Term Project

Empowering Sustainability: Solar Energy Integration to Reduce Grid Dependence at Northeastern University

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Revision History

7/8/2023	Draft #1: Updated Technical Approach.
7/17/2023	Draft# 1a: Updated the Purpose, Objective, Scope, Investor and Technical approach.
7/17/2023	Draft #2: Modified the title
7/17/2023	Draft #2: Completed organization. WBS and RACI
7/17/2023	Draft #2: Completed Mind map, UML activity and sequence diagram.
7/17/2023	Draft#2: Initial draft of Financial Plan.
8/1/2023	Draft#3: Made changes to organization. Added HR department for hiring purposes.
8/1/2023	Draft#3: Made the Gantt chart, PERT Chart, SWOT analysis.
8/9/2023	Final Draft: Modified the Purpose, Objective, Scope
8/9/2023	Final Draft: Modified the Organizational structure
8/9/2023	Final Draft: Completed the Financial Plan
8/9/2023	Final Draft: Performed Resource unloading
8/9/2023	Final Draft: Modified the Critical Success Factors and Assumptions
8/9/2023	Final Draft: Added the references

1. Purpose

This proposal aims to outline a project with a clear purpose: to mitigate Northeastern University's reliance on traditional grid-supplied energy and champion the widespread adoption of clean and renewable energy sources. By reducing grid dependence, the project intends to decrease the university's ecological footprint and actively contribute to the global transition toward a greener and more sustainable energy landscape. The end users of this renewable energy service will be Northeastern University itself, benefiting from decreased grid dependence, lower electricity costs, and a reduced environmental footprint.

2. Objective

The objective of this project is to offer Northeastern University a comprehensive design and implementation of a PV system, enabling them to generate clean energy on campus and optimize cost and efficiency.
The project aims to provide a reliable and efficient renewable energy solution tailored to the university's specific needs, contributing to their energy independence and environmental responsibility.

3. Scope

The core objective of this initiative is to deliver Northeastern University with a tailored clean energy solution directly on its campus centered around reducing the university's dependence on grid-supplied energy, fostering substantial cost efficiencies, and propelling its sustainability endeavors. The project will include the assessment of Northeastern University's energy requirements, the design and engineering of an optimal PV system tailored to the university's specific needs, the procurement and installation of high-quality PV equipment, and the integration of the PV system with the existing electrical infrastructure. The scope also encompasses the development of monitoring and control systems to ensure efficient energy generation and utilization.

4. Funder/Investor

Northeastern University is going to be the investor of this project. By investing in the comprehensive design and implementation of a Photovoltaic (PV) system, the university aims to take a proactive stance in reducing its carbon footprint and promoting renewable energy adoption. As the PV system generates clean energy on campus, Northeastern University will experience a significant reduction in its reliance on grid-supplied energy. This is expected to result in substantial cost savings, making it economically beneficial for the university in the long run. Lowered electricity prices will not only support Northeastern's financial sustainability but also demonstrate its commitment to becoming a model for sustainable practices within the academic community.

5. Critical Success Factors

1. Accurate Energy Assessment: Conducting a thorough and accurate assessment of the university's current energy consumption patterns, peak demand periods, and existing grid dependencies to inform the design and implementation of the PV system.
2. Optimized PV System Design: Developing a PV system design that is tailored to Northeastern University's specific requirements, site conditions, and energy needs to maximize energy generation and efficiency.

3. Vendor and Equipment Selection: Choosing reputable and reliable vendors for renewable energy equipment and components, considering factors such as efficiency, durability, and compatibility with the existing infrastructure.
4. Effective Integration and Monitoring: Ensuring seamless integration of the PV system with the university's electrical infrastructure and implementing a robust monitoring and control system to track energy generation, usage, and system performance.
5. Adherence to Regulatory Requirements: Complying with all relevant regulations, permits, and policies governing renewable energy installations and ensuring that the project adheres to legal and environmental standards.
6. Accurate Revenue Forecasting: Develop accurate revenue forecasts that consider factors such as energy production capacity, and market conditions to provide realistic revenue projections.
7. Continuous Monitoring and Optimization: Establishing a process for ongoing monitoring, analysis, and optimization of the PV system's performance to ensure long-term energy efficiency and benefits.

6. Assumptions

1. Availability of Suitable Rooftop Space: It is assumed that Northeastern University has sufficient rooftop space available for the installation of the photovoltaic (PV) system without any significant obstructions or limitations.
2. Consistent Solar Resource: The project assumes a relatively consistent and reliable solar resource in the university's location throughout the year, with predictable sunlight patterns.
3. Minimal Grid Connection Challenges: The project assumes that connecting the PV system to the university's electrical grid will not pose significant technical or regulatory challenges that could cause delays or disruptions.
4. Accurate Energy Consumption Data: It is assumed that accurate historical data on the university's energy consumption patterns, peak demand periods, and electricity usage are available for use in energy assessments and revenue forecasting.
5. Limited Natural Disruptions: The project assumes that the installation and operation of the PV system will not be significantly impacted by natural disruptions, such as extreme weather events, that could cause damage or downtime.

