Applied Project Handbook

For the

Solar Engineering and Commercialization
Professional Sciences Master’s Program

Arizona State University

By

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Contents
1. Introduction and Basic Information.......................................................................................................... 1
  1.1 Welcome ............................................................................................................................................. 1
  1.2 Purpose ............................................................................................................................................... 1
  1.3 Outcomes ............................................................................................................................................ 1
  1.4 Major Applied Project Deliverables .................................................................................................... 2
  1.5 Process ................................................................................................................................................ 2
  1.6 Schedule .............................................................................................................................................. 2
  1.7 Labor Budget ....................................................................................................................................... 3
  1.8 Project Hours Logbook Sheet .............................................................................................................. 4
  1.9 Project Notebook ................................................................................................................................ 4
  1.10 Transition from Student to Professional ........................................................................................... 6
  1.11 The Importance of Project Management ......................................................................................... 6
  1.12 Colloquium Applied Project Workshops ........................................................................................... 6
  1.13 Course SEC 593: Applied Project Preparation and Commercialization Principles ....................... 6
  1.14 Applied Project Advisors ................................................................................................................... 7
  1.15 Format for Progress Reports to Advisors .......................................................................................... 7
  1.16 Project Evaluation ............................................................................................................................. 8
  1.17 Lessons Learned ................................................................................................................................ 8
  1.18 Professional Communications .......................................................................................................... 8
  1.19 Applied Project Final Report Format ................................................................................................ 9
  1.20 Defense Presentation Format ......................................................................................................... 13
2. Applied Project Criteria, Format and Examples ...................................................................................... 15
  2.1 Criteria............................................................................................................................................... 15
  2.2 Format............................................................................................................................................... 15
  2.3 Prior Applied Project Examples.......................................................................................................... 15
  2.4 Example Scenarios for Applied Projects Incorporating a Student-Created Solution ..................... 16
  2.5 Example 1. Product Design ............................................................................................................... 17
  2.6 Example 2. Educational Software ..................................................................................................... 17
  2.7 Example 3. Performance of an Existing Solar System ....................................................................... 17
  2.8 Example 4. CSP Thermal Storage System ........................................................................................ 18
3. Phase 1: Exploration

3.1 Purpose

3.2 Outcomes

3.3 Approach

3.4 Career Questions

3.5 Literature Review and Interviews

3.6 Data Analysis and Selection of Candidate Topics

3.7 Phase 1 Exit Criteria Checklist

4. Phase 2: Selecting a Topic and Advisors and Presenting at the Shark Tank

4.1 Purpose

4.2 Outcomes

4.3 Approach

4.4 Problem Statement Selection

4.5 Enrollment of Advisors

4.6 Problem Statement Requirements Definition

4.7 First Progress Report to the Advisors

4.8 Project Management Competencies

4.9 Plan for Preparing the Initial Project Proposal

4.10 Preparing for the Shark Tank

4.11 Phase 2 Exit Criteria Checklist

5. Phase 3: Preparing the Project Proposal

5.1 Purpose

5.2 Outcomes

5.3 Approach

5.4 The Importance of the Project Proposal

5.5 How Can One Plan a New Project?

5.6 General Methods for Identifying Project Tasks

5.7 Also Use this Handbook to Identify Required Tasks

5.8 Why a Good Baseline Plan is Needed

5.9 Defining the Tasks

5.10 Turning Tasks into an Activity Network

5.11 Project Schedules
1. Introduction and Basic Information

1.1 Welcome

The Applied Project is the culminating event for the PSM SEEC program. It’s a wonderful opportunity for the student to apply what they have learned during the course of the program. It also provides an opportunity to network with industry leaders. In the process of conducting the Applied Project, the student will solve a solar industry problem and demonstrate the ability to manage a project using industry tools. Students find working on their Applied Project to be one of the most rewarding and enjoyable aspects of their academic career.

Members of the PSM SEEC faculty and industry advisory council are proud of the Applied Project process and are willing to help each student be successful. They are here to advise, guide and evaluate; however, it is up to the student to manage and conduct their own Applied Project effort. The Applied Project is designed to parallel the way the solar industry tackles challenging problems.

1.2 Purpose

The purpose of this handbook is to provide the PSM SEEC student with the information necessary to conduct their Applied Project. It is imperative the student become familiar with the contents and follow the guidelines provided herein.

This handbook has been also written for the Applied Project advisors. It should be used in conjunction with the Advisor’s Handbook.

1.3 Outcomes

The Applied Project is the culminating activity for the PSM SEEC student. It is a major effort requiring over 300 hours of student work spread over 11 months (September through July). The Applied Project requires the student to find a solar energy problem in the “real world” and then solve it using the skills and abilities gained through the solar PSM program. The solution can take a number of forms such as a business plan, prototype design, policy statement, a student designed/conducted performance evaluation, etc. The outcomes of the Applied Project are threefold:

1. To solve an industry problem concerning solar energy engineering and commercialization.
2. To have the student demonstrate the ability to apply solar PSM coursework to the project.
3. To have the student demonstrate the ability to plan and manage a project.
1.4 Major Applied Project Deliverables

The major deliverables for the Applied Project are as follows:

- Applied Project Notebook
- Applied Project Proposal
- Applied Project Final Report
- Applied Project Defense Presentation

1.5 Process

The Applied Project process is divided into seven sequential phases as follows:

- Phase 1: Topic Exploration
- Phase 2: Topic & Advisor Selections and Shark Tank Presentation
- Phase 3: Project Proposal
- Phase 4: Initial Work
- Phase 5: Major Work
- Phase 6: Final Work
- Phase 7: Reporting

1.6 Schedule

Figure 1-1 presents a generic Applied Project schedule. There are a number of key program milestones that must be considered when planning the Applied Project. All milestones discussed throughout this document are based on fall admission and a 12-month degree completion schedule. The major milestones are as follows:

- Program Kickoff Meeting (late August)
- Applied Project Colloquium Workshop (4 sessions, fall semester)
- Shark Tank (early February)
- Applied Project Proposal Due (early March)
- Phase 4 Review with Advisors (early-April)
- Schedule Defense Date (Mid-May)
- Phase 5 Review with Advisors (end of May)
- Phase 6 Review with Advisors (end of June)
- Final Report and Defense Presentation (mid through end of July)

As shown in the referenced figure, the Applied Project process starts near the end of August and extends into July. The student must follow this schedule. Milestones must be reached and work must be completed on time. Delays by the student in completing work as
scheduled may delay the normal graduation date. It is imperative that the student manages their time wisely and starts each phase at the appropriate time.

<table>
<thead>
<tr>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ Program Kickoff</td>
<td>Δ</td>
<td>Δ</td>
<td>Colloquium Applied Project Workshops (Qty = 4)</td>
<td>Δ Shark Tank</td>
<td>Δ Project Proposal</td>
<td>Δ Review 1</td>
<td>Δ Schedule Defense Date</td>
<td>Δ Review 2</td>
<td>Δ Draft Final Report</td>
<td>Δ Final Report Due &amp; Defense Presentation</td>
<td>Δ</td>
</tr>
<tr>
<td>Ph 1 Exploration</td>
<td></td>
<td></td>
<td></td>
<td>Ph 3 Proposal Preparation</td>
<td>Ph 4 Initial Work</td>
<td>Ph 5 Major Work</td>
<td>Ph 6 Final Work</td>
<td>Ph 7 Reporting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ph 2 Topic &amp; Advisors Selection and Shark Tank Presentation</td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Legend**
- **Δ** Milestone
- **Work to be Done**
  - Percentage of Work Completed
  - Slipped Schedule—50% Done
  - Slipped Schedule—100% Done

**Figure 1-1. Generic Applied Project Schedule**

1.7 Labor Budget
The student will need to spend at least 175 hours on the Applied Project. These hours are spread over 11 months. Table 1-1 provides a highly suggested allocation of the time by both month and semester.
1.8 Project Hours Logbook Sheet

Employers and clients expect their professionals to keep track of the hours spent on each project. Therefore, students will keep a record of the time they spend on their Applied Project on a Logbook Sheet. This is provided in Appendix A as Form 1. The Logbook Sheet will be included in the Project Notebook. It should be updated whenever the student spends time on the Applied Project. Keeping the logbook up-to-date is one of the factors affecting the Applied Project grade.

