



Cleaning Renewable Energy Systems in Nigeria

ENGR 2050 - Introduction to Engineering Design
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Agenda

- I. Problem Identification
- II. User IDs & Needs
- III. User Statements
- IV. Professional & Societal Factors + DEI
- V. Problem Statement
- VI. Design Specifications
- VII. Planning
- VIII. Team Development & Standards Agreement



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Problem Identification



What is the problem?

- A significant portion of Nigeria is unable to access stable energy.

What is the scope of the problem?

- 47% of Nigeria's 213.4 million population (approx. 100.3 million) [1]

Explain why the problem is a problem (symptoms)

- Citizens don't have consistent light
- Affects agriculture and food production
- Communication and medical equipment outages
- Lack of heat & air conditioning
- After 10 years, solar panel efficiency drops [5]

Why is the present state not sufficient? (What is the unsatisfactory state?)

- Frequent power outages
- Negatively affects businesses/economy
- Solar panel maintenance costs keep people from utilizing solar

Problem Identification (Cont.)

Why is there a need for innovation and improvement?

- Ensure consistent source of power
- Cost can be minimized by minimizing maintenance
- Dust on solar panels can cause shorts limiting the lifetime of the device
- A cheap method to clean debris of solar panels can make solar more affordable

What are the negative outcomes of the problem?

- Annual losses estimated at \$26.2 billion [1]

What could be the impact of a successful intervention?

- Increased lifetime of solar panels
- More reliable energy availability
- More production in day-to-day life
- Significant economic impact
- Makes it easier and cheaper to have solar panels (more of an incentive)
- A cheap method to clean debris of solar panels can make these devices more affordable



User IDs & Needs

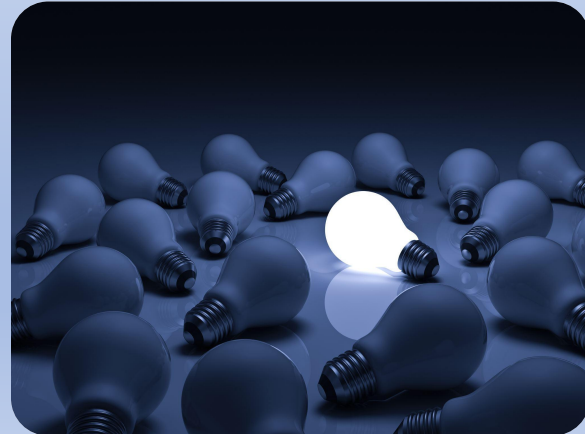
- User IDs
 - Low/middle class families in Nigeria
- Stakeholders:
 - Nigerian Government
 - Nigerian Energy Support Program
 - Environmental NGOs
- User Needs
 - Low cost - 1.25% of people in Nigeria use solar panels due to the high cost
 - Simple to install and maintain
 - Provide more energy due to removing debris that decreases power output of solar panels by 7% - 50% [3].
 - Increase lifetime and reliability of solar panels so that families can use them for longer (especially with constant and frequent blackouts)
 - Current cleaning costs (based on US data [9]): 268,950 - 564,795 Nigerian Naira (\$300 to \$630 USD) per year



[6]

User Statements

- 49 out of 50 users experience blackouts in Nigeria.
- 45 out of 50 users, who affected by blackouts, have their daily lives interrupted.
- 35 out of 50 users expressed that if the maintenance and cleaning costs were lower, they would install solar panels.



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Professional & Societal Factors + DEI

Potential users: Local communities which include families, especially families and people who require stable electricity to cook, clean, and need air conditioning.

Societal Factors:

- Affordability
- Accessibility- Not everybody has the physical accessibility of electricity services, some people live further out than others in the country which makes accessibility to the power source harder

Professional Factors:

- Infrastructure: The condition and availability of the electrical grid, transmission lines impact the electricity provided to local communities
- The framework of the power sector (licensing, pricing and quality control) affect the power provided
- Financial resources: The amount of funding and amount invested into it can affect the quality of the power provided

Problem Statement

General Statement: Almost half of Nigeria's population does not have access to stable, well-functioning power. The goal of this project is to design a product to reduce the time & labor of cleaning a solar panel in the absence of rain.

