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Solar PANEL model

Business Proposal for GSDP Group 4

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# Executive Summary

Total energy consumption in the UK decreased by 1.4 million tonnes of oil equivalent (Mtoe) (or 1.0 per cent) between 2018 and 2019 to 142.0 mtoe (Department for Business, Energy and Industrial Strategy, 2020). This is because of the UK Government's efforts to replace existing household electricity energy sources with cleaner and sustainable energy sources. These efforts include the adoption of various legally binding targets for emissions reduction and increasing the percentage contribution of renewable energy sources to the country’s energy consumption (Raybould et al, 2020), with incentives to meet these targets such as increasing tax on traditional energy sources, introducing new taxes on emissions, while offering tax rebates for renewable energy technology. This has been necessitated by the clear and present danger of climate change. Fossil fuels have provided the primary source for powering homes in the UK. The current scientific consensus is that this energy source is unsustainable and deadly for the environment, with well-founded fears of global warming and climate change, Solar power provides a viable alternative to meet both energy demands and environmental sustainability.

With oil prices rising to pre-pandemic levels, the threat of climate change and the government's policy direction on renewable energy, the case for the adoption of solar power energy generation has never been stronger. Solar power energy helps to reduce waste, decrease reliance on fossil fuels and aid the achievement of environmental sustainability goals. Therefore, this proposal puts forward a SOLAR POWER MODEL web application that aims to reduce the total cost of ownership of a solar panel system for a homeowner. This is done by providing the user with an interface to monitor and control the solar panel system, including the ability to adjust various variables that correlate to the user’s requirements in a system and output the best configuration of panels and batteries for that user.

# Business Case

## Problem Statement

The client has requested a web application that can simulate a working model of their solar system (Figure 3.1) which they plan to install at residential locations. This simulation – done over 24 hours and at the two solstices – should determine if the system can constantly power a house it is installed in. The solar panel system consists of a solar panel for electricity generation, a battery and a battery charge module (BCM), a power distribution module (PCM), and a baseload representing end-users electronics. Some parameters of the model’s calculations being simulated should be alterable by the user to reflect their needs. These parameters include type of solar panel (with the client offering two options, with differing efficiencies and costs, with a view to including a third option), location, size and elevation angle of roof available for solar panel installation. Other parameters to be considered include the angle of elevation of the sun, battery charge level, PCM and BCM efficiency.

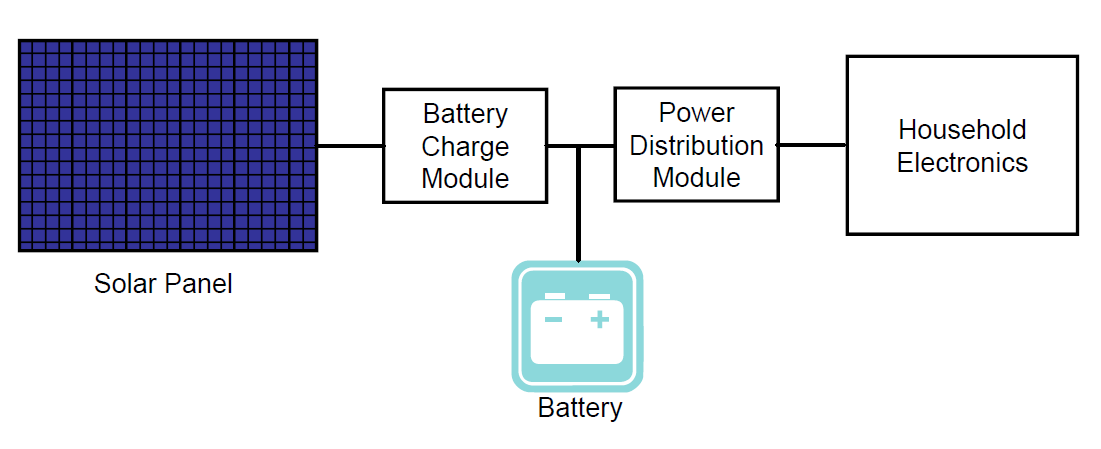


Figure Block diagram of the client's Solar Panel System

In a secondary scope which shall only be considered upon completion of the initial scope, the client is also seeking to upgrade its solar system with the addition of an onboard computer and telecommunications module for increased monitoring, control and telemetry data collection as shown in Figure 2. These upgrades include a data network, an onboard computer, low and high rate transmitters and receivers.