7. Technical Approach

To achieve the objective by lowering Northeastern Universities electricity bills by reducing Grid dependency the following steps will be undertaken:

Assessment and Planning:

- Conduct a thorough assessment of Northeastern University's current energy infrastructure, including energy consumption patterns, peak demand periods, and existing grid dependencies.
- Develop a detailed project plan outlining the timeline, milestones, resource requirements, and budgetary considerations.

Design and Engineering:

- Using design software like Helioscope to customize a PV system in accordance with Northeastern University's specific requirements and site conditions to determine the optimal number of solar panels, their arrangements, the number of panels per string, the compatible inverter, etc.

Procurement and Installation:

- Procure high-quality renewable energy equipment and components from reputable vendors, considering factors such as efficiency, durability, and compatibility.

Integration and Monitoring:

- Integrate the renewable energy system with Northeastern University's existing electrical infrastructure, ensuring seamless compatibility and grid interconnection.
- Installing a Data Acquisition System (DAS) to enable users to monitor energy performance, analyze data, and make informed decisions for optimization.

Revenue Forecasting:

- Forecast the revenue generation potential of the renewable energy system, taking into account the energy production capacity, potential feed-in tariffs, net metering arrangements, or other revenue-generating opportunities.

8. Organization

The organizational structure is a Matrix organizational structure. Project team members report to the functional managers and work for the project manager. The project manager is responsible for overseeing the project's successful completion, while functional managers are responsible for the day-to-day work of their team members and their professional development. The project manager coordinates the efforts of the functional teams, ensuring that resources are allocated appropriately, and tasks are completed according to the project plan. While team members report to their respective functional managers for performance evaluations and career development, they also work under the direction of the project manager to accomplish project-specific tasks.

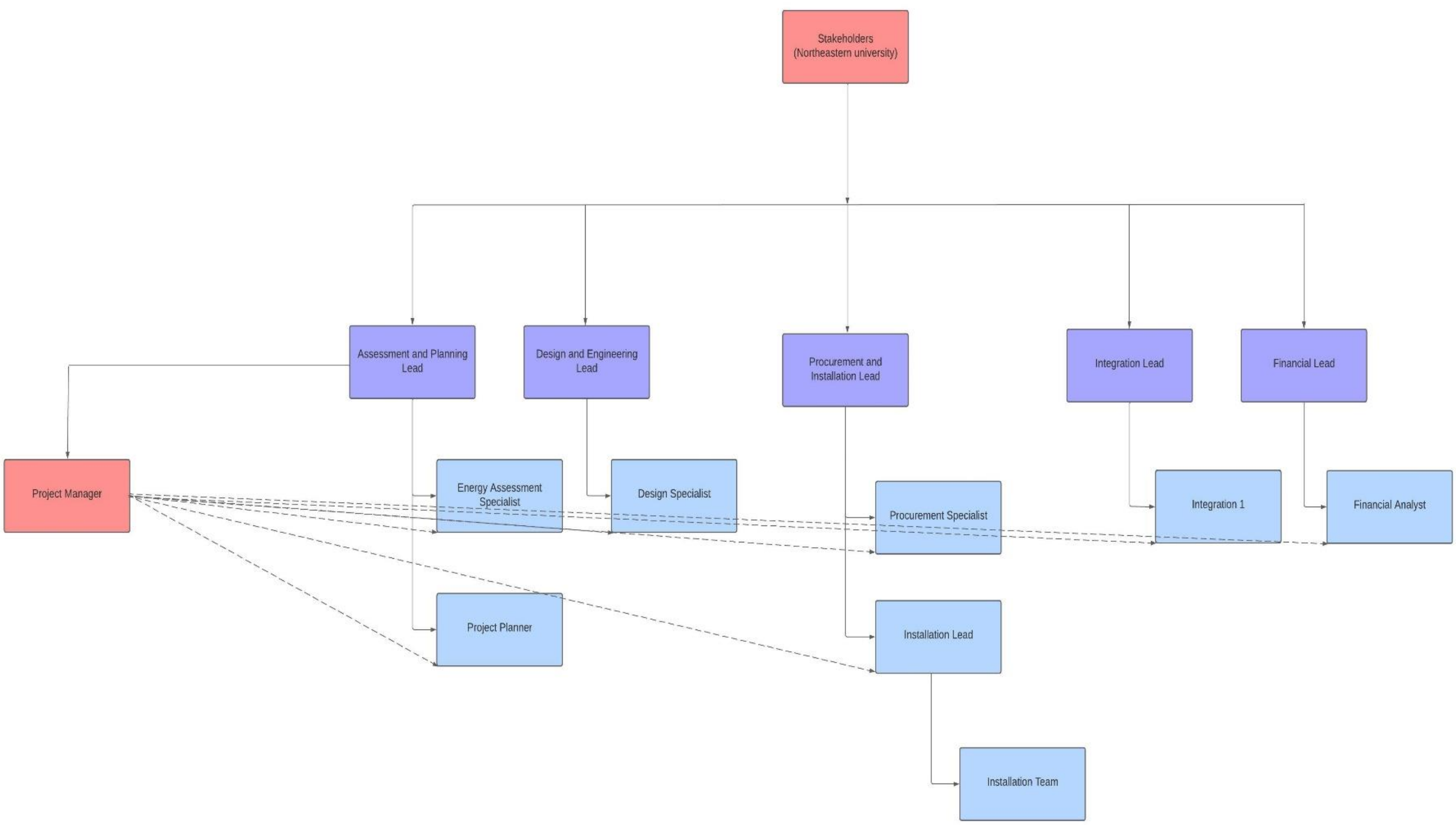

Figure 1: Organizational Structure

9. Project Plan

a. Work Breakdown Structure (WBS)