Unsatisfactory State & Symptoms:

- Unstable Power & Electricity in Nigeria
- Inability to use Internet, Hot Running Water, Household Appliances
- Spending Tons of Money on Power Sources (i.e. Solar Panels) just for them to be an Inconvenience

Impact of Successful Solution:

- Unleashing Nigeria's True Economic Potential
- Increase Access to Advanced Technologies
- Everyday Life Becomes Easier



Understanding Users/Stakeholder Landscape:

- Nigerian Families/Household
- Low/Middle Class Incomes

Defining Success:

- Increase in Percentage of people with access to well-functioning electricity/power

Innovation Opportunities:

- Decrease cost of Solar Panels
 - Self-cleaning Solar Panels
 - Shading Mitigation
 - Nanostructured Surfaces

Design Specifications for Debris Cleaning Solution

User Need	Metric	Target	Reason
Affordability	Cost of product	Less than \$100 USD	Most families able to afford it
Easy to install	Time of installation	Can install within 30 minutes	No outside sources required for installing
Energy	Energy output	Energy output stays above 90%	Consistent source of energy
Longevity	Lifetime of solar panels	Lifetime increases by 10 years	Don't need to replace panels nearly as often

Planning

Phase 1/ MS 1:

- Each step takes at least 2 – 3 days to complete
- Dividing work between team members is essential
- Have each part done by the assigned deadline makes completion much faster

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Project Name	Status	Comment	Owner	Start	End	29-Jan-24	30-Jan-24	31-Jan-24	1-Feb-24	2-Feb-24	3-Feb-24	4-Feb-24	5-Feb-24	6-Feb-24
2	MS1	30%		All	29-Jan-24	2024-02-06									Presentation
3	Title Slides	100%		All	29-Jan-24	29-Jan-24									
4	Background & Motivation	20%		All	29-Jan-24	31-Jan-24									
5	User needs	50%	Interview done	All	31-Jan-24	1-Feb-24									
6	Problem Statement	70%		All	1-Feb-24	2-Feb-24									
7	Design Specifications	0%		All	2-Feb-24	3-Feb-24									
8	Conclusions	0%		All	3-Feb-24	4-Feb-24									
9	Practice Presentation	0%		All	5-Feb-24	5-Feb-24									
10	Presentation	0%		All	6-Feb-24	6-Feb-24									

Planning (Cont.)

Looking forward to Phase 2:

- Continue to:
 - Use tools like Gantt Chart & Critical Path diagram
 - Assign certain members with tasks



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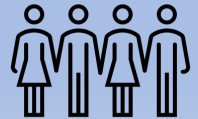
Team Development & Standards Agreement

Ground Rules

- Respect (not speaking over each other, don't edit each other's work)
- People are expected to hold themselves accountable and communicate what they need

Conflict Resolution

- Aim to make decisions as the result of discussion during meetings
- If a team member becomes a problem, some confrontation would be made to address that persons concerns and needs as well as the concerns and needs of the team



Team Development & Standards Agreement (Cont.)

Meeting Organization

- Agenda made in class before meetings
- Someone designated to take meeting minutes
- Someone designated to keep people on track
- Opportunity to check in and make sure people are hanging in there

Finances

- Necessary purchases will be charged to everyone evenly at the end of the semester
- Discussed keeping cost to a minimum



Citations (IEEE)

- [1] “Nigeria to Improve Electricity Access and Services to Citizens” World Bank. Accessed January 31, 2024. [Online]. Available: <https://www.worldbank.org/en/news/press-release/2021/02/05/nigeria-to-improve-electricity-access-and-services-to-citizens#:~:text=85%20million%20Nigerians%20don't.access%20deficit%20in%20the%20world>
- [2] “How Effective Are Dirty Solar Panels” Atlantic Key Energy. Accessed January 31, 2024. [Online]. Available <https://atlantickeyenergy.com/how-effective-are-dirty-solar-panels/>
- [3] “Scientists Studying Solar Try Solving A Dusty Problem” National Renewable Energy Laboratory. Accessed January 31, 2024. [Online]. Available <https://www.nrel.gov/news/features/2021/scientists-studying-solar-try-solving-a-dusty-problem.html>
- [4] “Nigeria Fuel Subsidy Solar Climate” AP News. Accessed January 31, 2024. [Online]. Available: <https://apnews.com/article/nigeria-fuel-subsidy-solar-climate-9b3f32283b0f2fab9f6096761ef815e7>
- [5] “Solar Panel Degradation And The Lifespan of Solar Panels” Paradise Solar Energy. Accessed February 02, 2024. [Online]. Available: <https://www.paradis solarenergy.com/blog/solar-panel-degradation-and-the-lifespan-of-solar-panels#>
- [6] “51 Color Photos That Capture Everyday Life of Nigeria in the 1960s” Vintage News Daily. Accessed February 03, 2024. [Online]. Available: <https://vintagenewsdaily.com/51-color-photos-that-capture-everyday-life-of-nigeria-in-the-1960s/>
- [7] “Scientists Studying Solar Try Solving A Dusty Problem” National Renewable Laboratory. Accessed February 02, 2024. [Online]. Available: <https://www.nrel.gov/news/features/2021/scientists-studying-solar-try-solving-a-dusty-problem.html>
- [8] “Consumer Price Index CPI” Trading Economics. Accessed February 02, 2024. [Online]. Available: <https://tradingeconomics.com/country-list/consumer-price-index-cpi>
- [9] “Solar Panel Maintenance” Home Advisor. Accessed February 02, 2024. [Online]. Available: <https://www.homeadvisor.com/cost/cleaning-services/solar-panel-maintenance/>