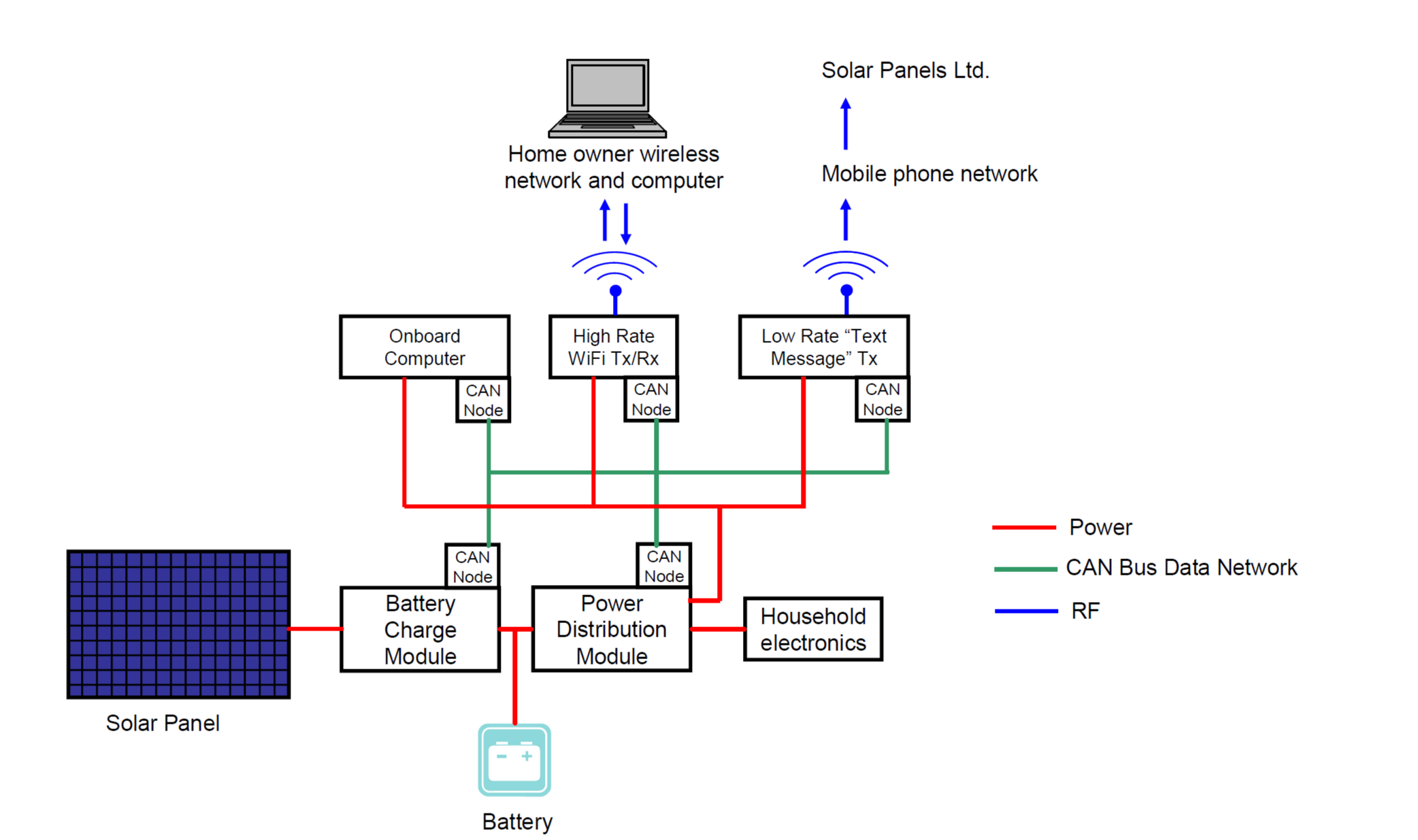


Figure Upgraded panel system with computing and communications modules

## Background

The client, Surrey Satellite Technology Co., Ltd. (SSTL) is a company engaged in the manufacture and operation of small satellites. As a spin-off company of the University of Surrey, it is currently wholly owned by Space. Surrey Satellite Technology Co., Ltd. (SSTL) is at the forefront of space innovation, providing complete and customizable mission solutions for Earth observation, science, communications, navigation, on-orbit debris removal, and services and exploration beyond the Earth’s infrastructure. SSTL was established in 1985, after successfully trying to use commercial off-the-shelf (COTS) components on the satellite, it was accumulated on the UoSat-1 test satellite. It provides funding for research projects at the University's Surrey Space Center, which researches satellites and space topics.” In 1998, he won the Queen's Science and Technology Achievement Award, and in 2005, he won the Queen's Enterprise Award. In 2006, he won the Times Higher Education Innovation and Technology Outstanding Contribution Award” In 2009, SSTL ranked 89th among 997 companies participating in the "Sunday Times" Top 100 Companies. In 2020, SSTL will begin manufacturing telecommunications spacecraft for lunar missions. It will be completed in 2024 and will be used to transmit data to the earth (Alchetron, n.d).