1.9 Project Notebook

Successful project managers keep an up-to-date Project Notebook to capture all the information pertinent to the project. The Project Notebook is a key deliverable for the Applied Project. It must follow the prescribed format and be current at all times. The contents of the Project Notebook will be submitted in a three-ring binder. It will be organized according to the outline presented in Figure 1-2.

### Table 1-1. Suggested Minimum Labor Budget by Month and Semester

<table>
<thead>
<tr>
<th>Month</th>
<th>Hours for that Month</th>
<th>Cumulative Hours</th>
<th>Percent of Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>8</td>
<td>8</td>
<td>Fall Semester 18%</td>
</tr>
<tr>
<td>O</td>
<td>8</td>
<td>16</td>
<td>Winter Break 12%</td>
</tr>
<tr>
<td>N</td>
<td>15</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>14</td>
<td>45</td>
<td>Winter Break 12%</td>
</tr>
<tr>
<td>J</td>
<td>14</td>
<td>59</td>
<td>Spring Semester 30%</td>
</tr>
<tr>
<td>F</td>
<td>15</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>15</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>15</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>35</td>
<td>139</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>20</td>
<td>159</td>
<td>Summer 40%</td>
</tr>
<tr>
<td>J</td>
<td>16</td>
<td>175</td>
<td></td>
</tr>
</tbody>
</table>
Project Notebook Outline

1. Copies of Email Progress Reports to Advisors and Minutes of Meetings with Advisors (in chronological order)
2. Applied Project Time Logbook Sheets
3. Updated Project Proposal
4. Phase 1
   a. Worksheets
   b. Exit Criteria Checklist
5. Phase 2
   a. Worksheets
   b. Exit Criteria Checklist
6. Phase 3
   a. Worksheets
   b. Shark Tank Presentation Slides
   c. Recommendations from Shark Tank
   d. Exit Criteria Checklist
7. Phase 4
   a. Worksheets
   b. Review 1 Presentation Slides
   c. Minutes from Review 1
   d. Exit Criteria Checklist
8. Phase 5
   a. Worksheets
   b. Review 2 Presentation Slides
   c. Minutes from Review 2
   d. Exit Criteria Checklist
9. Phase 6
   a. Worksheets
   b. Exit Criteria Checklist
10. Phase 7
    a. Exit Criteria Checklist

Figure 1-2. Outline for Project Notebook
1.10 Transition from Student to Professional

Students tend to be overcommitted. There are always more assignments than time to properly complete them. Successful students (i.e., those who get good grades) are good at cutting corners and streamlining their problem-solving strategies to save time. They put a premium on saving time. They consider this being efficient. This strategy often works in school because the problems tend to be simple and well defined.

Real world problems are different. They tend to originate as issues. A major task is identifying the right problem within the issue. These problems are usually complex with incomplete information. The pathway to a solution is usually not clear. There are often roadblocks and changing conditions. Assumptions made early on are often proved incorrect as the project progresses. Industry problems take time—a lot of time. The process by its very nature is not efficient (many false starts and mid-course corrections), yet the process is effective, that is, it results in a solution that solves the complex problem.

Many good students have trouble in solving industry problems. They want to cling to familiar student approaches rather than embracing the approaches used by successful professionals. The Applied Project process has been designed to transition the student into embracing effective approaches to solving complex industry problems. This process enables the student to be a critical thinker who challenges every assumption, documents their work, and looks for multiple candidate solutions before settling on a final approach.

1.11 The Importance of Project Management

Successful professionals define their project scopes to fit the available resources. They carefully define the outcomes to be achieved. They then manage their projects so they achieve all their objectives within the available resources and time frames. Employers want to hire new graduates who have demonstrated their project management skills in the execution of their Applied Projects.

1.12 Colloquium Applied Project Workshops

Four Applied Project workshops will occur in the fall semester. These workshops will cover Phase 2 of the Applied Project process. Students will have their Phase 1 Exit Criteria Sheets signed by the instructor during the first workshop. Students will have their Phase 2 Exit Criteria Sheets signed by the instructor during the fourth workshop.

1.13 Course SEC 593: Applied Project Preparation and Commercialization Principles

This course will cover Phases 3 through 7 of the Applied Project process. In addition, this course will cover commercialization principles and their application to the development of the solar energy industry. The student should plan on about three hours of homework for this
course in addition to the 50- plus hours of working directly on their Applied Project during the spring semester (see Table 1-1).

1.14 Applied Project Advisors

The Applied Project must address a solar energy industry issue. The student will need the advice and guidance of someone from industry who is associated with the selected issue. The student will also need advice and guidance from a faculty member to help the student apply PSM SEEC coursework to the Applied Project. The advisors also serve as the quality check on the student’s work. Therefore, the advisors will be the ones to approve the exit criteria checklists for Applied Project phases 3 through 7.

The student is the manager of the Applied Project and not the advisors. It is the student’s responsibility to meet all Applied Project schedule items on time and of acceptable quality. It is also the student’s responsibility to have regular communications with their advisors. Students are required to provide email progress reports to their advisors every two weeks. Copies of these emails must be included in the Applied Project notebook. Minutes from meetings with the advisors (in person, phone calls, emails, etc.) must be also included in the Applied Project notebook.

It is the student’s responsibility to enroll both a faculty member and a representative from the solar industry as project advisors. Students will have an opportunity to network with faculty and industry professionals during PSM SEEC events. PSM SEEC course instructors can also provide help to the student in finding the right advisors for their project.

Students should be aware their industry advisor is often an excellent avenue to networking within the solar energy industry and, ideally, will become a mentor or colleague throughout the student’s career. The opportunity to have an industry advisor is a unique benefit of the PSM SEEC program. These industrial advisors are very busy. The student needs to be mindful of the industrial advisor’s time constraints. The student needs to make special use of phone calls and emails to allow the industrial advisor to work their advising into an already busy schedule. The goal is to limit and maximize the time commitment of the industrial advisor. The same goal applies to the faculty advisor.

1.15 Format for Progress Reports to Advisors

It is important for the student to keep the advisors informed of their progress. It is up to the student to eliminate the burden of the advisors going back over prior emails to understand what is being done on the project. The best way to do this is for the student to email a progress report to their advisors every two weeks. A copy of this email must also be included in the project notebook. This progress report will provide an updated schedule, updated labor versus time and updated material expenditures versus time. In addition, there needs to be a
discussion of progress, current issues and plans for the next reporting period. A list of requested advisor action items also needs to be included. The goal is to be concise, but complete. An example of a progress report is given in Appendix B.

1.16 Project Evaluation

Successful projects meet all their objectives on-time and within their resource budgets. For the Applied Project, the most valuable resource is the student’s time as measured in labor hours. The key to effective project management is making the project plan a living document that is updated as conditions change on the project. These updates need to be discussed with and approved by the advisors.

Some of the questions that should be asked when evaluating the project are listed below.

- Did the project meet its objectives?
- Was the project notebook kept up to date?
- What unexpected issues occurred and how were they effectively handled?
- Did the project advisors receive email updates at least every two weeks?
- Was the risk mitigation plan presented in the project proposal effective?
- Were variances in schedule and budget properly addressed during Review 1, Review 2 and the project defense presentation?

1.17 Lessons Learned

Successful organizations are learning organizations. They take the time to evaluate their completed projects and identify what worked and didn’t work. For items that didn’t work, the organization identifies better approaches to be taken next time this issue is encountered. Learning organizations value employees and suppliers who identify and acknowledge these lessons learned.

Part of the Applied Project process is to demonstrate this competency. The best practice approach is to capture the lessons learned as they occur during the project and enter them into the project notebook. This record makes it easy to complete the lessons learned section of the final report during Phase 7.

1.18 Professional Communications

All Applied Project documents must be professionally prepared. This means the ideas are logically presented, the formats conform to the requirements, the rules of English grammar are followed and the writing is easy to read. It also means all graphics are easy to read and the captions tell the reader what is important about the graphic. All ideas and information not created by the student must be referenced. The documents should conform to the AP, MLA or ASME report format.
Students are expected to have another party review and edit their communications. Students are encouraged to use the Graduate Writing Center and the communications coach provided by the PSM SEEC program.

1.19 Applied Project Final Report Format

The Applied Project is intended for students whose career aspirations are best served by gaining practical experience in developing a solution to a solar energy industry problem. The Applied Project must be accomplished in partnership with an organization within the solar energy industry. The solution can take a number of forms such as a business plan, prototype design, policy statement, a student designed/conducted performance evaluation, etc.

