Final Report

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Revision 5

Solar

1. **Problem statement and approach**

Solar worked on creating a model that would allow Sun Corp, a company that delivers high efficiency solar panels, evaluate their business and take the right business decisions in a market with increasing and decreasing electricity buying prices from the power grid. The model predicts the sales volume, the revenue, the net income, the hiring schedule and the personnel cost, the costs of goods sold, the operating, equipment and other costs at a given electricity purchase price.

The sales volume of Sun Corp depends heavily on electricity buying prices from the power grid that are very unpredictable which makes it difficult to plan for and to take the right business decisions, such as how many installation technicians and other personnel to hire, how many equipments to acquire, and how to manage the inventory scheduling and other logistics. Without having an approximate idea about these metrics, the company is making less profit as they spend more than they should on holding inventory or hiring either not enough or more than necessary installation technicians and other staff. In order to effectively invest in business and reach profit goals, the company is in need of a model that carefully observes the market demand and behavior and generates a business strategy for the following years.

Solar started by making some assumptions. The first assumption is that the energy consumption of a household is 8500 kilowatt-hour per year. Other assumptions made were that the production cost is constant and the system output increases every year with better technology available, making the purchase of solar system more attractive for buyers. Solar used the concept of opportunity cost to measure the market demand. Opportunity cost was calculated by the difference of annual cost of energy consumption of a household with and without the solar system, taking into account the annual system payments and solar system output. So the opportunity cost takes into account both the changing electricity purchase prices from the power grid and the improving system output.

The calculated market demand references the opportunity cost between the use of the traditional energy systems and the use of the solar energy system to calculate the percentage of the market that would purchase the solar systems. As the opportunity cost favors solar systems, the demand increases. With smaller opportunity costs, the less demand there is. Even with negative opportunity costs, Solar projects some demand for the solar systems since there are some residential customers who are off electricity grid and depend on solar energy, and there is also a population investing in the solar systems with environmental concerns and with knowledge that opportunity costs will increase as electricity purchase prices from the grid and as the system output increases. Based on the market demand and in reference to the projected market share of Sun Corp in an increasingly competitive environment where system outputs improve annually, Solar then calculated the sales volume. All outputs of the model revolve around consumers’ decision of buying the solar systems, which is based on the cost benefit analysis of purchasing the solar system. So the sales volume also is a good projection of the system output.

Solar believes Sun Corp will benefit highly from this model that predicts consumer behavior and provides sales volume projections under different electricity purchasing prices and that makes it possible for the company to take more efficient strategic business decisions. The model not only allows the users to predict the sales volume, the personnel, the operational and the inventory costs and to project revenue and net income but also provides an analysis of the role the solar system output performance plays in customers’ decision to purchase the solar system in comparison to the electricity purchasing prices. A cost benefit analysis of the system technology improvement can also be measured in future, based on the model Solar created.

1. **Descriptions of scenarios**

The scenario number one starts off with a buying price of electricity from the power grid of $.22 and demonstrates a trend of increasing buying price of electricity from the power grid over the next twelve years. The scenario number two also starts off with a buying price of electricity from the power grid of $.22 but demonstrates a trend of decreasing buying price of electricity from the power grid over the next twelve years. The other parameters are kept the same and the scenarios differ from each other only in the buying price of electricity value, and of course in values of all cells that depend on the buying price of electricity from the power grid.

Keeping the projected market share and projected system output the same, the two different scenarios help us achieve the goal of our model; to identify the customer behavior based on increasing and decreasing buying prices of electricity and to project sales volume in order to predict future hiring stream, purchase of new equipment, inventory control and the net income.

We also expected the two selected scenarios to demonstrate the difference in opportunity cost in decreasing and increasing electricity purchasing prices. The output system values are the same in both scenarios so the difference in the market demand observed in the two scenarios are due to the difference in buying price of electricity from the power grid.

We expected these two scenarios to provide us with better predictions on consumer behavior since we created the model so all outputs are revolved around the consumer behavior. The two scenarios help us observe whether the trend for market demand for solar systems change with increasing or decreasing buying price of electricity from the grid. They also help us predict whether it is worth investing in technology for better system output in a market of decreasing electricity purchase price, by demonstrating us the opportunity cost change in two different scenarios that use the same values for system output.