ID	Task	Responsibility	Time (weeks)	Preceding Tasks	People Required
1	Assessment and Planning	Energy Assessment Specialist	1	-	2
1a	Develop Project Plan	Project Planner	1	-	2
2	Design and Engineering	Design Specialist	2	1,1a	2
3	Procurement of Equipments	Procurement Specialist	2	1a	2
3a	Installation of PV System	Installation Lead	2	2,3	6
4	Integration and Montioring	Integration 1	1	3	2
5	Revenue Forecasting	Financial Analyst	1	4	2

Table 2: Work Breakdown Structure

b. Resource Plan and Responsibilities (RACI)

ID	Step	Responsible	Accountable	Consulted	Informed
1	Assessment and Planning	Energy Assessment Specialist	Project Manager	Assessment and Planning Lead	Stakeholders
1a.	Develop Project Plan	Project Planner	Project Manager	Assessment and Planning Lead	Stakeholders
2	Design and Engineering	Design Specialist	Project Manager	Design and Engineering Lead	Stakeholders
3	Procurement of equipments	Procurement Specialist	Project Manager	Procurement and Installation Lead	Stakeholders
3a.	Installation of PV system	Installation Lead	Project Manager	Procurement and Installation Lead	Stakeholders
4	Integration and Monitoring	Integration 1	Project Manager	Integration Lead	Stakeholders
5	Revenue Forecasting	Financial Analyst	Project Manager	Financial Lead	Stakeholders

Table 2: RACI

c. Financial Plan

ID	Tasks	Estimates	1	2	3	4	5	6	7	8	9	10	11
1	Assessment and Planning	$ 5,600.00	$ 4,000.00	$ 1,600.00									
1a	Develop Project Plan	$ 7,000.00	$ 3,000.00	$ 4,000.00									
2	Design and Engineering	$ 14,000.00		$ 1,000.00	$ 5,000.00	$ 5,000.00	$ 3,000.00						
3	Procurement of equipments	$ 12,320.00			$ 2,640.00	$ 4,400.00	$ 4,400.00	$ 880.00					
3a	Installation of PV System	$ 25,200.00						$ 7,200.00	$ 9,000.00	$ 9,000.00			
4	Integration and Monitoring	$ 5,600.00									$ 4,000.00	$ 1,600.00	
5	Revenue Forecasting	$ 6,160.00										$ 2,640.00	$ 3,520.00
	Direct (Procurement cost)	$ 40,000.00			$ 10,000.00	$ 10,000.00	$ 10,000.00	$ 10,000.00					
	Total	$ 115,880.00	$ 7,000.00	$ 6,600.00	$ 17,640.00	$ 19,400.00	$ 17,400.00	$ 18,080.00	$ 9,000.00	$ 9,000.00	$ 4,000.00	$ 4,240.00	$ 3,520.00

Table 3: Financial Plan

d. PERT Chart

A PERT (Program Evaluation and Review Technique) chart, also known as a network diagram, is a project management tool that is used below to schedule, coordinate, and visualize the various tasks and activities involved in a project.