## The current Analysis

Renewable energy systems offer a considerable advantage over conventional energy systems in terms of global ecology, economic, and politics. By 2050, renewable energy sources are expected to cater for about three-fifths of the global power market and two-fifths of the global gasoline market. Furthermore, transitioning to a renewable energy economy will have major environmental and other benefits that cannot be measured in economic terms.

Because of efficient energy use and widespread adoption of renewable energy, it is estimated that global carbon dioxide (CO2) emissions will be decreased to 75% of their 1985 levels by 2050. Over the generation of electricity, solar renewable energy systems are more environmentally beneficial than traditional energy sources. The benefits of solar energy systems are divided into two categories: ecological and socioeconomic concerns. From an environmental standpoint, solar energy systems have several advantages, including reduced greenhouse gas emissions (CO2, NO2) and toxic gas emissions (SO2, particulates), prevention of soil pollution, lower transmission costs, and improved water resource quality.

Mainly quantity of power produced by PV systems and the quantity that currently used is dependent on both the amount of solar radiation incident on the solar panels and the current and voltage characteristics of the load. (*Ikedi,2021).* Gallium arsenide a compound semiconductor is one of these materials. silicon cells are not much priced in the modern industry but PV cells are the most expensive cells in the world market because of that no one cares about the price only cares about the efficiency. They can endure high temperatures and are employed in concentrating PV systems and applications that require extremely high efficiency.

They can endure high temperatures and are employed in concentrating PV systems and applications that require extremely high efficiency at any cost, including space operations. In the UK, both systems have a relatively slow electrical response to sunrise, with fixed PV systems performing similarly to tracking PV systems at noon. (Ikedi, 2021*)*

The efficiency in solar electric system is not a basic one that mainly depends on the materials that we used in the current market, but it depends on the type of application that it is used for. Apart from the silicon. There are so many other materials that use for the compound. They reduce or conduct the temperature. It is essential silicon cells in solar panels get 0.5v of output and the collection of that number of cells meets specific requirements. They are electrically interconnected with each other cells furthermore in an electrical combination more solar panels generate more energy than is required mostly. Those are currently named as PV arrays in the system.

### Benefits of Solar Panel Technology

Minimal maintenance and operational cost

The low operational and maintenance expenses are perhaps the most compelling — and well-documented — case for using solar power systems. Solar power systems are characterized by the low cost of operation and minimal maintenance costs. Typically, solar panels require an annual inspection and cleaning, which can be achieved for a nominal fee, as a result, solar panels require essentially zero maintenance throughout the year.

Reduced Energy Costs

The primary advantage of installing solar panels for household electrification is that they can produce electricity automatically and with no variable costs, resulting in significant savings on your monthly electricity bills. Relative to the amount of electricity consumed by the household on an annual basis, a solar power system could perhaps decrease your energy costs to zero.

Get more hot water in winter

Hot water requires a lot of energy. More than 40% of the water we use is hot. If they choose an energy-saving solution, you will save a lot of money in the long run. Why is there no solar energy, especially cold water from solar panels in winter? Solar hot water can meet 75% of the demand for fresh sanitary hot water. With solar energy, we no longer have to worry about turning on the water heater and worry about monthly fees.

Environmentally friendly

The Climate Agreement pledged each member state to a specific renewable energy goal and a detailed reduction in carbon emissions, ushering in potentially widespread government regulations. With changing attitudes toward clean energy and increased calls to reduce dependence on fossil fuels, solar power systems present an eco-friendly alternative for renewable energy.

## Existing Solutions

Most literature on this topic is concerned with the economic aspects of solar panel technology i.e. cost savings. Arun et al. (2009) and Askari et al. (2009) considered various PV systems and battery storage sizes and their effects on the cost of electricity generated, however they failed to specify the solar technology involved. Others such as Braun et al. (2009) focused on the battery technology used and how it also affects costs, narrowing the focus to lithium-ion battery technology. However, none of these solutions considered a user-centric approach with the user inputting the system parameters that reflect their realities. This is the market gap our solution aims to cater for.