1. **Conclusions of the study**

Comparing the results of the two scenarios, we learned that the trend for market demand is identical in the first six years with both increasing and decreasing buying prices of electricity from the power grid. Based on the assumptions that Solar made and the projected market share of Sun Corp, we observed that the advancements in the technology that lead to improved system output annually actually offset the decreasing electricity purchasing price which we thought could have decreased the demand. This interesting finding suggests investment in improving system output pays off in both decreasing and increasing electricity purchasing prices from the power grid. However, when we look at the effect of decreasing electricity purchase price on a longer term we see that, specifically for the years ten, eleven and twelve, the market demand for solar systems is drastically different under each scenario. The tenth year under the first scenario predicts a sales volume of 37,500 units per year compared to the 1,875 units per year predicted under the second scenario. On the contrary of the big increase in sales volume from 2,750 in year nine to 37,500 in year ten observed in the scenario one, scenario two demonstrates an increase in sales volume from only 1,650 to 1,875 for the same year. This difference poses different challenges for a solar system company in making the right business decisions. In scenario one, we are looking at a big expansion of services, staff and equipment that requires different planning than the second scenario does for the same company.

The total personnel cost remains the same over the twelve years for the company under the second scenario, whereas the company under the first scenario goes from an annual personnel expense of $730,000 to $4,310,000 from year nine to ten. The cost of goods sold is as well very different in the two scenarios from year nine on. The scenario one predicts the costs of goods sold as $44,004,450 in year nine compared to $26,403,487 predicted for the same year by scenario two.

The net income remains the same for the first six years in both scenarios. Scenario one projects a net income of $4,482,319 compared to $2,503,658 of scenario two in year seven. From year nine on however, the net income is even more different for the two scenarios. For the year twelve we observe a net income of $57,416,772 in scenario one compared to a net income of $2,504,017 of scenario two for the same year.

Both scenarios show similar trends in the sense that the market demand gradually increases over the first six years, and it decreases from year nine on. However the major difference between the two scenarios is how much the increase is in market demand after the ninth year. Scenario one, with the increasing electricity purchasing price over time demonstrates that market demand for solar systems increases from 12,500 units per year to 150,000 from year nine to year ten. There is however no change in the market demand for solar systems from year nine to year ten in the second scenario.

Although scenario two does not project as high of a net income as scenario one, it still projects positive net income value that seems to be due to the fact that the opportunity cost of acquiring the solar system continues to favor the system due to the advancements in technology that provides increasing system output performance annually.

1. **Budget and schedule performance**

The actual budget and schedule were much different than the initially planned budget and schedule. The difference is due to team dynamics and team management problems we encountered that will be discussed in the later sections of this paper. Our initial team consisted of four members. We, as a team of four, failed to deliver the scheduled milestones on their initial planned dates that some of the group members obeyed while some did not. This created a big problem as it not only delayed the group’s scheduled milestones but also created more work and required rescheduling of all tasks and redistribution of the roles.

In comparing the budget and schedule projections to the actual budget and schedule, we must do so in two steps; one for the earlier stages of the group work when the group consisted of four members, and the second after the group split in groups of two for the remaining of the project.

For the earlier stages, the group was not able to meet the scheduled milestones on deadlines set by group members themselves. This led to delays in all other stages of the scheduled tasks. Initially, each team member was expected to contribute five hours of brainstorming and planning for how to address the business needs of Sun Corp. The group members ended up spending long hours each on this phase, however, the discussions were not always concentrated in addressing the business needs of Sun Corp but a lot of discussion also took place about what we as a team were expected to deliver in this class, and what were the possible methods we could use to meet these requirements and meet our objectives. In reality, maybe more time was spent on trying to reach consensus on what is expected and how to go about it, rather than the actual planning for the project and its required components.

Also, after long planning discussion sessions, and having reached some sort of a consensus among the team members, the next time the team would meet to finish the planning task, we would find ourselves again discussing almost the same things we discussed in our previous planning session over and over again, and try to reach consensus again. So in reality, the team did spend the time we projected we would have spent on the first task, planning, however because it was not done in an effective and efficient way, it was more of “discussing” a lot of the same things over and over again, going in circles rather than actual “planning” that would have served towards the project. In the end, the team members realized we have spent enough time on this phase, and let one of us take the lead in concluding the planning phase and in providing us with an idea of how to move to the next steps.