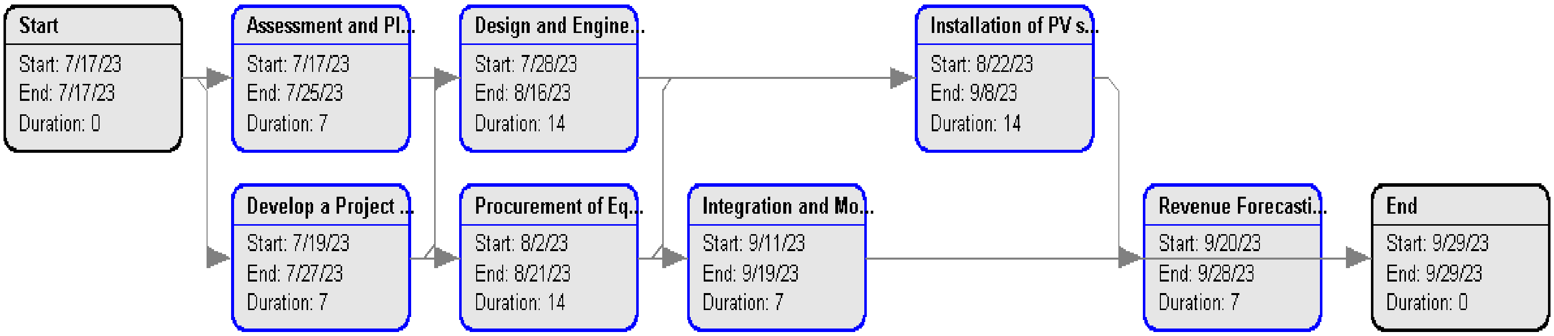

Figure 2: PERT Chart

e. Gantt Chart

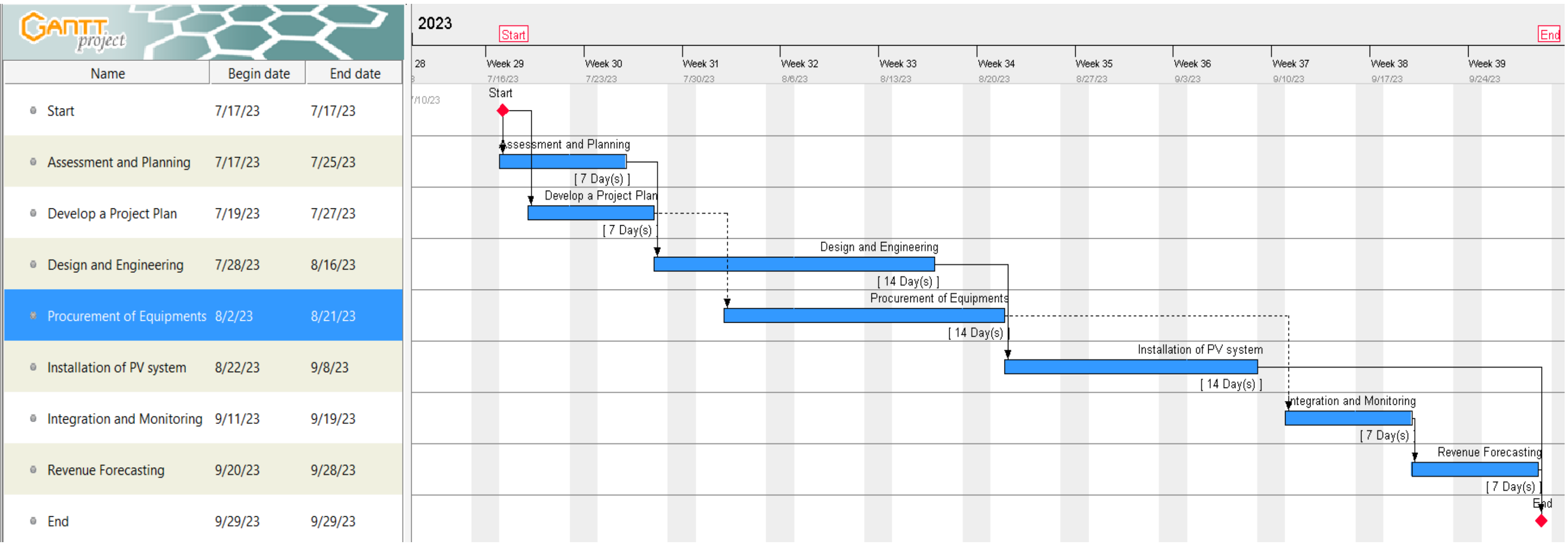

Figure 3: Gantt Chart

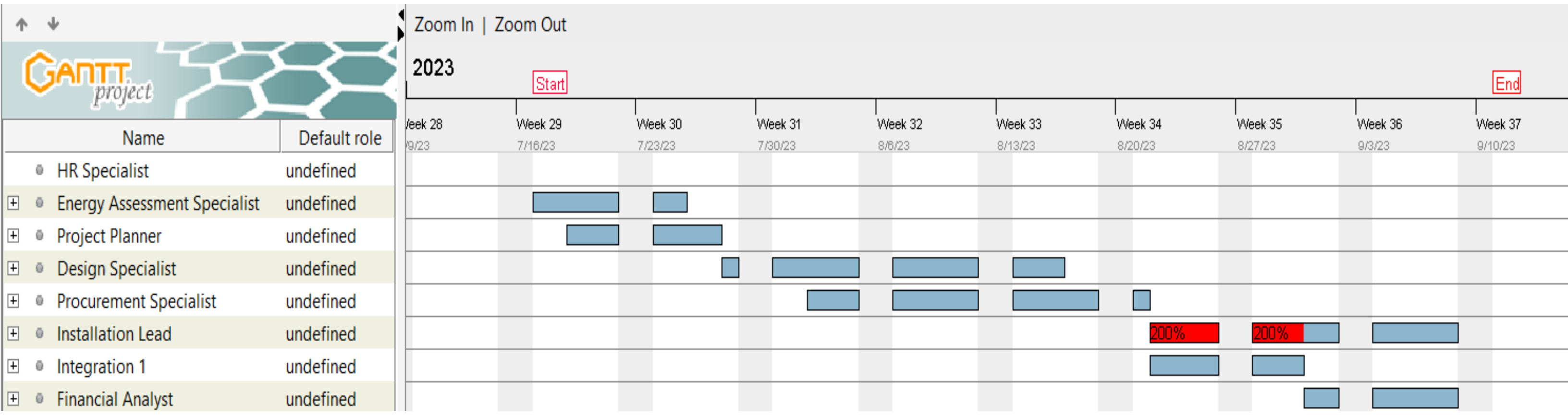

Figure 4: Resource loading without balancing

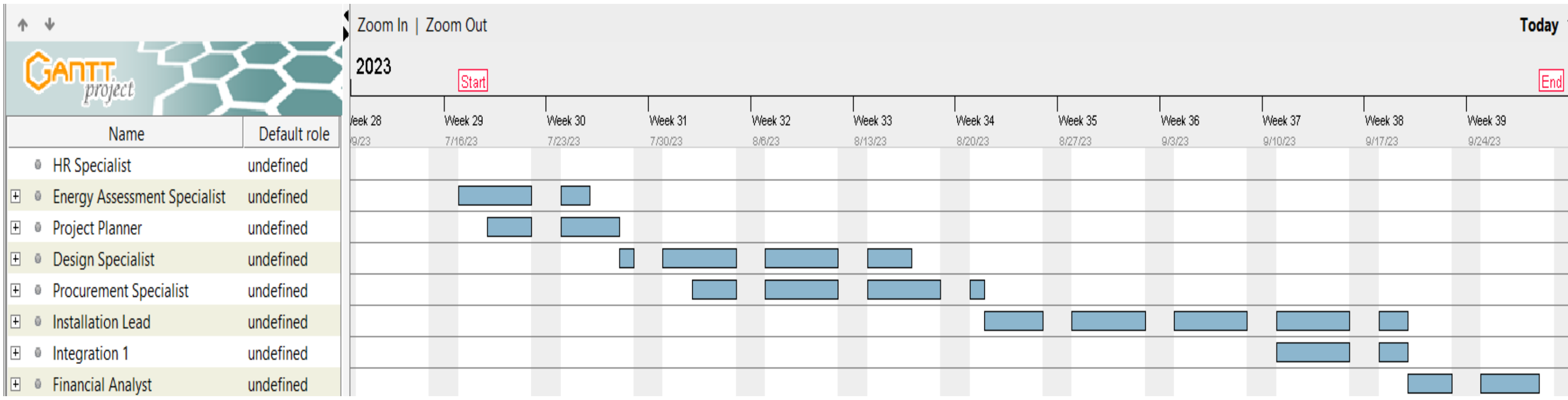

Figure 5: Resource loading with balancing

10. Risk Assessment

The potential weakness of the project is:

Weakness	Label	Risk
• Technical challenges in integrating the renewable energy system with the existing electrical infrastructure.	W1	3
• Difficulty in accessing roof structures.	W2	1
• Dependence on external vendors for the procurement of high-quality equipment.	W3	3

The above are internal challenges because:

- Integration issues can arise due to problems with compatibility, complex system configurations, or unforeseen technical obstacles.
- Accessing roof structures of certain viable places poses as internal challenges to the installation team.
- The project team is responsible for selecting and managing external vendors. Relying on external vendors can lead to delivery, quality, and coordinating issues.

The potential threat to the project is:

Threats	Label	Risk
• Fluctuating energy prices and market conditions.	T1	4
• Regulatory challenges and policy shifts.	T2	4
• Supply chain disruption.	T3	5
• Delays in obtaining permits.	T4	3

The above are external challenges because:

- Energy prices and market conditions depend on several factors like economic trends. Changes in energy policies etc.
- Regulatory challenges are driven by changes in government decisions or environmental policies. These can affect the incentives and tax credits the project will receive.
- Supply chain disruption can occur due to trade disputes or natural disasters. These factors may affect the timely delivery of the materials.
- Delays in obtaining the necessary permits and approvals can occur due to improper documentation and due to time taking bureaucratic procedures.

