

Career Episode One

Introduction

CE 1.1.1

I worked on a project during my academic studies and I am going to discuss its details to show my competency as a professional environmental engineer through this career episode. The project was related to designing of a system to lift water using solar energy for irrigational purposes. It was located at

██████████. The project was completed in ██████████. I was a final year student of the ██████████ and the geographical location of this project was ██████████

Background

CE 1.2.1

It was a final year thesis project done at ██████████ under the supervision of Assistant ██████████ Department of B.Tech. in Environmental Engineering. This project aimed to serve people of one of the rural areas of Nepal (i.e. Surkhet) where they were facing water scarcity for irrigation. Even there was no reach of good supply of electricity.

CE 1.2.2

The need of water for the selected area was a little above four hundred cubic meters daily. The Budhakhola perennial river provided water to the locality currently. There was a circular reservoir constructed of the capacity 1200+ cubic meters, whose distance from the river was 732 meters. Proper number of solar panels were fitted in appropriate locations. We gave top priority in selecting pump size, power required, motor and controller to make this project worth while.

CE 1.2.3

From this project we aimed designing a system to facilitate irrigation through solar pumping of water, at Chaukune rural municipality, Surkhet. In addition to this main objective, I developed smaller goals to achieve this objective. The specific goals were to calculate the total amount of water required per day, design the tank size required for storing water, select the appropriate pump, motor, and controller and calculate the required number of solar panels.

CE 1.2.4

During the project I performed the following set of responsibilities:

1. Literature review
2. Collect information from the field (primary source and secondary)
3. Find the best water source for the project by doing field survey and the use of different software like ArcGIS, remote sensing, AutoCAD
4. Locate the best site for PV panels
5. Perform feasibility study on the impacts on environment and economy
6. Design of system focusing on water requirement, size of water reservoir, calculation of design flow rate of the pump and power required for the pump
7. Select motor and controller to suit the project purpose
8. Attend regular meetings with the supervisor and team members

9. Complete the project report together in a team of two with the help of my team member

Personal Engineering Activity

CE 1.3.1

I have shown the hierarchy of the project reporting in the following image.

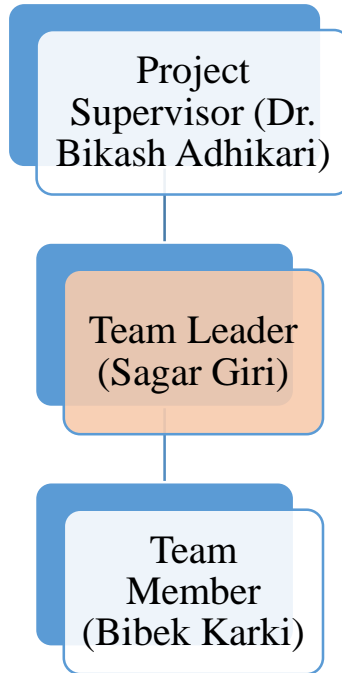


Figure 1: Project Reporting

CE 1.3.2

Being a project aimed at improving the irrigation system of the rural area of [REDACTED], it was very close to my heart. I wanted to perform this project successfully not just for grades but also because I felt an ethical responsibility towards the people of [REDACTED] and I wanted to do something to help them. Especially the people from the rural areas were the target of this project, who in [REDACTED] are normally not lucky enough to have access to modern amenities and a comfortable lifestyle. Therefore, this project was important to me for many reasons.

CE 1.3.3

At the beginning of the project, I first designed a methodological framework to follow throughout the project duration. This became helpful for us to mark milestones and decide how much time to invest on which task. It also helped me distribute tasks among myself and my fellow. I developed flow chart to show the methodological framework.