The Applied Project final report not only describes the problem and its solution, it also explains how the project was conducted and what lessons were learned regarding best practices for applied projects.

The details of the solution can be included in the body of the final report or it can be presented as a stand-alone appendix to the final report. For example, if a student wants to start their own consulting business, then part of the solution is a business plan. The business plan can be provided as an appendix. The process of developing the business plan is covered in the body of the report.

The format for the final report is provided in Figure 1-3. This is a multi-page figure that starts on the next page.
1. Introduction

1.1 Description of the Industry Issue

- What is the need the project seeks to address
- Why is the project worth doing
- What industry organization is involved

1.2 Problem Statement

- Provide a concise and clear problem statement that defines the type of solution desired and the scope of the solution expected.
- Include statements of what the problem does not cover
- Describe the significance of this problem to society
- Describe why this problem is unique

1.3 Solution Requirements

- List what requirements the solution must satisfy in order for it to be acceptable for the given problem statement.

2. Background Information

- Present the information gathered about the issue including prior attempts at a solution from both a literature review and interviews with appropriate people
- Present information about applicable solar energy coursework and tools such as computer programs, etc.
- Present information about solutions to similar problems

Figure 1-3. Final Report Outline (page 1 of 3)
3. Project Plan

- This section describes how the project was organized.
- Present the general approach taken including how the solution space was explored
- Discuss the tasks that were planned and how their outcomes will meet the problem statement requirements
- Present the project baseline schedule(s)
- Present the project labor and materials budgets
- Describe the project plan five key success factors (what elements of the plan insured success)

4. Project Implementation

- Discuss what actually happened during the course of the project.
- Present the final schedules and budget as actuals graphs and describe the variances with the baseline and how they were addressed.
- Describe how the solution space was explored and candidate approaches were identified.
- Explain how the final solution approach was down selected
- For the final solution approach describe how each task was accomplished to satisfy the problem statement requirements (this is a major portion of the report).

5. Conclusions

- Determine how well the solution satisfies the problem statement requirements.
- Determine if the project met its objectives of obtaining an acceptable solution on-time and within the allocated resources.

6. Recommendations

- Recommend whether the final solution should be implemented by the industry organization.
- Recommend further work in this area if applicable.

7. Project Evaluation

- Evaluate how well the project was managed.
8. Lessons Learned

- Describe the lessons learned by the student on how to successfully conduct an applied project
- Describe the lessons learned on how to apply the skills and abilities learned in the solar PSM program to industry problems.

9. References

- References should be in IEEE or ASTM format. Any deviation in formatting must be approved by the PSM SEEC Program Director and Faculty Advisor.

10. Appendices

Figure 1-3. Final Report Outline (page 3 of 3)
1.20 Defense Presentation Format

The purpose of the defense presentation is to demonstrate to the student’s advisors that the student has accomplished the following:

1. Transitioned from student to solar professional
2. Conducted original work that solved a solar industry problem
3. Properly applied to the project the principles covered in the PSM SEEC program coursework

The format for the defense presentation slides is provided in Figure 1-4.

- Title
- Issue Background
- Problem Statement and Significance
- Problem Statement Requirements
- Approach
- Candidate Solutions Considered
- Final Solution Implementation (several slides covering the work done and showing that the solution meets all the problem statement requirements).
- Conclusions
- Recommendations
- Project Evaluation
- Lessons Learned
- Acknowledgements

Figure 1-4. Outline for Defense Presentation Slides
2. Applied Project Criteria, Format and Examples

2.1 Criteria

The Applied Project must address a specific problem in the solar energy industry. The student must create a solution using the skills and abilities developed during the PSM SEEC program. It is desirable that the student actually implement the solution and measures its success. If this is not possible, then an implementation plan and a rationale for expected success must be provided.

The Applied Project must be centered on the student’s creative solution to a solar industry problem. The Applied Project cannot just involve the reporting of work done by others.

2.2 Format

It is helpful to compare and contrast the master’s thesis with the PSM SEEC Applied Project Report. The process for preparing a master’s thesis is as follows: a) the student does the work and documents it in a project notebook, b) the student writes a thesis that is usually 60 pages or more that describes how the work (which may take two or more years to complete) was done as well as what are the results/conclusions/recommendations and then c) the student writes one or more journal papers. These journal articles are usually only eight to 10 pages. They are a condensation of all the work that was done in conducting the thesis work. To get to an eight-page journal article a great deal of prior documentation must be accomplished.

The PSM SEEC Applied Project is less in scope as compared to a Master’s Thesis. However, it is much greater in scope than an eight-page research paper similar to the ones done in many regular courses. The Master’s Thesis may require 300 to 400 hours of work, while the Applied Project only requires 175 hours. However, both the Master’s Thesis and the Applied Project require a final report and a defense presentation.

The PSM SEEC final reports prior to 2018 primarily used an eight to 10-page journal format. These reports were sufficient, but they lacked all the detail needed to fully document the Applied Project work. Therefore, the PSM SEEC students now will be required to create a traditional project report as compared to a journal article. An outline for the final report is provided in Section 1.19.

2.3 Prior Applied Project Examples

Table 2-1 lists the titles of many prior project reports. This gives the student a good idea of the many different issues within the solar energy industry. Examples of selected reports are posted on the PSM SEEC program website. All PSM SEEC Applied Projects must feature a student-created solution to an industry problem where learnings from the program have been applied to the industry issue.
Table 2-1: Examples of Prior Applied Projects and Industry Advisors

<table>
<thead>
<tr>
<th>Applied Project</th>
<th>Industrial Advisor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Powered Bus Stop</td>
<td>City of Mesa</td>
</tr>
<tr>
<td>Solar Air Conditioning</td>
<td>TUV Rheinland</td>
</tr>
<tr>
<td>Natural Power &amp; Energy: Solar Made Easy (Incorporates solar engineering, financial forecasting and graphic user-interface design)</td>
<td>Natural Power &amp; Energy</td>
</tr>
<tr>
<td>Business Potential in Distributed Solar Thermal with Natural Gas Backup</td>
<td>TUV Rheinland/Flux Energy</td>
</tr>
<tr>
<td>Assessing the Feasibility of a Photovoltaic Fuel Cell Hybrid System for Sustainable Off-Grid Power Generation</td>
<td>Intel</td>
</tr>
<tr>
<td>Forecasting Model for Material Demands and Personnel Requirements</td>
<td>First Solar</td>
</tr>
<tr>
<td>Developing an Utility Business Model for Community Solar</td>
<td>Arizona Public Service</td>
</tr>
<tr>
<td>Grid-tied PV system with battery storage for biology field research station in Puerto Williams, Chile.</td>
<td>Flux Energy</td>
</tr>
<tr>
<td>An educational system for developing world solar technicians</td>
<td>FLUX Energy</td>
</tr>
<tr>
<td>Increasing concentrated solar power viability through energy market and financial mechanisms</td>
<td>Abengoa Solar</td>
</tr>
<tr>
<td>Examination of deregulation and the renewable portfolio standard in Arizona</td>
<td>Arizona Public Interest Research Group</td>
</tr>
<tr>
<td>Shadow influence on thin film VS Crystalline Silicon PV Modules</td>
<td>Sun Valley Solar</td>
</tr>
<tr>
<td>Solar energy solutions for microbreweries</td>
<td>Flux Energy</td>
</tr>
<tr>
<td>Design, construction and testing of a scaled proof-of-concept solar thermal rocket engine</td>
<td>Strategic Solar</td>
</tr>
<tr>
<td>Project development feasibility for potential installation of a Power Parosol.</td>
<td></td>
</tr>
<tr>
<td>Financing Solar for Rural Areas</td>
<td>Kyocera Solar</td>
</tr>
<tr>
<td>The PIP Box: Enhancing String Inverter Performance</td>
<td>Natural Power and Energy</td>
</tr>
<tr>
<td>PV Module Reliability Through Image Processing</td>
<td>TUV Rheinland</td>
</tr>
<tr>
<td>Influence of Soiling, Performance Ratio &amp; Performance Index on Solar PV’s Energy Production</td>
<td>TUV Rheinland</td>
</tr>
<tr>
<td>Performance Evaluation of CIGS Modules at Different Field Operating Conditions</td>
<td>TUV Rheinland</td>
</tr>
<tr>
<td>Pay-for-Performance: A Transitional Model</td>
<td>High Performance PV</td>
</tr>
<tr>
<td>Community Solar Program Design</td>
<td>Solar Electric Power Association</td>
</tr>
<tr>
<td>Solar Powered Automated Irrigation System to Maximize Efficiency of Water Use in Urban Community Gardens</td>
<td>TUV Rheinland</td>
</tr>
</tbody>
</table>

2.4 Example Scenarios for Applied Projects Incorporating a Student-Created Solution

Four example scenarios are presented below to show how the student can take an industry issue and arrive at a specific problem that is then solved by the student.
2.5 Example 1. Product Design

The engineering manager for the ABC Company needs to reduce the cost of the PV structure they produce by 30 percent. The engineering manager has a solution in mind. She wants the PSM SEEC student to analyze her potential solution relative to meeting the required structural loads and meeting the cost reduction target. The engineering manager has agreed to be the industry advisor.

