Solar-Powered Water Purifier

A STEM Based Community Welfare Project

Project Report by Ishaan Avi Gupta

Class X student at The Shriram Millennium School, Noida

Project Duration: Nov 2022 -- Present

PROJECT SUMMARY

Conservation of energy is essential in creating a sustainable environment for the future. My project is a Solar-Powered Water Purifier which uses the chlor-alkali process to purify water. The purifier is specially designed for remote villages where access to clean water is limited or non-existent. This system is simple, easy to operate and sustainable, making it ideal for rural communities with limited resources. My device uses a solar panel to generate electricity, which is used to power an electrolysis process that separates salt into sodium and chlorine. The chlorine is then used to disinfect the water and kill harmful bacteria, viruses and other pathogens present in the water. The purified water is collected in a storage tank and made available for use by the local community. Access to clean water can reduce the incidence of water borne diseases, which is also a cause of high mortality in children. The impact of my project in the villages of Delhi and Uttar Pradesh is significant as the availability of clean drinkable water can have a transformative impact on the health and well-being of the people. My aim is to improve the health and quality of life of the people in these remote locations.

THE COMMUNITY CHALLENGE & MY SOLUTION

My initiative is a small step in solving the shortage of clean water supply in schools and rural communities by providing a simple yet dependable source. The solar-powered water purifier helps to supplement the incoming municipal water supply at. My first set-up was installed at ‘Manav Mandir Mission Trust’, NGO at their school in Sarai Kale Khan in New Delhi. The positive feedback received from the students and the administration motivated me to develop another device and install it at their second location in Manju-ka-Tilla. This is a settlement of Pakistani Hindu refugees who migrated to India a few years ago and are in need for support for all basic commodities.

PILOT PROJECT STAGE

I wanted to build a device which is sustainable and environmentally friendly. Through basic drawings on paper, I developed its design concept, made a list of components, the measurements of the shaft assembly and the stand. Then I drew a circuit electricity diagram to connect the components in the correct sequence. In addition to the solar panels, a charge controller, battery and inverter were required. The purpose of the inverter is to convert the DC generated by the solar charged battery to usable AC. After procurement of the components from the local market, I started working on building the prototype.

UNDER THE MENTORSHIP OF 1M1B

Under my guidance of my mentor, Manav Subodh at The Purpose Academy (TPA), a program established by 1M1B, I formulated the idea of utilizing solar-powered technology to address water-related challenges. The device focuses on providing clean usable water to the under-served communities in remote areas. This innovative project encompasses various applications, including water purification, quality analysis, and distribution. While the purification aspect is well-known, there is a significant under-utilization of advanced technologies for water quality assessment and distribution systems.

Recognizing the social significance of the Solar-Powered Water Purifier, it was acknowledged by the Sutardja Centre for Entrepreneurship and Technology (SCET) at the University of California, Berkeley. In April 2023, I had the opportunity to present this work in San Francisco and receive feedback accolades from my peers. As an UN-accredited youth-focused organization, 1M1B is committed to supporting initiatives that address pressing global challenges, and I am proud to contribute to this mission through my project.

PROJECT INSTALLATIONS

Pilot Project: Rapid Engineering, A-11/1, Site 4 Industrial Area, Sahibabad, Uttar Pradesh- 201010

Manav Mandir Mission Trust, NGO
Location 1: KH-57, Sarai Kale Khan, New Delhi- 110013
Location 2: Manju-ka-Tilla, Wazirabad, Delhi
Location 3: Signature Bridge, Shahdara, Delhi (camp for Pakistani Hindu refugees)

COMMUNITY IMPACT

- My pilot prototype, installed in Sahibabad, Uttar Pradesh currently supplies clean water for domestic use for the migrant workers and their families working at the construction site and living in make shift homes

- One installation at a school in Sarai Kale Khan, New Delhi, helps an NGO, ‘Manav Mandir Mission Trust’ to supplement their communal water supply for domestic use. Demonstrating the mechanism of the device through live demos to the students also generated their curiosity in STEM subjects.

- One installation at a make-shift local community in Manju-ka-Tilla, a sister organisation of ‘Manav Mandir Mission Trust,’ helps supply clean water to the people. These are migrant refugee families who are living in huts and lack basic amenities.

SOCIAL MEDIA AND NEWSPAPER COVERAGE

https://scet.berkeley.edu/high-school-innovators-pitch-social-impact-projects-at-uc-berkeley/

https://bit.ly/3pgacKi Farm n Food, Hindi magazine

https://bit.ly/3CI3nV4 Saras Salil, Hindi magazine

https://bit.ly/3XIsAs6 Manav Mandir Newsletter

https://www.instagram.com/p/Cq-oAB4pxL5/?img_index=1

VOLUNTEERING AT MANAV MANDIR GURUKUL, NGO

I have been volunteering with 'Manav Mandir Mission Trust' to teach the students science through simple experiments since August 2020. I tutor children of grade 6-7 in Math and English during weekends and also guide them on how to use a computer. In addition, I have volunteered in their Republic day & Diwali celebrations and food distributions. During my visits, I held talks on sustainable living and issues related to availability of clean drinking water in rural areas.

