Testing and Commissioning**	**15 days**	**Tue 8/13/2**	**Mon 9/2/24**	
20		5.1 Performance testing of solar panels and charging	4 days	Tue 8/13/2	Fri 8/16/24	18
21		5.2 Implementation of quality assurance checks.	6 days	Mon 8/19/	Mon 8/26/24	20
22		5.3 User acceptance testing.	5 days	Tue 8/27/2	Mon 9/2/24	21
23		**6 6. Operations and Maintenance**	**5 days**	**Tue 9/3/24**	**Mon 9/9/24**	
24		6.1 Establishment of an ongoing maintenance plan.	5 days	Tue 9/3/24	Mon 9/9/24	22
25		6.2 Continuous monitoring of system performance.	5 days	Tue 9/3/24	Mon 9/9/24	22
26		6.3 Timely addressing of any issues or necessary repai	5 days	Tue 9/3/24	Mon 9/9/24	22

Due to the delay of the procurement of materials (batteries and solar panels), the completion of the project date has been shifted to September 09th, 24. As per the scope, the project construction work has to be completed before the start of the school. To achieve that, below adjustments are made so that the project can be completed as per the original scope.

Adjustment | Final results

Project team came together for a brainstorming session and came up with the approach of

Crashing Activities and resource allocation by adding fifteen additional manpower with a cost of $8,320, that is covered in more detail in the cost analysis section by Jaydon. By applying the approach we were able to pull back by Seven days as we reduced the task of “installation of the Solar panel system” by one day, reduced the tasks of “Construction of charging station structure by 4 days and reduced the task of “Setup of network and software platform” by two days.

After Final revision - Resource allocation | Project Crashing

	Task Mode	Task Name	Duration	Start	Finish	Predecessc
0		**Solar-Project-Final-Revision**	**107 days**	**Wed 4/3/24**	**Thu 8/29/24**	
1		**1 1 Preliminary planning**	**15 days**	**Wed 4/3/24**	**Tue 4/23/24**	
2		1.1 Porject initiattion and definition of objectives	5 days	Wed 4/3/24	Tue 4/9/24	
3		1.2 Identification of funding sources and preliminary budget estimation.	5 days	Wed 4/3/24	Tue 4/9/24	
4		1.3 Procurement of necessary permits and approvals	10 days	Wed 4/10/24	Tue 4/23/24	3
5		**2 2. Design and Engineering Phase**	**40 days**	**Wed 4/24/24**	**Tue 6/18/24**	
6		2.1 Design of the solar panel system.	7 days	Wed 4/24/24	Thu 5/2/24	4
7		2.2 Development of the electrical infrastructure plan	13 days	Fri 5/3/24	Tue 5/21/24	6
8		2.3 Architectural design for the charging station structure.	6 days	Wed 5/22/24	Wed 5/29/24	7
9		2.4 Development of the software platform.	14 days	Thu 5/30/24	Tue 6/18/24	8
10		**3 3. Procurement and parallel construction**	**17 days**	**Wed 6/19/24**	**Thu 7/11/24**	
11		3.1 Procurement of materials and equipment.	17 days	Wed 6/19/24	Thu 7/11/24	9
12		3.2 Negotiation of contracts with subcontractors.	10 days	Wed 6/19/24	Tue 7/2/24	
13		**4 4. Construction and Installation**	**32 days**	**Wed 6/19/24**	**Thu 8/1/24**	
14		4.1 Preparation of the project site.	3 days	Wed 6/19/24	Fri 6/21/24	9
15		4.2 Installation of the solar panel system	4 days	Fri 7/12/24	Wed 7/17/24	14,11
16		4.3 Construction of the charging station structure.	6 days	Thu 7/18/24	Thu 7/25/24	15,11
17		4.4 Installation of the electrical systems.	2 days	Fri 7/12/24	Mon 7/15/24	11
18		4.5 Setup of the network and software platform.	5 days	Fri 7/26/24	Thu 8/1/24	16,15,17
19		**5 5. Testing and Commissioning**	**15 days**	**Fri 8/2/24**	**Thu 8/22/24**	
20		5.1 Performance testing of solar panels and charging stations.	4 days	Fri 8/2/24	Wed 8/7/24	18
21		5.2 Implementation of quality assurance checks.	6 days	Thu 8/8/24	Thu 8/15/24	20
22		5.3 User acceptance testing.	5 days	Fri 8/16/24	Thu 8/22/24	21
23		**6 6. Operations and Maintenance**	**5 days**	**Fri 8/23/24**	**Thu 8/29/24**	
24		6.1 Establishment of an ongoing maintenance plan.	5 days	Fri 8/23/24	Thu 8/29/24	22
25		6.2 Continuous monitoring of system performance.	5 days	Fri 8/23/24	Thu 8/29/24	22
26		6.3 Timely addressing of any issues or necessary repairs.	5 days	Fri 8/23/24	Thu 8/29/24	22

COST ANALYSIS (REVISITED)

After facing materials delays and adjusting our labor projections, we requested additional onsite labor from the construction contractor in the form of (5) Construction Supervisors and (49) Construction Workers for a total of 20 days (compared to the 3 and 36 respectively for 27 days). This challenge and adaptation incurred an additional direct labor cost to the overall project of

$8,320, totaling $717,600.