# Risk Analysis

## Risk Identification And Analysis

This section contains the risk analysis of the project to be undertaken (Solar Panel Technology Development) which comprises the risk, risk type, description of the risk, probability of its occurrence and the mitigation strategy to overcome those risks.

## Methodology

The risks were identified based on the nature of work to be done, the cost to be incurred in executing the work, the health implications in installing such software and the timing of the project.

An interview was also conducted with team members and customers and the following risk were identify

1. Environmental risk (Application, Health and Safety)
2. Financial risk
3. Technology risk
4. Human recourse
5. Time risk
6. Communication risk

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| --- | --- | --- | --- | --- | --- |
| Risk | Risk type | Description | Probability | Rationale | Mitigation strategy |
| Application  Health and Safety | Project  Project | Future laws against that solar panel to be used.  Health and safety issues on employees and other stakeholders | Low  Medium | Laws on this solar panel are unlikely to be changed soon.  The operating system to be used might not be friendly for stakeholder at the beginning. | Have Constant review of software when necessary.  Getting adequate logistics for stakeholders to enable the system to be friendly for its usage. |
| Financial | Business  Process | Inadequate working capital.  Frequent Prices of material instability (inflation) | Medium  Low | The availability of funds to continue the project till the end.  Prices are stable in the jurisdiction of the operation of the project. | Company retaining part of the profit of unforeseen activities for the project.  Having periodic review on price level determinant. |
| Technology | Product | The technology to be used having multiply users or joint ownership | Medium | Conflict among partners to affect the project. | Ensuring clauses in contracts do not affect the project during conflict resolution and timing. |
| Human resources | Business | Having the needed skill set of employees to execute the work | Low | The company has all the skills set staffing to execute the project. | Regular training to maintain the qualified staff. |
| Time | Project  Process | Failure to execute the project within schedule.  Non-extension of the project deadline | High  High | Having a timetable/project management schedule plan for the project enabling the team to follow the execution of the project. | Putting in place quality mechanism to monitor schedule  Putting in place strategy to work with time given |
| Communication | Process | Failure to communicate project plan/schedule to the project team | Low | The project plan is likely to be communicated to the project team | Constant communication of project plans to team and involve teams in all planned activities on the project. |

## Risk planning and the strategy used to control

|  |  |
| --- | --- |
| **Risk** | **Strategy** |
| Application risk  Health and safety | Have Constant review of software when necessary.  Getting adequate logistics for stakeholders to enable the system to be user friendly.  ( Gipe 1995) |
| Financial | Company retaining part of the profit of unforeseen activities for the project.  Having periodic review on price level determinant.  (Bansal R. K, 2002) |
| Technology | Ensuring clauses in contracts do not affect the project during conflict resolution and timing. (Lippert M & Rock, S 2006) |
| Human resources | Regular training to maintain the qualified staff. (Kurth 2007) |
| Time | Putting in place quality mechanism to monitor schedule |
| Communication | Constant communication of project plans to team and involve teams in all planned activities on the project.  Ahmed, H. *et al.* (2012) |

# Project Scope

The aim of the project is the design and implementation of a 24-hour solar panel generation and distribution system. The scope shall define the expected outcome and deliverables, including the processes leading to these.

## Within Scope

* Develop a web application to simulate a model of a solar panel system consisting of the following:
  + Solar panel
  + Battery
  + Battery Charge Module (BCM)
  + Power Distribution Module (PDM)
  + Baseload
* The web application shall include a graphical user interface GUI to represent the user appliances and show the power draw of each
* The system shall simulate power generated by the solar panels to the base loads which consists of the user’s household electronics and charge the battery which in turn supplies power to the baseload when the panels cannot generate power.
* A model of the system based on demonstrable solar and electricity calculations. This model shall allow for end-user inputs for calculation parameters through the web application based on user requirements and shall produce results in a user-friendly format such as graphs and tables.
* The system is to be modelled over 24 hours and shall take into context solar elevation angle leading to variations in solar intensity and therefore power generated as the sun rises and sets. This includes periods of no power generation corresponding to night-time where the system runs on battery. The model is to be done over two instances corresponding to the summer and winter solstices respectively.
* Decide if the user system configuration can provide power over 24 hours in both summer and winter.
* Define upper and lower power limits of the solar panel system.

## Outside Scope

* Develop hardware solution.
* Connect web application to hardware system.