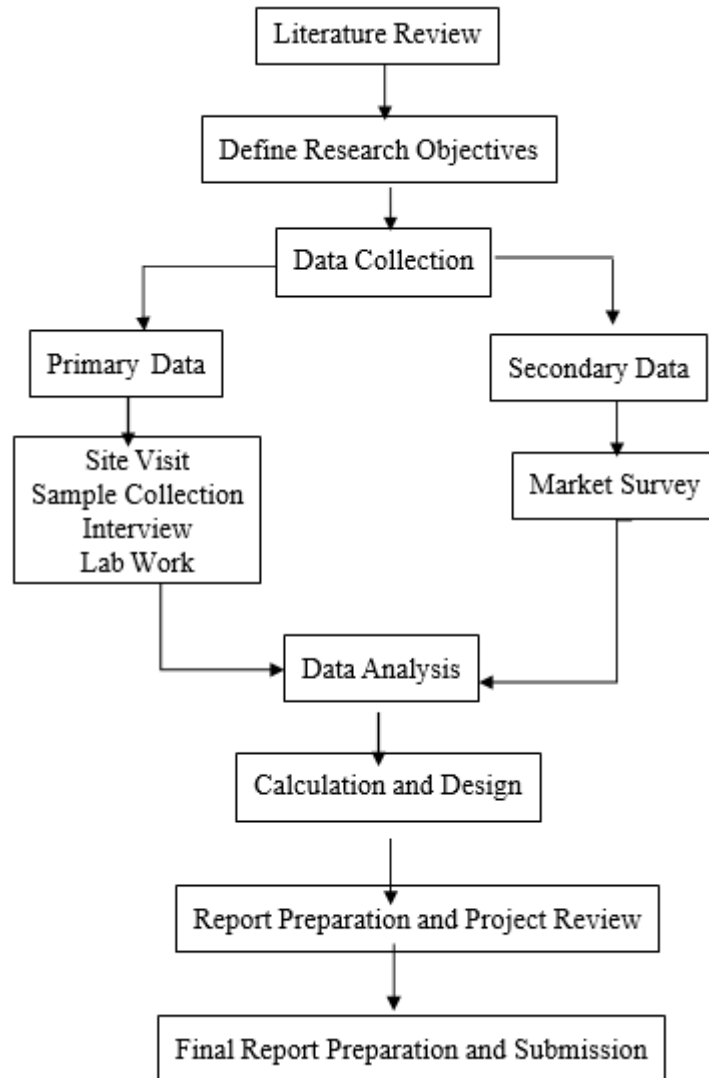


Figure 2: Methodological Framework

CE 1.3.4

We performed the data collection through primary and secondary means. For the secondary sources, I consulted the library of the university along with online material. I studied journals, articles, reports to equip myself with the necessary knowledge to conduct this project with maximum information. For the primary data, I with my team members visited the location.

CE 1.3.5

The area considered for this project was Chaukune rural municipality, ward no 01 located in Surkhet district, Karnali zone. The climate of this region is mostly upper tropical and sub-tropical to some extent. The elevation of Chaukune rural municipality was 1656 meters and the river Budhakhola is located at lower elevation that made irrigation difficult in this area. I discussed with my supervisor the problem in detail along with brainstorming solution ideas. One fitting solution that we decided was using solar powered pumping system that is both cheap in the long run and environment friendly.

CE 1.3.6

Therefore, I began the task of designing. I knew that for designing the system to pump water through solar energy, the first and most important step was to determine the overall demand for water. I calculated the water requirement for a day to be 400,170.85l. Budhakhola was the source of water for pumping. Availability of water along with its quality varied in every season. However, the stream flowed throughout the year and the water flow was adequate enough for supplying to the project panned and the quality of water was appropriate considering irrigational purposes. In order to avoid debris, sediments, etc. to enter to the intake, I made sure to use proper screening materials at suction points. Considering the data specific to the location, I designed the layout of the entire system.