Modeling, documents and execution milestones were completed after the team split into groups of two. This required rescheduling of all milestones, so the initially scheduled budget and schedule were no longer in effect. This significantly changed the total hours we also initially planned on spending on each task, since we now had two team members instead of four to take on the tasks that were initially designed for a team of four. This required much more effort than initially planned for each task. However, it also made it possible to record progress and to produce deliverables on time more efficiently, except at times when we faced unexpected problems and delays due to technical problems we faced at times with the use of technology.

The modeling was originally scheduled for twenty four hours. Although we began discussing this stage when our team was still a four member team, it was still in its earlier phases and required a lot of work. It was not until the group split in groups of two that be actually began working on the model. Generating the model took about as much time for the two member group as we initially planned it for the four member team but we spent more time playing with it and observing changes and updating it regularly as we saw fit. In a way, because the model we created was so dynamic and fun to play with to make different observations, we never set an official end or completion time to it. We created it, it was complete within our scheduled budget, but more or less out of curiosity, we put more time in it than we intended to.

Documents were originally scheduled to take thirty eight hours and included production of midpoint status report, final report, reference guide and user guide. When we were a team of four, we expected the hours per document to be as follows: midpoint status report: 2 hours, final report: 16 hours, reference and user guides: 20 hours. As a team of two, we rescheduled the tasks and set short term goals instead of long term ones. Instead of dividing the tasks by how many hours we expect we will spend on each, we set short term deadlines and monitored progress and adjusted our delivery schedules accordingly. This provided a very realistic time table for completion of tasks. For example, instead of declaring “we will spend 20 hours on reference and user guides” and “we will complete all of them by X date”, we said “we will get together and work on this document or task for three hours, record our progress and see how much time we actually will need to complete it”. This allowed flexibility in adjusting our schedules as necessary while allowing us to focus on real problem areas instead of trying to finish up documents under certain hours or work. As we worked together towards reaching smaller goals we set, we also identified each other’s strengths and preferences that helped us move more efficiently. Also, as we ran into problems, we took a note of them and continued our scheduled work and at the end we divided the list of required ‘touch ups’ in between us, based on our strengths and preferences again. This method, in comparison to the initial scheduling with larger tasks and longer deadlines, proved to be a more efficient one. It also created more accountability that will be discussed in the later section of this report.

The execution was originally scheduled for a total of eight hours when we were a team of four and included exploring the two scenarios and making observations on the behavior that provides recommendation strategies. As a team of two, when we created the model, as discussed earlier, we continued playing with it by changing our parameters to make several different observations. In reality we spent a lot of time discussing the results and the projections of our model and of our scenarios even when we were working on other scheduled tasks. This allowed us to have a better sense of how the model actually works and how one can manipulate some of its values to observe different behavior.

As a group of two, each member of the group naturally spent a lot more time than we initially planned for when we were a group of four. However, milestones that we could not accomplish by the deadlines when we were a group of four were accomplished timely when we were a group of two because it was easier to manage the group and the group dynamics and talent in a smaller group. So it is fair to say we each did more work than the one planned in the originally scheduled budget, but we also managed to meet the scheduled (rather, the re-scheduled after the group split) deadlines more timely and efficiently.

1. **Lessons learned**

The main challenge we had while working towards reaching the goals of this study was to work together as a team of four and to produce the scheduled milestones on time and in a work quality all four of us agreed to. Our group ended up so dysfunctional that we considered and pursued the option of breaking the group in two, despite the fact that this meant at least twice more work than originally planned for each member and in a much smaller timeframe. There are a lot of lessons learned from this experience as we think back and reflect on the problems and their possible root causes, in an effort to more effectively and productively deal with similar situations in future. First let us address the different aspects of the project effort and move on to our lessons learned.