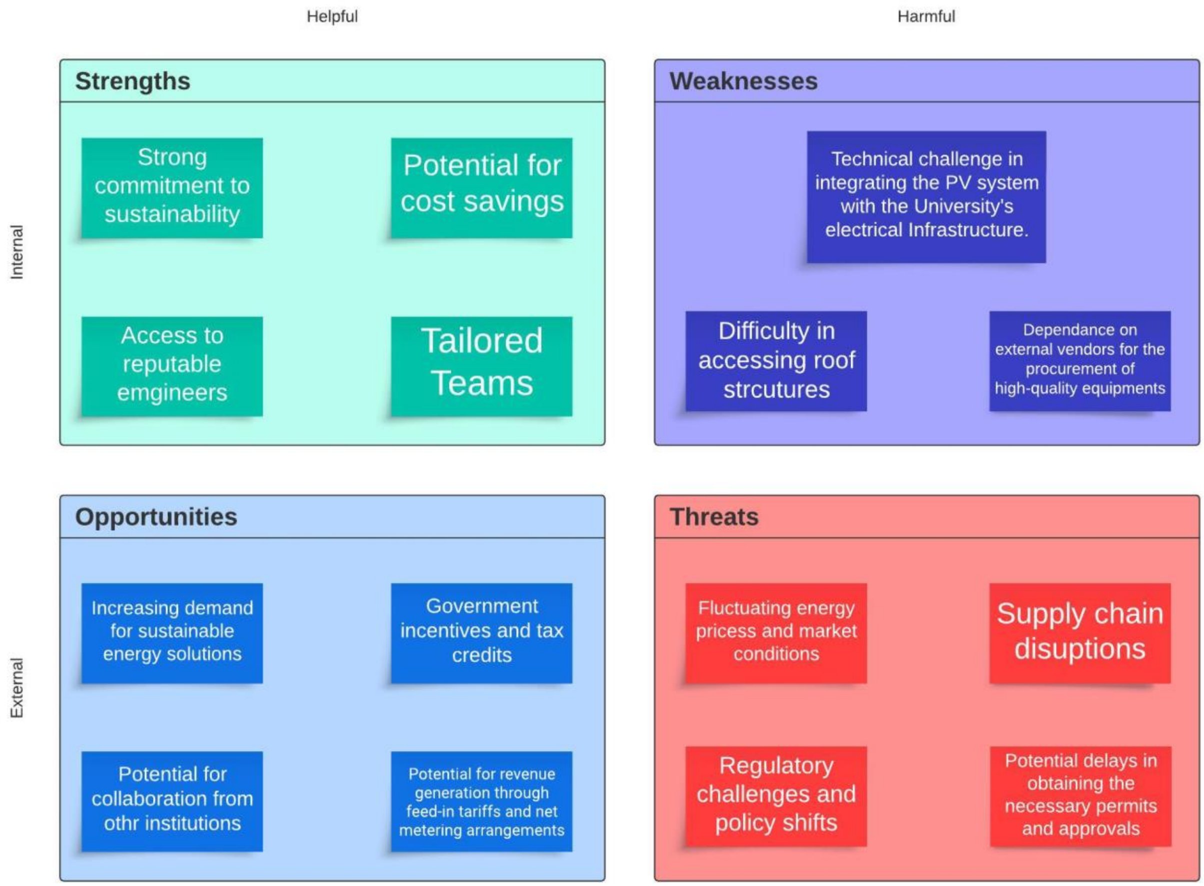

Figure 6: SWOT Analysis

Failure Mode	Severity (S)	Likelihood (L)	Ability to Detect (D)	RPN (S x L x D)
Technical Challenges in Integration	3	4	4	48
Difficulty in accessing roof structures	1	2	4	8
Dependence on external vendors	3	2	3	18
Fluctuating Energy Prices and Market Conditions	4	3	2	24
Supply Chain Disruptions	5	2	2	20
Regulatory changes and Policy Shifts	4	2	2	16
Potential delays in obtaining permits	3	3	2	18

Table 4: FMEA

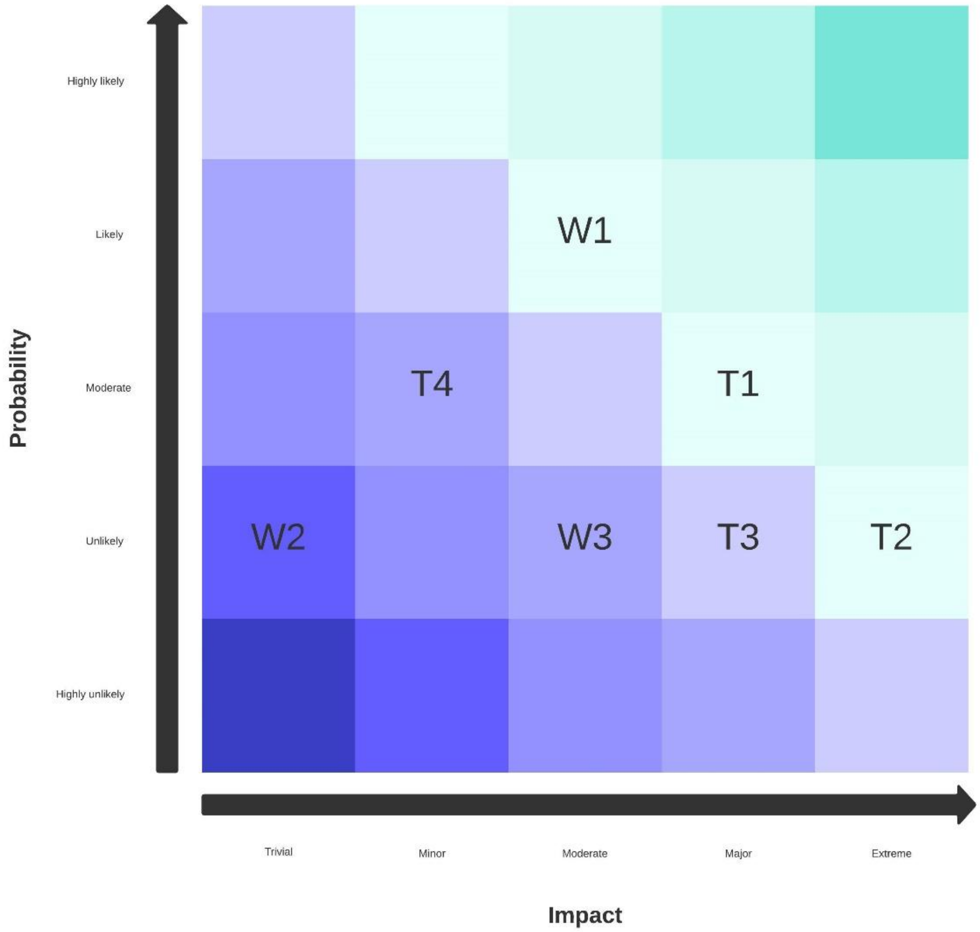

Figure 7: Risk Matrix

The above risk matrix was drawn using the FMEA table generated above. The label for each of the weakness and threats are given above and is in the same order of the FMEA given above.