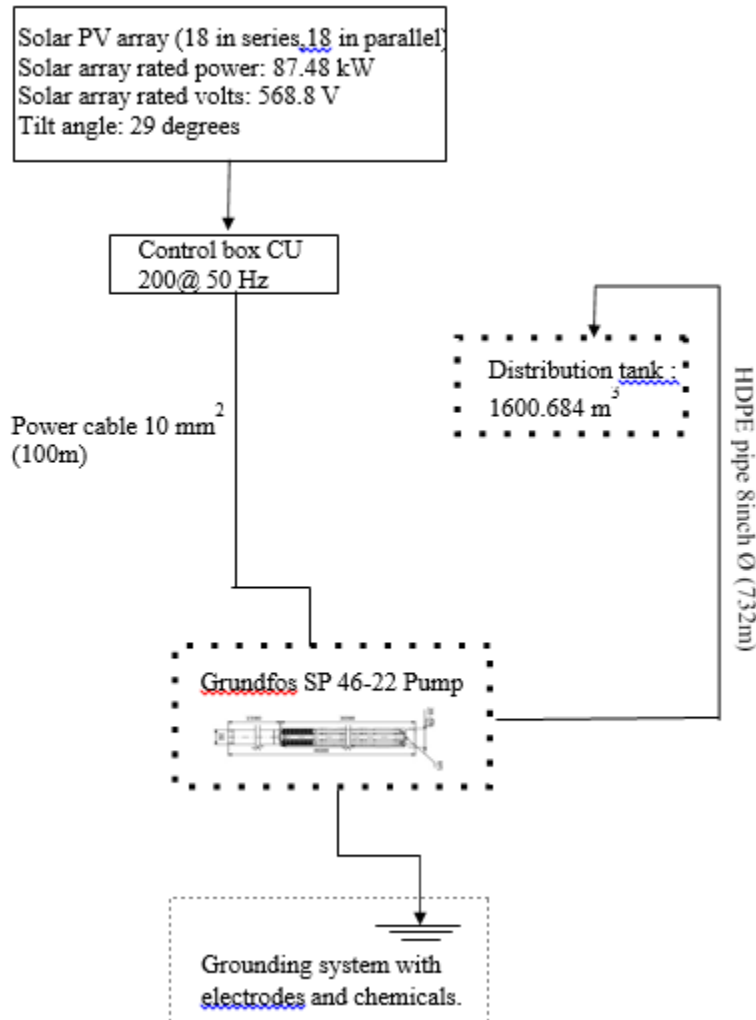
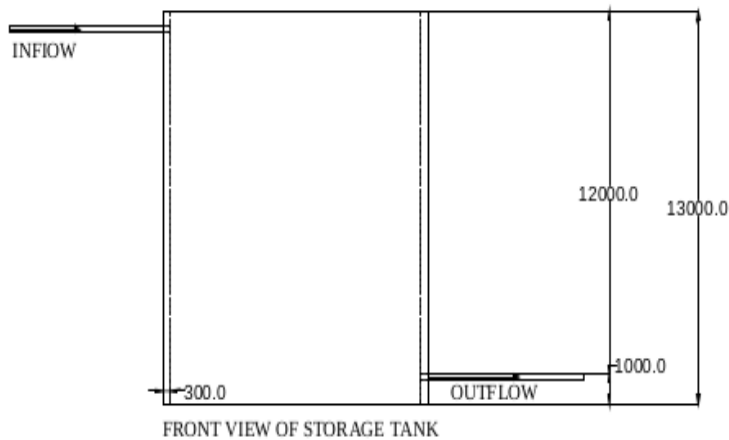
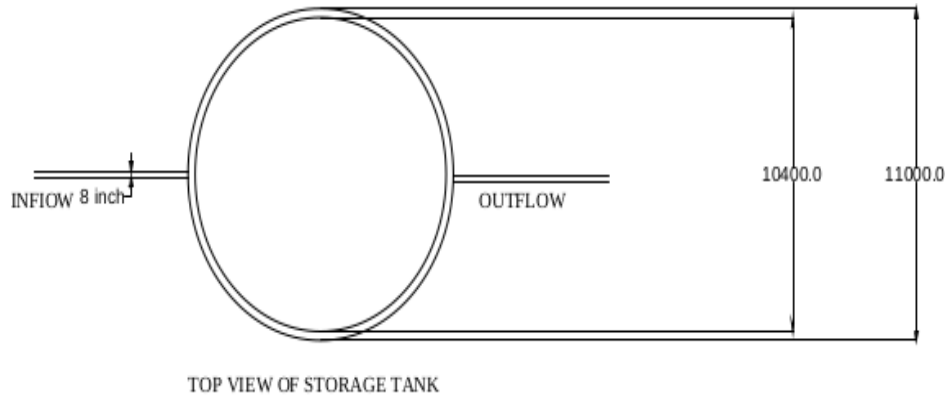


Figure 3: System layout of the project

CE 1.3.7

I designed the storage tank which would be useful for the storage of water at the time when the production of energy would be at its peak so to fulfill the water demand during cloudy weather or maintenance periods. I designed overall capacity of storing water in the tank to be appropriate to hold the water pumped for 3 days. I selected circular storage tank over a rectangular tank because I knew it would be structurally stronger, more economical and easier to clean. Furthermore, I knew from basic

thermodynamics that a round structure minimizes the surface area through which heat can radiate i.e. it keeps the stored water at a constant temperature for longer period than that of box-shaped tanks. As a result, water is less affected by ambient temperature fluctuations. I designed the storage tank on AutoCAD which I have shown below.