# Requirements Engineering

This section details the services provided by the proposed solution, and constraints on operations. The requirements reflect the needs of the customer as contained in the project documentation and elicited from the client during the meeting with the client as detailed in Appendix C.

These requirements are the team's initial assessment of what would be needed to satisfy the client's problems. Further updates to requirements are to be expected during the development phase of the project as the realities become clearer.

## Functional Requirements

### User Requirements

1. Maximum power generated by the solar panel under any conditions must be less than 2000 W
2. The power generated should be less than 60 pence per Watt, evaluated at noon on each day of the year.
3. The system should sustain constant power discharge of 300W of household electronics in both summer and winter
4. A limiter to prevent the battery from dropping below 25% of its total capacity to extend battery life

### System Requirements

1. Monitor, display and control energy production and consumption levels in line with the client's requirements.
2. Calculate the energy output of solar panels during the winter and summer solstices.
3. Accept user input for variables in the solar panel model calculations
4. Produce user-friendly output for calculations based on user input.
5. Enable upper and lower bounds for energy generation.
6. Enable lower bounds for battery discharge level.
7. Cost monitoring to ensure costs within clients specification.

## Non-Functional Requirements

**Optimum Performance**

Firstly, optimum performance is also another type of non-functional requirements that stipulates that all systems should be developed with a minimum acceptable standard of performance as some minimum criteria. Performance can be affected by poor storing procedures and high-load third-party services hence important to focus on these areas when looking to achieve a consistent optimum level of performance with a system.

**Compatibility with existing hardware**

Secondly, for a system to work effectively and efficiently, it must be compatible with other systems of operation. The hardware, operating system and their versions including the browsers on which the system runs on must be compatible and not in conflict with any other compatible system within the environment

**Usable**

This requires that the solution developed be intuitive and user-friendly, not requiring any specialist knowledge or techniques to operate. This serves the clients goal of increasing the adoption of solution and this can be aided by as little learning curve required as possible.

**Improve Scalability of Solution**

Scalability on the other hand looks at how accommodative can the system to be developed takes large volumes of data over time. It must also include resistance, which is the means to scale up and down rapidly or speedily as required by any system. This is even made easier to be achieved because of modern technology such as cloud-based solutions with the needed auto-scale system according to their requirements.

**Reliability OF power supply**

Reliability as a requirement of NFR describes that the system must be reliable and available for it to be used as much as possible. This is important to minimize the interruption in the development of the software.

**Increased ease of Maintainability**

In maintainability, the system to be put in place or deployed must be able to be maintained with regards to its cost over its expected lifetime. The system maintainability should also be able to have added values to be able to incorporate, configure and extend its usage maintaining it.

## Use Cases

### Use Case Diagram

**Use Case diagram**

Customer

Administrator

<< include >>

<< include >>

<< extend >>

<< include >>

<< include >>

<< include >>

<< include >>

<< extend >>

<< include >>

|  |  |  |
| --- | --- | --- |
| Use Case | |  |
| **Name** | Monitor, display and control energy production and consumption levels in line with the client's requirements. | |
| **Actor** | customer | |
| **Description** | The application provides a user interface for interaction with the web application. This interface should display to the user,   * The quantity of energy generated from the solar panels * Amount of energy consumed by household electronics * Battery charge level * Indicate whether the system can power the user's electronics over 24 hours | |
| **Normal Course** | 1. User accesses the web application 2. User Logs on to the web application to view the data from their particular installation 3. The system displays power generation and consumption data in a user-friendly and intuitive format | |
| **Alternate Course** | 1. The user inputs their consumption data, i.e power their appliances currently consume, chooses solar panel option along with roof area available for installation and other configuration options. 2. The application takes this data and simulates a working model of the solar panel system with the user's specification and defined in the above step 3. The application displays the results of this simulation in a user-friendly and easily understandable format such as graphs and charts. 4. The application also determines if the set-up can power the user’s house over 24 hours in both the summer and winter solstice. | |
| **Pre-Conditions** | Configuration options must fall within the user’s budget. | |
| **Post-Conditions** |  | |
| **Assumptions** | * Constant power draw during simulation * No obstruction of sunlight during daytime | |