Risk Mitigation

Technical challenges in Integration:

- Conduct a thorough feasibility study.

Potential delay in obtaining necessary permits:

- Early engagement with authorities and understanding the approval requirements, and timelines in advance to start the procedure within time.
- Accurate documentation and identify bottlenecks to generate a contingency plan.

Dependence on external vendors:

- Conduct thorough research before selecting vendors.
- Establishing a clear contract with the vendors specifying the timelines, quality and quality standards.

Fluctuating Energy Prices and Market Conditions:

- Perform scenario analysis for revenue forecasting.

Supply Chain Disruptions:

- Identify alternate vendors for critical components.
- Establishing a buffer inventory and maintaining open communication with the vendors.

Regulatory changes and policy shifts:

- Stay informed about market trends and policy changes.

11. Summary

The presented project proposal titled "Empowering Sustainability: Solar Energy Integration to Reduce Grid Dependence at Northeastern University" outlines a comprehensive plan to significantly decrease the university's reliance on conventional grid-supplied energy by implementing a tailored photovoltaic (PV) system. This project seeks to enhance Northeastern University's sustainability efforts, decrease its ecological footprint, and foster the adoption of renewable energy. The proposed PV system will be specifically designed and implemented to align with the university's energy requirements, featuring an intricate technical approach that covers assessment, design, procurement, integration, monitoring, and revenue forecasting. The project's organizational structure employs a matrix model to ensure efficient coordination and resource allocation. With a meticulous risk assessment and a clear roadmap, the project aims to achieve critical success factors while adhering to a projected timeline and budget. The project report integrates various visual aids such as diagrams, charts, and tables to present a comprehensive overview of its purpose, objectives, technical strategies, organizational setup, and risk management.