(NOTE : ALL DIMENSION ARE IN mm)

Figure 4: Storage tank designed on AutoCAD

CE 1.3.8

I did water testing in the lab and checked several parameters like total dissolved solids (TDS), pH, suspended solids, Sodium Adsorption Ratio (SAR), chloride, pesticides and contaminants. I calculated the water requirement by following the steps below.

Water requirement per week = Total farm area * required litre of water for 1m² per week

With the help of volume of the stored water, I calculated height of tank as designed by assuming a suitable diameter by using simple mathematical formula:

$$V = (\pi D^2/4) H$$

Where,

V= Volume of reservoir (m³)

D= Diameter of reservoir (m)

H= Height of the reservoir (m)

CE 1.3.9

1. I performed calculation of Design flow rate of the pump. I calculated it by using the following formula.

$$\text{Design flow rate of the pump} = \frac{\text{Daily water required}}{\text{Peak sun hours}}$$

2. I also performed calculation of total dynamic head.

Total Dynamic Head = Static height + Static lift + Friction loss

Where frictional loss = $\frac{608,704,451}{d^{4.8655}} * \left(\frac{Q}{C}\right)^{1.85}$ [Hazen William's formula]

d= internal diameter, C= roughness coefficient for HDPE pipe, Q= water flow

3. I also did the calculation of Pump size.

$$\text{Required hydraulic power of the pump, } P = \frac{Q\rho gh}{3600}$$

Where,

Q = flow rate of the pump

ρ = density of water (1000kg/m³)

g = acceleration due to gravity (9.81 m/s²)

h = total dynamic head of liquid (m)

4. Also I performed the calculation of motor power

$$\text{Motor power, } P_m = \frac{P}{\eta_m}$$

Where, η_m = motor-pump efficiency and is assumed to be 75%.

CE 1.3.10

I used help from the software programs AutoCAD, Grundfos, Remote sensing, ArcGIS and Environmental Modelling software (SWAT) during this project. The project supervisor assisted in making suitable environment for finding project title and project location. He made a favorable environment in every project step like surveying, designing, using devices like theodolite, remote sensor, flow meter,

pressure gauge, rain gauge and software like AutoCAD, Grundfos, Remote sensing, ArcGIS, Environmental Modelling software (SWAT). I took the supervisor into confidence regarding all major project decisions.

CE 1.3.11

I followed the engineering standards of International Electrotechnical Commission (IEC) Standards, Building Code, International Organization for Standardization (ISO) Standards and National and Local Regulations. I performed Risk Assessment, followed Safety standard and codes, equipment safety, personnel safety, environmental considerations during the project.

CE 1.3.12

I and my team member had a regular meeting with the supervisor every week via zoom and sometimes in person as well. In that meeting we discussed about the progress of the project, major findings, possibilities, lacks and obstacles, completion deadline etc. As I was a team leader for the project, I demonstrated my leadership skills in following ways. I set clear objectives at the beginning of the project. I made sure that we follow our set objectives and milestones. I communicated effectively with the supervisor and the team member throughout the project.

CE 1.3.13

Once the project was completed, I prepared its thesis report following standard protocols. I kept a detailed record of the project weekly progress. Therefore, I was able to use that record into the project report. I also used to record the minutes of every meeting proceeded further to the complete project report.

Summary

CE 1.4.1

Eventually we were actually able to complete the project and benefit the rural areas. The selected site fell within the tolerance wind speed of 85mph (or less) so it was good for mounting PV panels. I decided to do ground mounting of panels since it provided flexibility for optimum tilt angle. Besides that, I knew ground mounting provided natural convection to cool the solar module using air. I also opted for ground mounting as it was also easier for safe installation and maintenance for the local people.



Figure 5: Ground mounting

During the project I attended an online seminar on advanced research in water quality Engineering and Management. The success of the project was a testament to our hard work and conviction to completing the project for the rural folk.