This appears to be a promising Applied Project. However, the student cannot just consider the solution recommended by the engineering manager. The student must start with the requirements of the PV structure in terms of structural loads, life, reliability, environment, ease of installation, location, etc. The student must then explore the design space and identify at least two other candidate solutions in addition to the solution proposed by the engineering manager.

The student then compares the candidate solutions to determine which solution approach best meets the requirements. The student takes the selected solution approach and optimizes the solution through analysis with the goal of reducing production cost. The cost of the optimized solution is then compared to the current production cost. The student then concludes whether the optimized solution meets the cost reduction goal.

The student also needs to develop an implementation plan for the optimized solution. The plan needs to have a compelling rationale of why it will be successful. All the work accomplished on this project will be covered in the Applied Project Report.

2.6 Example 2. Educational Software

The student is interested in developing solar energy educational software. The development of the software is not sufficient. The software must be the solution to an actual solar energy industry need. Establishing the need and defining specific solution requirements are an important part of the Applied Project. The student will also need to identify a specific path to implementation of the software into the solar community. For example, the student could partner with a non-governmental agency and use one of its representatives as the industry advisor.

2.7 Example 3. Performance of an Existing Solar System

The student is interested in determining the performance of an existing solar facility. Part of the project is finding a facility that needs that type of testing. A representative from the facility should serve as the industry advisor. The student must work with the industry advisor to define the performance questions that need to be answered with the test data.
The student must create the test plan and test procedures, install and calibrate the equipment, collect and analyze the test results, and determine how well the performance questions have been answered. The students must also manage the project, evaluate its conduct and identify the lessons learned.

2.8 Example 4. CSP Thermal Storage System

The student wants to learn more about the use of CSP thermal storage as a way of managing loads on the grid. It is not enough for the student to gather existing information on the subject and report on the findings. This knowledge must be applied to a specific solar energy industry problem. One option would be to design an off-grid industrial park that has its electricity needs solely provided by a CSP plant with thermal storage. In this scenario, the student would have to find a candidate industrial park and obtain its requirements. The student would then design the plant, estimate its capital and operating costs, and estimate the cost of electricity. A good industry advisor would be someone involved in CSP thermal storage or someone involved in developing industrial parks.
3. Phase 1: Exploration

3.1 Purpose
The overall Applied Project process that is divided into seven phases was presented in Section 1.5. This major section discusses how to conduct the first phase which is exploration of the solar energy industry to find a topic of interest.

3.2 Outcomes
The following outcomes will be achieved in this phase:

- The student will thoroughly comprehend the information in the student handbook and agree to follow the process presented therein.
- The student will have explored a variety of potential topics and their associated industry issues.
- The student will have completed the Phase 1 exit criteria and have the checklist approved by the colloquium Applied Project workshop instructor.

3.3 Approach
The student will use literature surveys, interviews and coursework to explore interesting solar energy topics. For topics of interest, the student will identify applicable industry issues. Whenever the student works on the project, they will enter the time spent on the time logbook sheet filed in the project notebook (see Section 1.8 for more details).

3.4 Career Questions
Phase 1 is an exciting time in the project. The student is starting the process with all things possible. The best way for the student to start is to ask questions regarding their solar energy career. Worksheet 1 (See Figure A-2 in Appendix A) lists a number of such questions. The student must complete Worksheet 1 and file it in their project notebook. It is a good idea for the student to show this worksheet to potential advisors so they know what the student wants to achieve with their Applied Project.

The answers to these questions will guide the student towards the right topics and industry issues. The Applied Project can be an excellent avenue for networking into a desired career area within the solar energy industry.
3.5 Literature Review and Interviews

The student will need to find relevant literature to review such as recent books, journal articles, trade magazines, information from solar energy organizations, etc. The student will also need to interview members of the solar energy community such as course guest speakers, members of the PSM SEEC industry advisory board, and so on. Information from these explorations must be written down on Worksheet 2 (see Figure A-3 in Appendix A) and Worksheet 3 (see Figure A-4 in Appendix A). Many of the guest lectures and networking events offered through the PSM SEEC program will provide excellent opportunities for the well-prepared student to ask questions and explore topic ideas.

3.6 Data Analysis and Selection of Candidate Topics

After completing the above worksheets, the student will need to analyze this information and then use Worksheet 4 (see Figure A-5 in Appendix A) to identify at least three topics with their industry issues for further consideration during Phase 2.

3.7 Phase 1 Exit Criteria Checklist

Phase 1 must be completed prior to the first colloquium Applied Project workshop that occurs near the end of October. The final task in this phase is to fill out the exit criteria checklist given in Figure B-1 in Appendix B. This document will be submitted to the colloquium Applied Project instructor during the first workshop session. The instructor will approve and sign the form and return it to the student so it can be filed in the project notebook and also sent to the PSM SEEC Program Director.
4. Phase 2: Selecting a Topic and Advisors and Presenting at the Shark Tank

4.1 Purpose
The purpose of Phase 2 is to (1) select the Applied Project topic and advisors and (2) prepare and present an initial project plan at the Shark Tank meeting in early February.

4.2 Outcomes
The following outcomes will be achieved in this phase:

- The student will attend Sessions 3 and 4 of the colloquium Applied Project workshop. The workshops will be scheduled during the required SEC 588-Solar Energy Colloquium class.
- The student will select the Applied Project topic area, identify the chosen solar industry issue and define a specific problem statement.
- The student will identify the requirements that must be met by the solution to the selected problem statement.
- The student will enroll both an industry advisor and a faculty advisor.
- The student will submit their first progress report to the advisors by the end of January.
- The student will demonstrate that they have the competencies to plan and manage a project successfully.
- The student will prepare a detailed plan for how they will assemble the Project Proposal during Phase 3.
- The student will review and comprehend the writing guidelines for the Applied Project.
- The student will work with their advisors to prepare an initial project plan for the Shark Tank.
- The student will present their initial project plan at the Shark Tank in early February.

4.3 Approach
The student will learn how to complete Phase 2 during the colloquium Applied Project workshops 3 and 4 that will be conducted in the November time frame. The student will work over the Winter Break to complete many of the Phase 2 outcomes. The student will select their topic and advisors in enough time for the student to prepare the initial project plan for the Shark Tank with guidance from their advisors. The student will start the course SEC 593 during Phase 2. The SEC 593 instructor will help students prepare for the Shark Tank presentation.

4.4 Problem Statement Selection
For Phase 2, the student will review the Phase 1 results and arrive at a final topic area. The student will then explore the topic area to identify a number of solar energy industry issues.
From these candidate issues, the student will select a specific issue for the Applied Project. The student will then identify a specific problem associated with this issue. As the student performs these tasks, they will fill out Worksheet 5: Problem Statement Selection (see Figure A-6 in Appendix A).

4.5 Enrollment of Advisors

Once the topic area is selected, the student will enroll both an industry advisor and a faculty advisor. The word “enroll” is used because no faculty member or industry person is obliged to be one of the student’s advisors. The student must convince the potential advisors that participation on the student’s Applied Project will benefit the advisors in specific ways. It should be noted that the PSM SEEC program does provide a small monetary honorarium to each advisor although most benefits for the advisors are less tangible. The advisors are primarily motivated by a desire to help students prepare for successful careers in industry. It is their way of “giving back” to their professions. At this time, the student will fill out Worksheet 6: Enrollment of Advisors (see Figure A-7 in Appendix A). The advisors will help the student finalize their problem statement as discussed in Section 4.4.

4.6 Problem Statement Requirements Definition

The student will refine the problem statement by defining the requirements that must be met for the problem to be solved. These requirements will be listed in Worksheet 7: Problem Statement Requirements (see Figure A-8 in Appendix A). The selected advisors should be included in the process of defining these requirements.