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| --- | --- | --- |
| Use Case | |  |
| **Name** | Model calculation for the solar panel | |
| **Actor** | Customer | |
| **Description** | The application accepts user input as variables used for the model calculation of the solar power generation. | |
| **Normal Course** | 1. User inputs resourceful variables for household power. 2. User inputs values for battery capacity. 3. User inputs value for battery voltage | |
| **Alternate Course** |  | |
| **Pre-Conditions** | User has usefully conducted output for calculations based | |
| **Post-Conditions** | All parameters composed from the user are reserved for a period of the session and stored in the database upon session expiry | |
| **Assumptions** |  | |

|  |  |  |
| --- | --- | --- |
| Use Case | |  |
| **Name** | calculate the energy output of solar panels during the winter and summer. | |
| **Actor** | customer | |
| **Description** | The user inputs values to determine the optimal power generation and capabilities of a solar panel solution in the summer and winter and also user inputs a series of values to determine the Constant Base Load of Power over a day in the summer and winter. | |
| **Normal Course** | 1. User inputs solar panel efficiency between 0 and 1. 2. User inputs value for battery capacity (BattCap). 3. User inputs value for battery voltage (Battvolt). 4. User inputs value for household power consumption (PHouse) 5. User inputs cost of panels (£ / m2). 6. The system calculates and displays optimal power generated at the summer and winter solstices. | |
| **Alternate Course** | * 1. If the user inputs a value that does not meet all of the following criteria the system will show a related message and prompt that calculation cannot be made:      + Decimal.      + 0 ≤ value ≤ 1. | |
| **Pre-Conditions** | The location has been configured for min/max sun elevation (ESun) and Power of sunlight (PSun) | |
| **Post-Conditions** | All parameters collected from the user are kept for the duration of the session. | |
| **Assumptions** | * Maximum roof area set arbitrarily at less than 10000m2. * Valid angles for roof elevation do not include negative values. | |

|  |  |  |
| --- | --- | --- |
| Use Case | |  |
| **Name** | Produce user friendly output for calculations based on user input | |
| **Actor** | Customer | |
| **Description** | This provides users with a calculation of how much power is needed, taking into account the low efficiency of various sub-components. | |
| **Normal Course** | 1. The system calculates and displays the best (cheapest) power possible during the summer and winter solstices. 2. User inputs value for BCM efficiency (BCMeff) 3. User inputs value for PDM efficiency (PDMeff). 4. User inputs value for battery capacity (BattCap). 5. User inputs value for battery voltage (Battvolt). 6. User inputs value for household power consumption (PHouse) | |
| **Alternate Course** | 1.1. If the value entered by the user does not meet all the following conditions, the system will display relevant information and prompt that calculation cannot be performed:  • Decimal.  • 0.00 ≤ value <10000  • Limited to 2 decimal places. | |
| **Pre-Conditions** | • The user has successfully proceeded the calculate energy output. | |
| **Post-Conditions** | * Keep all parameters collected from the user during the session. | |
| **Assumptions** | * The maximum price of solar panels per square meter is arbitrarily set at £9999.99. * The effective angle of the roof elevation does not include negative values. | |

|  |  |
| --- | --- |
| Use Case | **Reference:**  UC-04 |
| **Name** | View Cost Calculations |
| **Actor** | Customer |
| **Description** | the cost of panels based on m^2  Cost= £/m^2 (100 of panels)  The instalment cost  Mtotal= A\*M  The cost of power produces based on roof location and technology of panel  F=Mtotal\*panel/total power  For example,  Midwinter (min power)   |  | | --- | | F=7\*100/900  £0.78 per Watt |   Mid summer (max Power)   |  | | --- | | F=7\*100/1395  £0.50 per Watt | |
| **Normal Course** |  |
| **Alternate Course** |  |
| **Pre-Conditions** | * Efficiency is the around 0.2 * Successfully conducted by client |
| **Post-Conditions** |  |
| **Assumptions** |  |

# Outline Solution

## Recommended Approach

As per the clients request contained in the project documentation, an Enterprise System Approach would be adopted to the development of the solution in order to enable the client better understand the potential and capabilities of enterprise technology solutions.

This approach would be better understood by breaking down the concepts. An enterprise is an entity comprised of interdependent resources (e.g., people, processes, organizations, technology, funding) that interact with each other (to, e.g., coordinate functions, share information, allocate funding) and their environment to achieve their defined goal (Rebovich, 2005). Abstracting this concept to the process of software development would mean taking into consideration, achieving the higher goals of the enterprise in addition to meeting the specification for the software. This involves understanding the goals of the client as an entity and how it interweaves with their stated specifications and requirements for the software that is to be developed. This ensures that the software not only serves the immediate goals of the clients but also its wider goals. These wider goals contribute to the non-functional requirements of the software as discussed, and failure to meet these non-functional requirements could lead to the software being unusable (Sommerville, 2016).