**The choice of problem:** The choice of problem was introduced by a group member who no longer was in our group when we started actually working on the project (as a team of two). The problem presented an interesting opportunity to explore and we are glad to have worked on it. One thing that could be done differently if we were doing the project again in a larger group could be to choose a problem all group members could be on the same page with while discussing its possible solutions. It is almost always fruitful to have different opinions in a group, but it may make it more difficult to advance at the required pace to meet deadlines if all members of the group are not comfortably engaged in discussions about the problem and able to reach a consensus due to their different backgrounds. Although this could be handled by better group management, it still may be of importance to reconsider choice of problem to ensure all group members are equally interested in and or able to work comfortably with the topic in order to work more efficiently.

**The design**: We are very much satisfied with the design of our model. It would have been very interesting to make our model a little more complex, introduce other parameters and analyze consumer behavior under different scenarios, however, for the purposes of this course we had to keep it as simple as possible and not to exceed the maximum requirements for the documents. If we were to do this project over again without time and size limitations, we would be very curious to introduce some other parameters we discussed and to observe the demand behavior and the sales projections again. One thing we wish we have done differently has to do with the use of defining local names function. We did not have a system of documenting the names we used in the model which made it very difficult for us to go back and identify the undefined names and not accidently delete some of the defined names. If we were to do the same project over again, we would have worked on developing better documenting systems, not just for the recording of names but for the overall project. This would allow us to work more efficiently in providing a “clean” model.

**Use of technology:** The team, whether when it was a team of four or a team of two, made the best use of technology in communicating and in producing the required tasks. A lesson learned is to use every possible technological means of communication and collaboration available as it proved to be very successful in our case. Our team used every available tool to collaborate, from Skype to Google Documents and made a lot of progress using a very systematic recording system of progress.

**Budget and schedule performance:** As discussed earlier in this report, our group was split in two very late in the semester, with not much milestones accomplished up at that time. This led to rescheduling of performance and budget in order to divide the work of a group of four into work for a group of two. When we split the group we also developed this “working on smaller tasks with more frequent deadlines” method which worked very well. If we were to do the project over again, we would definitely start by setting micro goals and sub groups in the group to tackle each micro goal. This not only allows better projection for completion dates but also creates more accountability. If we were to do the project over again, in a large group, we would divide the workload not only according to the deadlines but also according to group members’ skills, strengths, weaknesses and preferences.

**Organization and management:** The underlying problem in our original group’s not meeting delivery schedules timely is the lack of organization and proper team management. We believe majority of the problems we faced as a group resulted from poor group and talent management.

If we were to do the project again, in a group of four, we would first start by assigning a coordinator. This would have saved our initial group a lot of time as it would have not only guided the group but would also prevent us from going over and over same discussions and not very productive meetings again. We would not only assign a coordinator, but we would also make a better effort in realizing all group member’s strengths and weaknesses before assigning parts of the project to group members and expect everyone to deliver the same quality of work at the same time. Each group member’s interest, individual goal both from completing the class and the model should be discussed openly at the first meeting. This would allow better assignment of roles and responsibilities and would provide more accountability.

Another thing we would have done differently would be ‘to act sooner’. It seemed clear that our initial group had an issue that kept it from delivering good quality of work on time. Instead of addressing the problem sooner, we waited until an important deadline set by our group members when it was already too late to try to solve the group dynamics problem and still make it on time with class requirements and deadlines. At that point we did not have a choice but to break a dysfunctional group of four into groups of two and to start working on the deliverables. If we assigned a group coordinator at the beginning, and if all group members were on the same page with deadlines and required deliveries, may be this problem could have been avoided.

Another thing we could have done differently is, instead of spending many hours and meetings verbally discussing the model and its prospective projections before beginning the project, we could have started directly by creating a very simple and small model to help us visualize the problem and its possible solutions. This would have allowed us to plot different parameters and observe their effects on the outputs and better prepare us to create a model, than verbally discussing the options did. Brainstorming was a very important step along the way, however, we could not tell which road to take until we ‘got our hands dirty’ and actually started doing the model.

In sum, if we were to redo the project with a group of a larger than three again, we would first start by identifying each member’s individual goals and interests. We would then move to selecting a coordinator to manage the team and to identify each team members’ strengths and weaknesses, as well as preferences of work. We would better organize the team work to allow more flexibility and accountability, and to make it possible to record progress and act timely when problems arise. We would set micro goals instead of large tasks and we would make sure to communicate prior big deadlines and as problems arise.