4.7 First Progress Report to the Advisors

The student will prepare the first progress report to the advisors and submit it to them at the end of January. All progress reports will be prepared in accordance with the guidelines provided in Appendix C.

4.8 Project Management Competencies

During the colloquium Applied Project workshop sessions, the student will learn the project management competencies necessary to successfully complete the Applied Project. These competencies will be covered again in the spring semester in SEC 593.

4.9 Plan for Preparing the Initial Project Proposal

The process for preparing the initial project plan to be presented at the Shark Tank will be covered during the colloquium Applied Project workshop Sessions 3 and 4. The student will then fill out Worksheet 8: Plan for Preparing the Initial Project Proposal (see Figure A-9 in Appendix A). The student will begin the process of preparing the Initial Project Proposal during the Winter Break. The student should read Section 5 to understand what will eventually need
to be in the final Project Plan prepared in Phase 3. The presentation to the Shark Tank should include most of these topics, but only at an executive-summary level. The student will have only about eight minutes to make the Shark Tank slide presentation. This will be followed by about seven minutes of feedback from the audience.

4.10 Preparing for the Shark Tank

The Shark Tank meeting occurs in early February. In this meeting each PSM SEEC student will present their proposed project to faculty members and industry representatives. The students will receive constructive feedback that should be integrated into the final project proposal to be completed in Phase 3. To prepare for the Shark Tank, the list of slides given in Figure 4-1 should be prepared. Each student will have only 8 minutes to present. This will be followed by about seven minutes of audience feedback. The student needs to focus on the big ideas and not get bogged down in explaining the details. The slides need to be prepared in enough time for the student to adequately practice giving the presentation and making sure that the presentation can be given within the allowed 8 minutes. The Shark Tank presentation should be given to the advisors before the student presents at the Shark Tank.

List of Slides for the Shark Tank Presentation

1. Title slide (include names of advisors)
2. Problem Statement
3. Solar Industry Significance
4. Problem Statement Requirements
5. Project Scope and Objectives
6. Approach
7. Project Schedule
8. Labor and Material Budgets
9. Risk Mitigation Plan
10. Five Reasons the Project Will Be Successful
11. Summary of Work Already Done
12. Areas Where Advice Is Needed

Figure 4-1. List of Slides for the Shark Tank Presentation

4.11 Phase 2 Exit Criteria Checklist

Phase 2 will be completed when the student presents at the Shark Tank in early February. The final task in this phase is to fill out the exit criteria checklist given in Figure B-2 in Appendix B. This document will be submitted to the SEC 593 instructor. The instructor will approve and sign the form and return it to the student so it can be filed in the project notebook.
5. Phase 3: Preparing the Project Proposal

5.1 Purpose
The purpose of Phase 3 is to (1) integrate the Shark Tank feedback into the initial Project Proposal and complete the final Project Proposal and (2) start work on the project in anticipation of Project Proposal approval by the SEC 593 instructor.

5.2 Outcomes
The following outcomes will be achieved in this phase:

- The student will incorporate feedback from the Shark Tank into the final Project Proposal.
- The student will work with their advisors to finalize the Project Proposal that will include the following:
  - Identify all the tasks that must be accomplished to complete the project.
  - Arrange the flow of the tasks to fit the program milestones.
  - Prepare a project schedule, a time-phased labor budget and a time-phased materials budget.
  - Prepare a risk mitigation plan and then modify the plan to incorporate the elements of the risk mitigation plan.
- The student will start work on appropriate project tasks in anticipation of Project Proposal approval by the SEC 593 instructor.
- The student will continue to submit progress reports to the advisors.
- The student will complete the Project Proposal and have it approved by their advisors and the SEC 593 instructor.

5.3 Approach
The student will follow the standard proposal preparation process presented in this section of the Applied Project handbook. The student will allocate adequate time to work on the proposal. This includes time to do additional research on the industry issue being addressed. The student will document the work accomplished in this phase and file it in the project notebook. A key part of the proposal will be the risk mitigation plan. The student will work with their advisors to identify all the project tasks and the proper additional tasks to mitigate the risk of the project not (1) meeting all the problem statement requirements, (2) not meeting the program milestones, (3) exceeding the allocated resources, or (4) any combination of the first three items.
5.4 The Importance of the Project Proposal

It takes resources to solve problems. In industry, someone has to pay the professionals to solve the problem. Most sources of project money will not provide the funding unless they are confident the problem will be solved within the budget and time frame specified. This means the proposal needs to be clear on what the project will do, how it will do it and how it will be managed to prevent the risks of not meeting schedule and/or budget.

5.5 How Can One Plan a New Project?

Granted, it is not easy to identify all the tasks that are needed to accomplish a project that has not been done before. However, this must be done and done well if the project is to receive the needed resources. Preparing proposals for projects that tackle new problems is a major task of the solar energy professional. The Applied Project is the opportunity to learn and then demonstrate this important skill.

5.6 General Methods for Identifying Project Tasks

Professionals faced with planning a new project do the following:

1. Study how similar projects were done.
2. Consult with experts familiar with the topic being considered.
3. Study in detail the problem requirements and list all the tasks that must be done to achieve them.
4. Identify the desired outcome of each task and think about what conditions might cause this outcome to not occur. Then, identify what additional tasks can be done to prevent these conditions from occurring.
5. After this preliminary listing of tasks is accomplished, the professional uses their imagination to build a mental model of how the project will flow. This process will help identify additional tasks.

5.7 Also Use this Handbook to Identify Required Tasks

In addition to the generic methods of identifying the project tasks, the PSM SEEC student should use the phase descriptions in this handbook to identify additional tasks such as worksheets, checklists, etc.

5.8 Why a Good Baseline Plan is Needed

It is important to remember that the baseline plan in the proposal is just that—a baseline. It is expected that unplanned events will occur as the project progresses. That is why project management is so important. The project must be managed to accommodate these unplanned
events. But, a starting point is required. There has to be some basis for funding the proposed project. Hence, a baseline project plan is vital to launch the project successfully. The better the baseline plan, the easier it is to manage the project once funded.

5.9 Defining the Tasks
Once the list of tasks is assembled, each task needs to be defined. This definition includes what is to be done, how it is to be done, when it is to be done and the expected final outcomes when the task is completed. It is also important to define what tasks must be done prior to this task, i.e., what are the predecessor tasks.

5.10 Turning Tasks into an Activity Network
Each task can be represented by a block as shown in Figure 5-1.

Input:
Prior Task Information

Task Name

Outcomes:
Task Deliverable

Required Resources
- Calendar Time
- Labor & Material
- Information/Expertise

Figure 5-1. Generic Task Block Diagram

Once the project tasks have been defined, the student needs to determine how these tasks relate (i.e., predecessors and successors). This is done by arranging the tasks into an activity chart similar to the example given in Table 5-1. By arranging the tasks according to dependencies in an activity network, it is possible to see which tasks must be accomplished sequentially and which can be done in parallel. An activity network chart for the example given in Table 5-1 is presented in Figure 5-2. In this example, the sequential Task B and Task Care accomplished in parallel with Task D. Note that the calendar time necessary for each task is included in the chart. Once the network is constructed, the critical path can be determined. This is the shortest time that all tasks can be accomplished. It is the path that takes the longest to accomplish. In the example figure, this is the path A-D-F-G. This critical path is indicated with heavy lines. If the time required to complete all the tasks exceeds the allocated calendar time, then one or more of the task calendar times needs to be decreased. However, only tasks that
are on the critical path should be considered. Changes to other tasks will not reduce the overall project calendar time.

Table 5-1. Example Project Task Information

<table>
<thead>
<tr>
<th>Task</th>
<th>Predecessor</th>
<th>Successor</th>
<th>Time, weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Start</td>
<td>B</td>
<td>1.0</td>
</tr>
<tr>
<td>B</td>
<td>A</td>
<td>C</td>
<td>1.0</td>
</tr>
<tr>
<td>C</td>
<td>B</td>
<td>E</td>
<td>1.0</td>
</tr>
<tr>
<td>D</td>
<td>A</td>
<td>E</td>
<td>2.5</td>
</tr>
<tr>
<td>E</td>
<td>C, D</td>
<td>G</td>
<td>1.5</td>
</tr>
<tr>
<td>F</td>
<td>C, D</td>
<td>G</td>
<td>2.0</td>
</tr>
<tr>
<td>G</td>
<td>E, F</td>
<td>End</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Figure 5-2. Activity Network Chart for Example Project Defined in Table 5-1
5.11 Project Schedules

Once the activity network is complete, this data can be converted into project schedules in the form of a Gantt charts. This set of charts should include a top-level chart similar to the one shown previously in Figure 1-1. More detailed Gantt charts for each phase should also be created.

