

Data File: Impact of Regular Cleaning on Solar Panel Efficiency

1. Interview Guide

Purpose of Study:

The purpose of the study is to find out what is the impact of regular cleaning on the performance of solar panels in producing electricity. It also looked at maintenance procedures, operational issues, environmental effects, and possible ways to improve efficiency.

Participant Demographics:

- **P1:** Maintenance Engineer, Noida, 6 years' experience, Large-scale installation
- **P2:** Plant Manager, Delhi, 10 years' experience, Large-scale installation
- **P3:** Operations Technician, Ghaziabad, 5 years' experience, Small-scale installation
- **P4:** Senior Engineer, Gurgaon, 12 years' experience, Large-scale installation
- **P5:** Maintenance Technician, Delhi, 7 years' experience, Small-scale installation
- **P6:** Plant Supervisor, Noida, 8 years' experience, Large-scale installation

Table 1.: Demographic profile of selected Participants

Participant	Role	Organization Location	Years of Experience	Type of Installation
P1	Maintenance Engineer	Noida	6	Large-scale
P2	Plant Manager	Delhi	10	Large-scale
P3	Operations Technician	Ghaziabad	5	Small-scale
P4	Senior Engineer	Gurgaon	12	Large-scale
P5	Maintenance Technician	Delhi	7	Small-scale
P6	Plant Supervisor	Noida	8	Large-scale

Interview Questions:

1. Can you share a little bit about your current job? What experience do you have in the solar power area?
2. How long have you been looking after solar power plants?
3. What obstacles have you faced while maintaining the efficiency of your solar power plant?
4. In your experience, do you think dust on the panels affects how well they work?
5. How does shadow impact the plant's ability to produce electricity?
6. What upkeep procedures are in place now to deal with problems like dust buildup and shade?
7. How frequently do you maintain or clean the solar panels? Which techniques do you employ?
8. Have you seen any adjustments in performance following maintenance or cleaning tasks?
9. What impact do weather conditions like wind, humidity, and temperature have on solar panel performance?
10. Have you put any plans in place to lessen these environmental factors' detrimental effects?
11. What tactics, in your opinion, might be used to raise the efficiency of the solar power plant?
12. Do you think any cutting-edge methods or technologies could be implemented to improve performance?
13. How do you keep an eye on the solar panels' performance? Which metrics are you monitoring?
14. Have you seen any trends in the performance data that point to certain areas that need work?
15. Would you like to add anything more about the efficiency of solar power plants or the difficulties you encounter?
16. Do you have any suggestions for additional study or areas that require more investigation?

2. Coding Framework

Codes:

- **Dust_Accumulation:** References to the accumulation of dust on panels and its effects.
- **Shading:** Mentions of shading from trees, buildings, or other structures.

- **Maintenance_Practices:** Descriptions of cleaning and maintenance routines.
- **Temperature_Effects:** Discussions on how temperature impacts panel efficiency.
- **Humidity_Effects:** References to how humidity interacts with dust and cleaning.
- **Wind_Effects:** Mentions of how wind affects the panels (positively or negatively).
- **Efficiency_Improvement_Strategies:** Suggested methods for improving efficiency.
- **Innovative_Technologies:** References to new technologies or practices (e.g., AI, drones).
- **Monitoring_Practices:** Descriptions of how the performance of the solar panels is monitored.
- **Performance_Patterns:** Observations about patterns in panel performance data.

Codebook:

- **Dust_Accumulation:** Any reference to dust affecting the efficiency of solar panels, including its causes, effects, and management.
- **Shading:** Any discussion of shading impacts, including causes (e.g., trees, buildings) and effects on efficiency.
- **Maintenance_Practices:** References to routine maintenance activities, including cleaning schedules, methods, and tools.
- **Temperature_Effects:** Comments on how high or low temperatures affect panel performance.
- **Humidity_Effects:** Mentions of how humidity influences the cleaning process and dust adherence.
- **Wind_Effects:** Descriptions of the dual role of wind in both cleaning and bringing debris to panels.
- **Efficiency_Improvement_Strategies:** Suggestions made by participants to enhance efficiency, including frequency of cleaning and technology use.
- **Innovative_Technologies:** Mentions of technologies like AI, robotic cleaners, or drones that could aid in maintenance and efficiency.
- **Monitoring_Practices:** Descriptions of the tools and methods used to track solar panel performance.
- **Performance_Patterns:** Observations of trends or patterns in performance data that indicate areas needing attention or improvement.

3. Categories

Environmental Difficulties:

- **Dust_Accumulation**
- **Shading**
- **Temperature_Effects**
- **Humidity_Effects**
- **Wind_Effects**

Maintenance and observation:

- **Maintenance_Practices**
- **Monitoring_Practices**
- **Performance_Patterns**

Strategies for Increasing Efficiency:

- **Efficiency_Improvement_Strategies**
- **Innovative_Technologies**

4. Themes

Theme 1: Environmental Elements as Major Challenges to Efficiency

- **Description:** The primary environmental factors that negatively affect solar panel efficiency are temperature, shadow, and dust deposition. [++][+] These factors provide unique challenges in certain areas or during specific seasons. [+]
- **Related Categories:** Environmental Difficulties

Theme 2: The Advantages of Regular and Economical Maintenance

- **Description:** Regular cleaning and maintenance are vital to keep solar panels operating as efficiently as possible. [++][+] Automated options require a larger investment but are more effective than manual approaches, which are labor-intensive yet necessary for smaller installations. [+]
- **Related Categories:** Maintenance and observation

Theme 3: Using Latest Technology to Increase Productivity

- **Description:** A rising number of people are interested in using advanced technology such as robotic cleaners, drones, and AI-driven predictive maintenance to increase productivity and reduce labor costs. [+]
- **Related Categories:** Strategies for Increasing Efficiency:

5. Coding Process

Approach:

- The interview transcripts were read through manually to manually code the data. Selected passages from the book were underlined and categorized using one or more of the coding framework's codes.
- After codes were applied, they were categorized into more general groups to find trends among various individuals.
- After that, these categories were examined to identify overarching themes corresponding with the study's goals.

Example of Coded Data:

- **Transcript Excerpt (P1):** " If dust accumulation persists, the panel's efficiency may drop by as much as 15%. We've found that regularly uncleaned panels generate significantly less power."

Assigned codes	Dust_ Accumulation, Maintenance_ Practices
Category	Environmental Challenges
Theme	Environmental Factors as Efficiency Barriers

Intercoder Reliability:

If necessary, two coders may independently code a portion of the data; the outcomes would then be compared to guarantee uniformity in the way the codes were applied. Any differences would be addressed and worked out.