## Management style

An Agile Project Management (APM) methodology has been adopted as the management style of the project for the following reasons

* Speed. Due to the time constraints of the project, APM is the obvious choice as agile methods are designed to produce software quickly (Sommerville, 2016).
* Increased likelihood of customer satisfaction as the client is involved in the development process as this is part of the agile manifesto (Beck et al, 2001).
* The size of the team is more suited for APM as agile works better with smaller teams (Conforto et al, 2014).

However, due to the amount of documentation expected as deliverables, we would be applying some aspects of the Waterfall PM, especially at the beginning of the project (planning phase) to satisfy all requirements.

Also, the lack of team members experience with APM could prove to be a significant but not insurmountable challenge in the adoption of APM. This is further explored in the Risk Analysis section

## Proposed Solution

Our solution is to develop a web-based application to manage and collect data of energy with the consumption of the solar panel system model. The web application shall include a graphical user interface GUI to represent the user appliances and show the power draw of each. The system shall supply power generated by the solar panels to the base loads which consists of the user’s household electronics and charge the battery which in turn supplies power to the baseload when the panels cannot generate power.

After connecting the web application to the hardware system. Homeowners will able to manage the solar panel. This includes periods of no power generation corresponding to night-time where the system runs on battery. The model is to be done over two instances corresponding to the summer and winter solstices respectively so that our system contains a cost monitoring system to ensure the expenses that the homeowner will get within his specification.

Base on available mathematical calculations and using the other considerations which help get the idea of the most efficient power consumption and distribution strategy.

We have to verify that the customer requirements can be met with the specified panel technology using the following calculations:

PPanel  = CSpeff × PSun × ARoof × sin(ESunRoof)

= (0.15 X 1000W X 10m^2 X sin⁡(40^o+60^o))/m^2 = 1477 Watts

The customer requirement Cust-010 says that the maximum power generated by the solar panel must be less than 2000 watts. Option #2 generates 1477 Watts.

The customer requirement Cust-020 says that the cost of the solar panel per unit of power it generates in Watt should be less than 60p/W. Option #2 has a cost of 58 pence per Watt of power generated as shown below.

F£/W = MTotal/PPanel ; MTotal = ARoof x 〖 M〗\_Spcpa

MTotal = (〖10m〗^(2 ) X £85)/m^2 = £850

F£/W = (£850 )/(1477 Watts) = £0.58/W or 58p/W

From the above calculations, we can also confirm that Option #2 is feasible for implementation as it meets customer requirements Cust-010 and Cust-020. In the next section, we will discuss our recommended option for implementation.

This generated power should be calculated to make sure that it meets the customer’s expectation. The maximum power generated should be less than 2000 W.

The factors affecting the calculation of the maximum power generated are the power of the sunlight per square meter, the solar panel efficiency. The equation to calculate total power generated (PPanel) in Watts is:

* C: solar power efficiency as described in the documents
* A: roof area available in m2.
* ESunRoof: elevation angle of the sun on the solar panel.

The customer wants to know that the can system keeps the house fully powered throughout 24h time in summer and winter. The calculation to know whether the system can supply that much power for the household electronics depends on the knowledge of the power output of the battery.

To Calculate the constant baseload and power balance

Constant baseload of power (PBase)

Power Balance (PBal)

Our solution involves building an integrated web application that solves the client’s using NextJS, a modern Javascript framework for building scalable integrated web applications that utilize NodeJS environment and React library. The web application would provide a user-friendly interface for interacting with the application that does not require any specialized hardware or software to run as it can be accessed from any web browser.

NextJS offers an integrated system with both the front-end (for the user to interact with the system i.e. view simulation results and alter input parameters) and the back-end (for running the simulation and calculations) within the same framework and written in the same language. This speeds up the development process and aids the completion of the project within schedule. Javascript was chosen as it is the language of the web, and as stated earlier, does not require specialized hardware and software to run. Having a solution written in a single language aids maintainability and improves integration. Also, the NodeJS environment offers diverse free libraries that can enable the abstraction of certain tasks, minimizing the amount of code needed to be written. NextJS also offers inbuilt functionality that abstracts certain web development tasks such as web routing, Javascript bundle optimization etc (nextjs.org, n.d). NextJS offers server-side rendering (SSR), a technique that greatly speeds up the launching of a web application vs traditional client-side rendering (CSR) (Connolly, 2020) meaning a blazing fast application that improves the user experience. Also, React offers stateful variables that can be used to model the solar system.