There are a number of computer programs for making Gantt charts such as MS Project. For the Applied Project, the student will make their Gantt charts using MS PowerPoint. This skill will be covered during the colloquium Applied Project workshop.

5.12 Project Schedules are Living Documents

Project schedules are an important management tool to illustrate how the project is progressing. It compares actual work on the tasks versus the baseline planned work. From the schedule, the student can show what percentage of the task is complete, when the work was done and when the task is scheduled to be completed. It also shows slips in the planned completion dates of tasks.

The example schedule in Figure 5-3 shows the following:

- The project started in August and is scheduled to end the following July.
- The schedule reports work through May 1
- Phases 1 and 2 were completed on schedule.
- Phase 3 is complete but it slipped in schedule and completed in late March instead of early March.
- Phase 4 was scheduled to be completed in early April. However, only 50 percent of the work has been done and the task is now scheduled to complete in early May.
- Phase 5 was scheduled to begin in early April, but it has not started yet. However, it is still planned on being completed on-time at the end of May.
- Work has not begun on Phases 6 and 7
- Review 1 has not been completed.

Based on the data given in Figure 5-3, the example project is behind schedule. Since Phase 5 does not show a slip in schedule, the project is planning on catching up and still completing Phases 5, 6 and 7 on schedule. The schedule is incomplete because Review 1 has not occurred as planned, but no planned slip date is indicated. This schedule indicates that a great deal of work will be accomplished in May. The project advisors should work with the student to see if that is a reasonable management approach and what other approaches should be considered.
5.13 Labor Budget Chart

Based on Table 1-1, the suggested labor budget spread of the minimum of 175 hours for the Applied Project is shown in Figure 5-4.

5.14 Tracking Actual Labor Spent versus Budgeted Amount

Figure 5-5 shows the actual and budgeted labor values for the example project shown in Figure 5-3. The project was on budget through January, but little work has been done in February, March and April. The project now has a labor budget variance. That is, the actual labor spent does not match with the budgeted labor planned. Good project management requires that this variance be addressed and the project changed such that the overall project completes on-time and within budget. The estimated line shows the planned labor to be spent for the remainder of the project. Note that there is a large amount of time planned for May. The student needs to work with the advisors to see if this is really a viable solution to the variance.
5.15 Material Budgets

There may be some materials that are needed to accomplish the project. These costs are measured in dollars and are handled in a similar way to project labor. A budget is set and then actual material expenses are tracked as they occur. The materials budget should be submitted to the PSM SEEC Program Manager to pursue purchasing/acquisition options. Each applied
The project has been allocated a materials budget. Students should note that all materials will remain the property of ASU. Students should not expect reimbursement for items purchased without prior authorization from their advisors and the PSM SEEC Program Manager.

5.17 Managing Risk

Project risk is the risk that the project will fail, that is, not meet all its objectives on-time and within budget. A risk mitigation plan seeks to eliminate conditions that would cause the project to fail. Risk management starts with reviewing the baseline project plan and identifying what might cause a problem on the project. For example, the analyses may take too long, or a key interviewee may not be available. Once this list is assembled, each potential risk cause must be given a probability of occurrence and a level of severity value. For the probability of occurring, a good method of doing this is to use a scale of 1 to 5 where 1 means there is little probability of the risk occurring and 5 meaning there is a likely chance that the risk cause will occur. Likewise, the level of severity can be numbered from 1 to 5 with 1 meaning there is little effect on the project and 5 meaning there is a major effect on the project. A risk number is then assigned to each risk cause by multiplying the probability of risk by the severity level. The risks are then listed with the highest risk numbers at the top of the list. For the high-risk number causes, ways of minimizing each risk must be identified. These risk mitigation tasks must then be added to the project task list and integrated into the project plan.

5.18 Final Project Proposal Outline

The final project proposal should be completed within 10 days of the Shark Tank meeting. The final project proposal is a written document that has more details than presented in the Shark Tank slides. The final project proposal should follow the outline provided in Figure 5-6. The final project proposal must be approved by the advisors.

5.19 Phase 3 Exit Criteria Checklist

Phase 3 must be completed within 10 days of the Shark Tank meeting. The final task in this phase is to fill out the exit criteria checklist given in Figure B-3 in Appendix B. The advisors will approve and sign the form and return it to the student so it can be filed in the project notebook.
Project Proposal Outline

Title Page
Abstract
Table of Contents
1. Introduction
2. Background and Industry Issue
3. Problem Statement, Requirements and Industry Significance
4. Scope and Objectives
5. Approach
6. Project Schedule
7. Labor and Material Budgets
8. Risk Mitigation Plan
9. Top Five Success Project Success Factors

Figure 5-6. Project Proposal Outline
6. Phase 4: Initial Work

6.1 Purpose
The purpose of Phase 4 is to start and complete as many tasks as possible. Starting a task early and gathering data helps to identify any issues that were not planned for during the proposal phase. This early identification of issues provides more time to factor these new results into the project.

6.2 The Dangers of Not Working Hard in Phase 4
Phase 4 occurs during the middle part of the spring semester. This is a busy time for students as they work on their other courses. It is all too easy for the student to push Applied Project work into a later time frame so more time can be spent on other courses. This must not be done. For the student to be successful and graduate on-time, a great deal of work must be accomplished in Phase 4.

6.3 Outcomes
The following outcomes will be achieved in this phase:

- The student will start as many tasks as possible.
- The student will update the project plan as needed.
- The student will document all work on the Applied Project in the project notebook.
- The student will present Project Review 1 to the advisors in the form of a slide presentation. Feedback will be integrated into the project.
- The student will log all time spent on the log sheet.
- The student will continue to submit progress reports to the advisors.
- The student will complete the phase exit criteria checklist

6.4 Approach
The student will work on the Applied Project in a disciplined manner by following the project plan. The focus will be gathering as much data as needed for analysis in Phase 5. The student will also prepare any analysis models that will be used in Phase 5. The student will complete any remaining research and data gathering that was not accomplished in prior phases. The student will start preparing draft sections of the final report. The student will work closely with their advisors to make sure that adequate progress is being made on the project.
6.5 Project Review No. 1

The purpose of the project review is to (1) hold the student accountable for staying on schedule and investing adequate time in the conduct of the Applied Project and (2) to provide the student with an additional avenue to receive guidance, advice and feedback from the advisors.

The project review can be accomplished through email, teleconference, Skype or a face-to-face meeting. The important points are that (1) the student provides a PowerPoint document to the advisors and (2) the advisors provide feedback to the student. The student and advisors are encouraged to make this an opportunity for discussion. Advisors are encouraged to ask questions and stimulate the student’s thinking.

The student’s PowerPoint presentation should include the following slides:

- Title
- Summary of Industry Issue
- Problem Statement
- Problem Statement Requirements
- Approach
- Schedule
- Budgets
- Candidate Solutions Considered
- Final Solution Description
- Initial Progress on Solving the Problem
- Key Issues
- Go-Forward Plan

Following the presentation, each advisor will take about 15 to 20 minutes to fill out the advisor feedback form. The forms for the industry advisor and the academic advisor are provided as Figures A-10 and A-11 in Appendix A, respectively. These filled-out forms will be sent to the student. The student will incorporate the feedback into their Applied Project. The student will also file these forms in the project notebook.

6.6 Phase 4 Exit Criteria Checklist

The final task in this phase is to fill out the exit criteria checklist (see Figure B-4 in Appendix B). The advisors will approve and sign the form and return it to the student so it can be filed in the project notebook.
7. Phase 5: Major Work

7.1 Purpose and Overview
The purpose of Phase 5 is to complete the majority of the project tasks. The nature of the specific tasks will depend on the type of problem being addressed. These tasks were defined during the project proposal activities. Significant work should have already been completed in Phase 4.