LIST OF COMPONENTS USED IN THE DEVICE

No.	Item	Quantity	Price / Unit	Price in Rupees	Specification
1	Solar Panel	1	10,000	10,000	250W / 12 V
2	DC Geared Motor	1	1,380	1,300	DC / 3.5 RPM
3	Voltmeter	1	350	350	Measure Voltage of Battery
4	Bearings	2	500	1,000	F204
5	Steel Shaft	1	200	200	20 mm Diameter, 16 inch length
6	Fabricated Steel Stand	1	1,500	1,500	
7	Charge Controller	1	4,200	4,000	12 Volts
8	Battery	1	6,800	6,500	12 Volts DC 80 AH
9	Invertor	1	7,000	7,000	12 Volts / 300 VA
10	Electrical Wires	1	270	250	
11	Tubs	2	250	500	
12	Stainless Steel Sheets	2	300	600	

PROJECT MECHANISM

The Solar-Powered Water Purifier, unlike traditional solar panels, incorporates an innovative 'Solar Tracking System' that optimizes the positioning of the solar panel based on the sun's movement throughout the day. By sensing the sun's location and rotating in sync, the purifier ensures that the solar panel directly faces the sun at all times, maximizing its efficiency and energy generation. This unique

feature results in a higher voltage and DC output compared to fixed solar panels, enhancing the overall performance of the system. Additionally, the purifier utilizes stainless sheets in the chlor alkali process, which involves the electrolysis of NaCl to produce NaOH and chloride ions, enabling efficient water purification. There are two components of the purifier:

1. Electrolysis of NaCl (Sodium Chloride present in water/ desalination) using Stainless Sheets
2. Sun Location Sensor & Rotating Mechanism

Electrolysis of NaCl using Stainless Sheets

The mechanism of the Solar-Powered Water Purifier involves the use of stainless sheets in the chlor alkali process, specifically the electrolysis of NaCl (sodium chloride). This process occurs through two key components: the cathode and the anode.

The ***cathode***, typically made of stainless serves as the negative electrode. When an electric current passes through the purifier, the cathode attracts positively charged ions. In this case, the current promotes the reduction of sodium ions (Na+) present in the NaCl solution. As a result, sodium ions gain electrons and are converted into sodium metal (Na), which collects at the cathode. On the other hand, the ***anode***, acts as the positive electrode. Here, the current promotes the oxidation of chloride ions (Cl-) found in the NaCl solution. The chloride ions lose electrons and are converted into chlorine gas (Cl2) at the anode.

Overall, the electrolysis of NaCl in the Solar-Powered Water Purifier leads to the separation of sodium and chlorine components. The sodium metal obtained at the cathode can be utilized for various purposes, while the chlorine gas released at the anode can be safely captured or disposed of. This process allows for the purification of water, effectively removing impurities and contaminants.

Sun Location Sensor & Rotating Mechanism

The **Solar-Powered Water Purifier** has ***three identical small solar panels*** of 5 Watts each (A, B, C). They are located at 60 degrees to each other and form the three sides of an equilateral triangle. The three solar panels (A,B,C) are wired to a single geared ***DC motor*** to generate opposing voltage. In other words, the voltage generated by one solar panel cancels out the voltage generated by another solar panel. Therefore, depending upon the sun's position, one of the three (A,B,C) solar sensors generates higher voltage and current compared to the other two sensors, thereby rotating the DC motor in its direction. The DC motor, in turn, rotates a steel shaft. A large ***electricity-generating solar panel*** is mounted on the ***steel shaft***. ***Two bearings*** support the steel shaft**.** The entire assembly is mounted on a ***steel frame***.

KEY FEATURES OF THE PURIFIER

1. The project aims to provide clean and drinkable water for remote villages in Delhi
2. Utilizes the chlor alkali process using stainless sheets to effectively purify water
3. Features an automated sun tracking system, maximizing the energy absorption and ensuring consistent water purification
4. Requires minimal maintenance with only daily cleanings of the solar panel

UTILITY OF THE PURIFIER

The solar-powered water purifier holds immense utility in addressing the critical need for clean and drinkable water. Its utility extends to various sectors, making it a versatile solution for multiple applications. In agriculture, it can be utilized for irrigation purposes, ensuring that crops receive clean and uncontaminated water, in turn leading to improved yields and healthier produce. The purifier also provides clean drinkable water in remote communities where access is limited. Its portable design and using renewable solar energy makes it suitable for disaster stricken areas, enabling rapid deployment and immediate access to purified water.

TDS AND pH LEVELS

To ensure the quality of the purified water, I measured the Total Dissolved Solids (TDS) and pH levels of both the incoming water and the outgoing water from the tank. This system helps assess the effectiveness of the purification process and ensures that the water meets the desired standards. For checking the TDS, a TDS meter or conductivity meter is utilized. The meter measures the electrical conductivity of the water, which is directly related to the concentration of dissolved solids. This provides an indication of the level of dissolved minerals, salts, and other impurities present in the water before and after the purification process. Similarly, the pH of the water is measured using a pH meter or pH test strips. The strips are dipped into the tank to assess the acidity or alkalinity of the water. The pH value determines whether the water is within the acceptable range, as extreme pH levels can be detrimental to health.

FUTURE SCOPE OF THE PROJECT

The future scope of my project is vast and promising. With increasing concerns about water scarcity and the need for sustainable solutions, my innovative technology has the potential to revolutionize access to clean and safe water not only in remote villages in Delhi but other parts of India. By continuously refining its mechanism and expanding its outreach through strategic partnerships and collaborations, I envision a future where every individual will have a reliable water source, fostering improved health and well-being.