This application will connect to a MongoDB no-SQL database. This was chosen primarily because of the lack of SQL experience and knowledge within the team. Also, Mongo provides excellent integration with NextJS on the NodeJS environment (Laurren, 2019) and handles scaling very well.

Finally, MongoDB offers a free tier that is necessitated by budget constraints.

The team shall take into cognizance, the client's needs and requirements and build a solution that exceeds the customer’s expectations.

## Reasons for selecting our solution

Our solution does not require any particular Operating system or hardware to run and can be accessed through any device with a modern browser.

A blazingly fast web application.

Our solution can scale easily.

Easy to maintain as everything is integrated.

## Benefits of our Solution

### Technical improvements

Improvements in solar technology have increased its capacity. We live in an era of advanced technology, and we no longer rely on traditional technical means. With the advancement of technology and software, the world can use more solar energy due to its cost-effectiveness. In return, as more and more people turn to solar energy, your investment can increase in value.

### Stable and reliable returns

An efficiently managed 24-hour power supply system that powers your home regardless of weather or time of day conditions.

### Granular system control

The web application offers users granular control over settings and the ability to regulate consumption. This is done through an easy to use user interface that allows the user to input variables matching their use case scenarios.

## Project Schedule

The project schedule as presented was drawn up by the PM. Except where dependencies are specified, the tasks are expected to mostly run concurrently. With the adoption of an APM approach for software development, the requirements would be broken up into related blocks during the iteration planning, and each requirement block would be integrated during consecutive iteration sprints over 1 month.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Task | Duration (in days) | Dependencies (M- milestone) |
| Init | | | |
|  | Team Charter | 2 days |  |
|  | Project Selection | 2 days | T1 (M1) |
| Business Case/Specification | | | |
|  | Feasibility Study | 4 days | T2 |
|  | Risk Analysis | 2 days | T3 |
|  | Requirements Engineering | 2 days | T3 |
|  | Use case Development | 2 days | T5 |
|  | Business proposal | 14 days | T4, T5, T6, (M2) |
| System Design | | | |
|  | System Modelling | 2 days | T5 |
|  | Architectural Design | 2 days | T5 |
|  | UI/UX | 7 days | T8, T9 |
|  | Database Design | 4 days | T8, T9 |
|  | Model Components design | 7 days | T8 (M3) |
| System Development | | | |
|  | Iteration Planning | 3 days | T8 |
|  | First iteration | 7 days | T13 |
|  | Reiterate till requirements are satisfied | 21 days | T15 (M4) |
| Validation and Quality Management | | | |
|  | Testing | 3 days | T14 |
|  | QA/QC | 7 days | T14 |
|  | Risk Register | 7 days | T4 |
|  | Design Documentation | 7 days | T12 |
|  | Run book | 7 days | T16 |

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# Appendix

Appendix A



Appendix B



Appendix C

**Week: 2**

**Meeting minutes**

Meeting number: Five (5)

Chair/ Moderator: **Dr Emmanuel Ogunshile**

|  |  |
| --- | --- |
| **Date: 4th June, 2021** | **Time: 11;00 am** |
| **Location: Microsoft Teams** | **Minutes taken by: Irene Ofori Asare** |
| **Attended by:**  **Dr Emmanuel Ogunshile**  **John Anwana**  **Irene Ofori Asare**  **Dilshani Herath Mudiyanselage**  **Janith Sooriyathilaka** | **Apologies: Pratiksha Patel** |
| **Tasks**  Feasibility study on solar panel technology development. | **Status as on the date of meeting along with the name of the person   responsible.**  Members were asked to go and redo the task |
| **Agenda***(To be sent two   days before the meeting)*   1. Requirements elicitation from client 2. Business proposal 3. Review of task 4. Presentation | **Action plan along with any delegation of tasks.**  **John Anwana**  **Irene Ofori Asare**  **Janith Sooriyathilaka** |
| **Summary of the meeting**   The group had a meeting the lecturer (Client) in order to better understand the project. The client provided the group with an explanation of the project and briefed the group on the expect requirements and specifications. He went ahead to explain the benefits and the challenge of developing the solar software.  **Update of task assigned**  Based on the lecturer explanation, the group agreed that members should re- do the task assigned. | |
| **Date of next   meeting: 8th June, 2021** | **Type : BBCollaborate** |
| **Issues identified:** | Lack of understanding of project |
| **Action proposed to resolve** |  |