7.2 Outcomes
The following outcomes will be achieved in this phase:

- The student will address the feedback given in the Phase 4 Project Review No. 1.
- The student will update the project plan as needed.
- The student will schedule the defense date by May 15.
- The student will document all work on the Applied Project in the project notebook.
- The student will present Project Review 2 to the advisors in the form of a slide presentation. Feedback will be integrated into the project.
- The student will log all time spent on the log sheet.
- The student will continue to submit progress reports to the advisors.
- The student will complete the phase exit criteria checklist

7.3 Approach
The student will work on the Applied Project in a disciplined manner by following the project plan. The focus of this phase is completing most of the project tasks. In this phase, the student will analyze the data gathered in prior phases and implement the results of those analyses. The student will work closely with their advisors to make sure that adequate progress is being made on the project.

7.4 Project Review No. 2
The purpose of the project review is to (1) hold the student accountable for staying on schedule and investing adequate time in the conduct of the Applied Project and (2) to provide the student with an additional avenue to receive guidance, advice and feedback from the advisors.

The project review can be accomplished through email, teleconference, Skype or a face-to-face meeting. The important points are that (1) the student provides a PowerPoint document to the advisors and (2) the advisors provide feedback to the student. The student and advisors are encouraged to make this an opportunity for discussion. Advisors are encouraged to ask questions and stimulate the student’s thinking.
The student’s PowerPoint presentation should include the following slides:

- Title
- Summary of Industry Issue
- Problem Statement
- Problem Statement Requirements
- Approach
- Schedule
- Budgets
- Candidate Solutions Considered
- Final Solution Description
- Initial Progress on Solving the Problem
- Key Issues
- Go-Forward Plan

Following the presentation, each advisor will take about 15 to 20 minutes to fill out the advisor feedback form. The forms for the industry advisor and the academic advisor are provided as Figures A-12 and A-13 in Appendix A, respectively. These filled-out forms will be sent to the student. The student will incorporate the feedback into their Applied Project. The student will also file these forms in the project notebook.

7.5 Phase 5 Exit Criteria Checklist

The final task in this phase is to fill out the exit criteria checklist given in Figure B-5 of Appendix B. The advisors will approve and sign the form and return it to the student so it can be filed in the project notebook.
8. Phase 6: Final Work

8.1 Purpose
The purpose of Phase 6 is to complete all project tasks except the final version of the final report and the defense presentation.

8.2 Outcomes
The following outcomes will be achieved in this phase:

- The student will complete all tasks except the finalizing of the project final report and the defense presentation
- The student will update the project plan as needed.
- The student will document all work on the Applied Project in the project notebook.
- The student will log all time spent on the log sheet.
- The student will continue to submit progress reports to the advisors.
- The student will complete the phase exit criteria checklist

8.3 Approach
The student will work on the Applied Project in a disciplined manner by following the project plan. The focus will be completing all outstanding tasks. The student will also complete the rough draft of the final report. The rough draft content must be complete. The rough draft must conform to all writing guidelines and must be free of spelling and grammatical errors. It must have been edited by someone other than the student. The student will submit the rough draft to the advisors for their review of the content. The advisors will not proof-read the report. If it does not follow the writing guidelines, it will be rejected and the student must resubmit once the writing is correct. This will probably delay the student’s graduation date, so this outcome should be avoided.

8.4 Phase 6 Exit Criteria Checklist
The final task in this phase is to fill out the exit criteria checklist given in Figure B-6 of Appendix B. The advisors will approve and sign the form and return it to the student so it can be filed in the project notebook.
9. Phase 7: Final Documentation

9.1 Purpose
The purpose of Phase 7 is to complete the final report and prepare/present the project defense.

9.2 Outcomes
The following outcomes will be achieved in this phase:

- The student will complete and submit the final report to the advisors.
- The student will prepare the defense presentation.
- The student will present the defense.
- The student will log all time spent on the log sheet.
- The student will complete the phase exit criteria checklist

9.3 Approach
The student will incorporate feedback from the advisors into the final version of the project final report. The student will prepare the defense presentation by following the outline presented in Section 1.20. The student will complete the project notebook and submit it to the advisors during the defense for their final review. At the defense, the advisors will tell the student if any changes to the final report will be required. The student will make these changes and submit the corrected final report to the advisors.

9.4 Phase 7 Exit Criteria Checklist
The final task in this phase is to fill out the exit criteria checklist given in Figure B-7 in Appendix B. The advisors will approve and sign the form and return it to the student so it can be filed in the project notebook.
Appendix A: Forms and Worksheets

Applied Project Time Logbook Sheet

<table>
<thead>
<tr>
<th>Date</th>
<th>Start Time</th>
<th>Finish Time</th>
<th>Work Description</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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Form 1. Applied Project Time Logbook Sheet
Worksheet 1: Solar Industry Career Questions       Name ____________________  Date ______

The student must answer the following questions to provide guidance in selecting an Applied Project topic. The answers must be typed. The completed worksheet must be filed in the project notebook.

Q: What do I want the Applied Project to do to further my career goals?
A:

Q: What do I want to accomplish during my career?
A:

Q: Where do I want to live?
A:

Q: Is there a specific company in the solar energy industry that I want to join?
A:

Q: Is there a new solar product or service I want to develop?
A:

Q: Do I want to start my own business?
A:

Q: Am I interested in certain solar energy models such as community solar? Describe.
A:

Q: Do I want to change solar policy?
A:

Other Questions and Answers

Q:
A:

Q:
A:

Q:
A:
The student must list at least eight literature items that have been reviewed. Each item must be referenced and relevant topics and issues must be listed. The completed worksheet must be filed in the project notebook.

Item 1:

Item 2:

Item 3:

Item 4:

Item 5:

Item 6:

Item 7:

Item 8:
The student must list at least six relevant solar-industry people that have been interviewed regarding important topics and industry issues. Each interview must be referenced with the name, title, company and date of the interview, along with a list of relevant topics and issues. This information must be typed. The completed worksheet must be filed in the project notebook.

Interview 1:

Interview 2:

Interview 3:

Interview 4:

Interview 5:

Interview 6:
Worksheet 4: Go-Forward Topics and Issues  Name __________________________ Date ____

The student will analyze the information in the first three worksheets. The student will then identify at least three topics with their industry issues for further consideration during Phase 2. The completed worksheet must be filed in the project notebook.

**Topic and Issues 1:**

**Topic and Issues 2:**

**Topic and Issues 3:**

**Other Topics and Issues:**
Worksheet 5: Problem Statement Selection  Name __________________________ Date ____

The student will document the process of selecting the problem statement by typing the answers to each question listed below. The completed worksheet must be filed in the project notebook.

1. **Define the topic area and explain why this topic was chosen.**

2. **Identify a number of solar industry issues associated with this topic and select one of these issues. Provide a rationale for the selection.**

3. **For the selected solar industry issue, formulate a specific problem statement that has a scope that can be accomplished within the resource limitations of the PSM SEEC Applied Project.**
Worksheet 6: Enrollment of Advisors   Name __________________________ Date ____

The student will document the process of selecting the advisors by typing the answers to each question listed below. The completed worksheet must be filed in the project notebook.

1. Describe the process taken to select the industry advisor. What skills/knowledge do they possess that will benefit your Applied Project research?

2. Describe the process taken to enroll the selected industry advisor.

3. Identify the industry advisor including their contact information.

4. Describe the process taken to select the faculty advisor. What skills/knowledge do they possess that will benefit your Applied Project research?

5. Describe the process taken to enroll the selected faculty advisor.

6. Identify the faculty advisor including their contact information.
Worksheet 7: Problem Statement Requirements  Name _____________________ Date ____

The student will type the list of requirements for the problem statement on this worksheet. The completed worksheet must be filed in the project notebook.
The student will prepare the plan by typing out the answers to the following questions. The completed worksheet must be filed in the project notebook. The student should seek the guidance of the advisors in preparing this information.

1. **List the proposal preparation tasks including their names and descriptions**

2. **Prepare a proposal preparation schedule in the form of a Gantt chart. Prepare the Gantt chart in MS PowerPoint and paste it here.**

3. **Prepare a calendar time-phased labor budget for preparing the Applied Project proposal. Prepare the budget in MS Excel including the chart maker. Paste the chart here.**

4. **List the top five reasons why you will be successful in preparing an effective proposal preparation plan.**
1. Does the problem statement adequately apply to a solar industry issue or does it need modification?

2. Does the problem statement requirements list need to be modified?

3. Has the student made appropriate progress on the project? If not, what must be done?

4. Please list any additional feedback.
1. Does the problem statement adequately apply to a solar industry issue or does it need modification?

2. Does the problem statement requirements list need to be modified?

3. Has the student made appropriate progress on the project? If not, what must be done?

4. Has the student appropriately applied the solar engineering and commercialization principles covered in the PSM SEEC program coursework?