	Count/Unit	Hourly Rate	Days Needed	Hours/Day	Est Cost	Mark-up (100%)
General Admin	6	$ 35.00	80	8.00	$ 134,400.00	$ 268,800.00
Procurement Officer (Admin)	2	$ 50.00	35	8.00	$ 28,000.00	$ 56,000.00
Solar Engineer	2	$ 45.00	70	8.00	$ 50,400.00	$ 100,800.00
Electrical Engineer	2	$ 85.00	70	8.00	$ 95,200.00	$ 190,400.00
Construction Supervisor	5	$ 40.00	20	8.00	$ 32,000.00	$ 64,000.00
Construction Crew	49	$ 35.00	20	8.00	$ 274,400.00	$ 548,800.00
Safety Officer	2	$ 35.00	27	8.00	$ 15,120.00	$ 30,240.00
IT Specialist	1	$ 125.00	26	8.00	$ 26,000.00	$ 52,000.00
Quality Control Inspector	1	$ 35.00	30	8.00	$ 8,400.00	$ 16,800.00
Project Manager	1	$ 55.00	122	8.00	$ 53,680.00	$ 107,360.00
					$ 717,600.00	$ 1,435,200.00
					$ 8,320.00	$ 16,640.00

Additionally, by using the same 100% mark-up for the onsite labor adjustments, we can estimate the lost revenue (non-billable time or opportunity cost) would be $16,640. Assuming we're unable to submit change orders to CSU East Bay, we will assume this $16,640 as uncollectible and instruct our billing team to write this off as a Bad Debt charge.

PROJECT VALUE

The CSUEB Solar Power Parking Structure project will have a significant impact on the university's solid commitment to ecological sustainability and responsible financial management. Through this project, we have explored the complicated advantages that this project presents in a detailed manner, encompassing its environmental implications, substantial financial benefits, and the remarkable enhancements it adds to the campus experience.

1. Environmental Impact and Cost Savings:

Integration of Solar Panels into Parking Lot Roofs: The addition of solar panels onto the parking lot roofs represents an innovative step toward the effective utilization of renewable energy sources. These systems adeptly capture solar energy and convert it into clean electricity, thereby reducing our dependence on finite fossil fuel resources.

Clean Electricity Generation from Solar Radiation: The application of solar energy has a clear and positive effect on our carbon footprint, as it significantly lessens our reliance on conventional energy sources responsible for environmental pollution. By generating electricity directly from sunlight, this initiative constitutes a substantial contribution to our commitment to the environment.

Pollution Reduction and Showcase of Environmental Commitment: Furthermore, this project not only reduces greenhouse gas emissions but also serves as an indication to our commitment to sustainable practices.

Energy Cost Reduction and Financial: One of the most compelling aspects of this initiative lies in its capacity to significantly reduce energy expenses. As we transition towards self-sufficiency in electricity generation, we concurrently reduce our utility costs, thereby generating substantial fiscal savings for the university.

2. Financial Benefits and Strategic Investment:

Strong Returns from Energy Savings: The CSUEB Solar Power Parking Structure transcends its role as a simple sustainability venture, representing a judicious financial investment. Over time, the significant energy savings generated conclude in a substantial return on investment (ROI), consequently enhancing the university's financial stability.

Government Incentives for Sustainability Initiatives: Our commitment to eco-friendliness is suitably recognized and rewarded by governmental entities, which extend incentives to encourage environmentally responsible endeavors. These incentives translate into additional financial support, further reinforcing our financial resilience.

Augmented Funding for Enhanced Financial Viability: The supplementary financial resources accrued from energy savings and governmental support contribute to our overall financial health. These funds can be strategically allocated to reinforce other major projects and strategic endeavors of CSUEB.

3. Elevating the Campus Experience:

Provision of Shaded Parking in Extreme Weather: For both our students and staff, the CSUEB Solar Power Parking Structure excels its role as a parking facility. It offers shaded parking spaces, providing much-needed break during summer days, thereby enhancing comfort and safety.

Protection Against Adverse Weather Conditions: In addition, the structure offers an essential shield against extreme weather conditions, ensuring that individuals can move across the campus with comfort and convenience, even in adverse weather. This provision significantly enhances the overall campus experience.

Enriching the Quality of Campus Life: Importantly, the project leads to a comprehensive improvement in the quality of campus life. By promoting a more comfortable and convenient environment, it creates a positive atmosphere that leads to enriched learning experiences and increased community engagement.

CONCLUSION

In conclusion, we were able to meet our project objective. We were able to deliverable a complete and fully functional solar system parking structure in Lot H of Cal State East Bay Campus within the summertime frame. Unfortunately, we did run into a supply chain challenge, where we were not able to receive our solar panels and batteries on time, in fact they were delayed by 1 week. This was because we were not strategic with our suppliers. We had only 1 source for both our solar panels and batteries coming from China that delayed our schedule. With the rise in tension between the US and China, this geopolitical conflict we should have been more careful here especially with a schedule that is on a strict time frame. Thankfully a quick crash analysis allowed us to decide to reallocate our resources and pull in the schedule again by 1 week total at a cost of $8,320 total. A small price to pay to pull back the schedule. Next time, when working on a strict timeline, we will make sure to have dual sources for our critical suppliers to avoid future any potential delays!

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