12. Appendix

a. MindMap

Figure 8: Mind Map

b. Tool#1

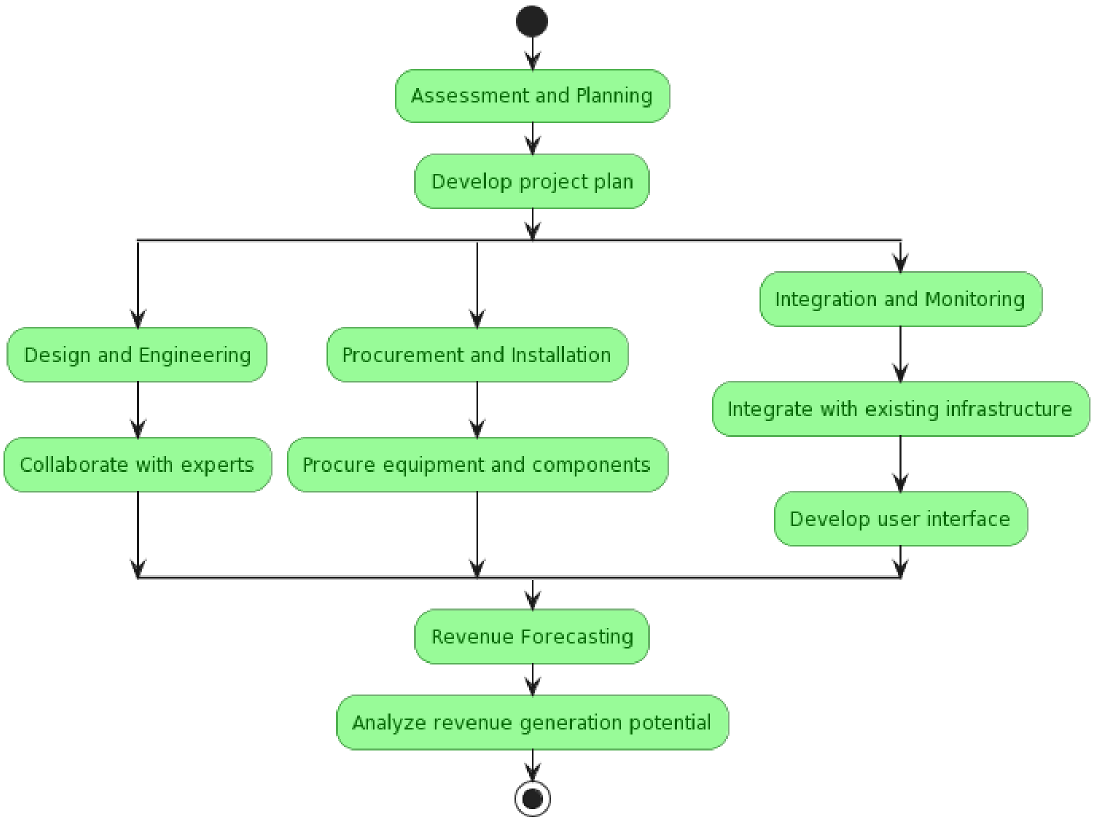

Figure 9: UML Activity Diagram

c. Tool#2

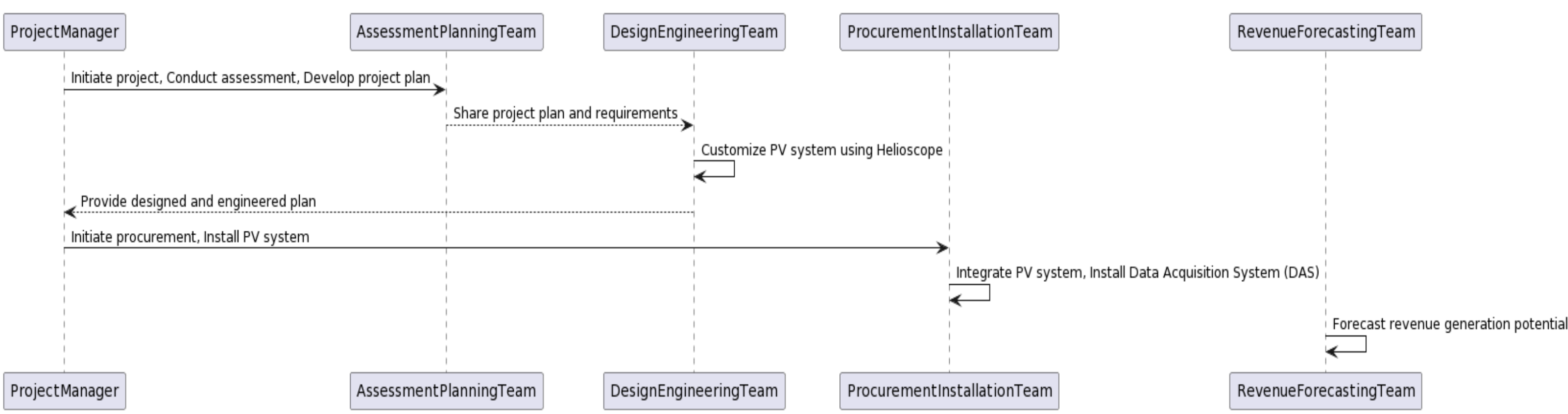

Figure 10: UML Sequence Diagram Project

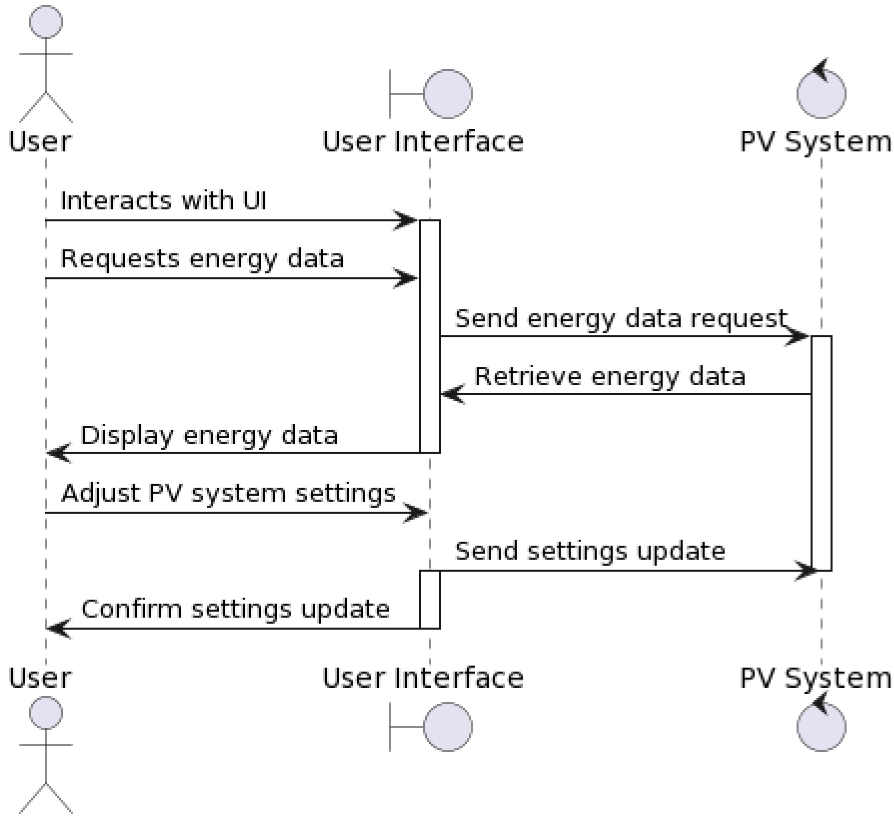

Figure 11: UML Sequence Diagram Product

13. References

- Plant UML for sequence and activity diagrams: [Open-source tool that uses simple textual descriptions to draw beautiful UML diagrams. (plantuml.com)]

- Textbook: Jack R Meridith, Scott M. Shafer; Project Management a Strategic Managerial Approach

- Class Slides

- Lucid app for the SWOT analysis and Organizational Structure; [Documents (lucid.app)]

- OpenAI for sentence reconstruction

- Gantt Project for generating the PERT and Gantt chart.