5. Please list any additional feedback.
Review No. 2 Feedback Form for Industry Advisor

Advisor’s Name ___________________________ Student’s Name __________________________

1. Does the problem statement adequately apply to a solar industry issue or does it need modification?

2. Does the problem statement requirements list need to be modified?

3. Has the student made appropriate progress on the project? If not, what must be done?

4. Please list any additional feedback.
Review No. 2 Feedback Form for Faculty Advisor

Advisor’s Name ___________________________ Student’s Name __________________________

1. Does the problem statement adequately apply to a solar industry issue or does it need modification?

2. Does the problem statement requirements list need to be modified?

3. Has the student made appropriate progress on the project? If not, what must be done?

4. Has the student appropriately applied the solar engineering and commercialization principles covered in the PSM SEEC program coursework?

5. Please list any additional feedback.
### Exit Criteria Checklist: Phase 1 Exploration

<table>
<thead>
<tr>
<th>Exit Criteria</th>
<th>Comments</th>
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<tbody>
<tr>
<td><strong>Done</strong></td>
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<tr>
<td>1. Project Notebook initiated</td>
<td></td>
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<tr>
<td>2. Worksheet 1: Solar Industry Career Questions completed</td>
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<tr>
<td>3. Worksheet 2: Literature Review completed.</td>
<td></td>
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<tr>
<td>5. Worksheet 4: Go-Forward Topics and Issues completed.</td>
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<tr>
<td>6. All time spent on Phase 1 entered into the time logbook sheet.</td>
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<tr>
<td>6. Notebook checked and approved by instructor</td>
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**Approved by**

Name and Title

Completion Date
<table>
<thead>
<tr>
<th>Exit Criteria</th>
<th>Comments</th>
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<tbody>
<tr>
<td>1. Progress Reports to the Advisors have been emailed to the advisors and are on file in the project notebook.</td>
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<tr>
<td>2. Minutes of meetings with the advisors have been filed in the project notebook.</td>
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<tr>
<td>3. Worksheet 5: Problem Statement Selection completed.</td>
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<tr>
<td>5. Worksheet 7: Enrollment of Advisors completed.</td>
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<tr>
<td>6. Worksheet 8: Plan for Preparing the Project Proposal completed.</td>
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<tr>
<td>7. Shark Tank slides have been reviewed with the advisors prior to the Shark Tank.</td>
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<tr>
<td>8. A slide presentation was made at the Shark Tank and the slides and Shark Tank feedback are in the project notebook.</td>
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<tr>
<td>9. All time spent on Phase 2 entered into the time logbook sheet.</td>
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<tr>
<td>10. Notebook checked and approved by instructor</td>
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Approved by

Name and Title

Completion Date
### Exist Criteria Checklist: Phase 3: Proposal Preparation

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<th>Done</th>
<th>Exit Criteria</th>
<th>Comments</th>
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<tr>
<td>1.</td>
<td>Progress Reports to the Advisors have been emailed to the advisors and are on file in the project notebook.</td>
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<tr>
<td>2.</td>
<td>Minutes of meetings with the advisors have been filed in the project notebook.</td>
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<td>3.</td>
<td>The Project Proposal has been approved by the advisors and the SEC 593 instructor.</td>
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<td>4.</td>
<td>The Project Proposal has been placed in the project notebook.</td>
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<td>5.</td>
<td>All time spent on Phase 3 entered into the time logbook sheet.</td>
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<td>6.</td>
<td>Notebook checked and approved by instructor</td>
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## Exit Criteria Checklist: Phase 4: Initial Work

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<td>1.</td>
<td>Progress Reports to the Advisors have been emailed to the advisors and are on file in the project notebook.</td>
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<tr>
<td>2.</td>
<td>Minutes of meetings with the advisors have been filed in the project notebook.</td>
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<td>3.</td>
<td>Work accomplished in this phase has been documented and filed in the project notebook.</td>
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<td>4.</td>
<td>Project Review No. 1 has been successfully completed.</td>
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<td>5.</td>
<td>The documents from Project Review No. 1 (presentation slides, advisor feedback forms, action item lists, etc.) are filed in the project notebook.</td>
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<td>6.</td>
<td>All time spent on Phase 4 has been entered into the time logbook sheet.</td>
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<td>8.</td>
<td>Notebook checked and approved by advisors</td>
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Approved by: ____________________________

Name and Title: ____________________________

Completion Date: ____________________________
Exit Criteria Checklist: Phase 5: Major Work

Name: ____________________________________________________

Date Started: _________________                    Date Completed: ________________________

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<td>1</td>
<td>1. Progress Reports to the Advisors have been emailed to the advisors and are on file in the project notebook.</td>
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<td>2</td>
<td>2. Minutes of meetings with the advisors have been filed in the project notebook.</td>
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<td>3</td>
<td>3. The student has scheduled their defense date by May 15.</td>
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<td>4</td>
<td>4. Work accomplished in this phase has been documented and filed in the project notebook.</td>
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<td>5</td>
<td>5. Project Review No. 2 has been successfully completed.</td>
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<td>6</td>
<td>6. The documents from Project Review No. 2 (presentation slides, advisor feedback forms, action item lists, etc.) are filed in the project notebook.</td>
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<td>7. All time spent on Phase 5 has been entered into the time logbook sheet.</td>
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<td>8. Notebook checked and approved by advisors</td>
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Approved by | Name and Title | Completion Date
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Exit Criteria Checklist: Phase 6: Final Work

Name: ____________________________________________________

Date Started: _________________                    Date Completed: ________________________

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<tr>
<td>2. Minutes of meetings with the advisors have been filed in the project notebook.</td>
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<tr>
<td>3. Work accomplished in this phase has been documented and filed in the project notebook.</td>
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<td>4. The draft project final report has been submitted to the advisors.</td>
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<td>5. The draft project final report has been edited for content by the advisors and approved as the draft.</td>
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<td>6. All time spent on Phase 6 has been entered into the time logbook sheet.</td>
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<td>8. Notebook checked and approved by advisors</td>
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Approved by Name and Title Completion Date
## Exit Criteria Checklist: Phase 7: Final Documentation

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<td>1. The project final report has been submitted to the advisors.</td>
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<td>2. The student has successfully presented the defense.</td>
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<td>3. All time spent on Phase 7 has been entered into the time logbook sheet.</td>
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<td>4. Notebook checked and approved by advisors</td>
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<td>5. Applied Project approval form has been signed by the advisors.</td>
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Approved by: ____________________________

Name and Title: ____________________________

Completion Date: ____________________________
Appendix C. Progress Reports to the Advisors

Introduction
Starting at the end of January, the student will submit a progress report to the advisors every two weeks. The purpose of the progress report is to keep the advisors up to date on the progress of the project. It is important to respect the advisors’ time. The progress report should be concise, yet complete. The report should be in the form of an email with the schedule and the labor actuals vs. budget chart attached.

Progress Report Email Format
- Descriptive Name of Project:
- Reporting Period:
- Progress During Reporting Period
  -
  -
  -
- Issues During the Reporting Period and Steps to Resolve Them
  -
  -
  -
- Requested Advisors Actions
  -
  -
  -
- Planned Work for the Next Reporting Period
- Updated Schedule and Labor Chart are attached to this email

Schedule Format
The schedule to be used is a PowerPoint slide that will be provided by the instructor during the Colloquium Applied Project Workshop.

Labor Chart Format
The labor chart to be used is an Excel worksheet that will be provided by the instructor during the Colloquium Applied Project Workshop.
Example Progress Report

Progress Report

- **Name of Project:** Stand-Alone Solar Power a Remote Industrial Park
- **Reporting Period:** February 1-15
- **Progress During Reporting Period**
  - Presented at Shark Tank and feedback incorporated into Project Plan
  - Project Plan draft 90 percent complete and will be sent to advisors by Feb. 20
- **Issues During the Reporting Period and Steps to Resolve Them**
  - Dr. X was unavailable for the scheduled interview on Feb. 10. It is rescheduled to Feb. 21. This will not impact the project schedule.
- **Requested Advisors Actions**
  - I will be sending the Project Plan draft on Feb. 20. Please review and provide me feedback by February 27.
- **Planned Work for the Next Reporting Period**
  - Complete Project Plan
  - Start Phase 4 earlier than planned.
- **Updated Schedule and Labor Chart are attached to this email**