



GUJARAT TECHNOLOGY UNIVERSITY
CHANDKHEDA, AHMEDABAD

Dr. S & SS Ghandhy
Government Engineering College,
Surat



A

Project report on
Electricity Generation with Combination of Wind and Solar Energy

DESIGN ENGINEERING 1 BE SEM.- 3 BRANCH: - MECHANICAL

Submitted By:

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Academic year (2017-18)



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CERTIFICATE

This is certifying that the dissertation entitled “*Electrical Energy Generation with Combination of Wind and Solar Energy*” has been carried out by

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In fulfillment of the requirement for the award of the **Design Engineering in Mechanical Engineering of the Gujarat Technological University (GTU), Ahmedabad, Dr. S & SS Ghandhy Government Engineering College, Surat**, is a record of his own work carried out under the our supervision and guidance.

Prof. B.K. Gotawala
(Guide)

Prof. V.D. Dhiman
(HOD)

ACKNOWLEDGEMENT

“A single idea can change the world if we put all our efforts to make it true.”

“We are the change that we seek”

We glad to thank first the GOD to give us the better thinking ability then to our knowledge, guide prof. B.K. GOTAWALA for his guidance, motivation and support during our project. We are especially thankful to him for his continuous interest and immense.

We would like to thanks our patents for their emotional support and belief us. Lately we express sense of gratitude to our department in charge prof. V.D. DHIMAN and staff member of Mechanical Department. Also thank Scavengers who give clean and healthy environment for thinking best idea for people of INDIA.

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ABSTRACT

Electricity generation with combination of Wind and Solar energy is the project developed for global energy demand and often used separately. The aim of this report is to exploit the combined system in two configurations.

This project presents a new system configuration of generating solar and wind energy from one place and save space for set-up project.

This configuration allows the two sources to supply the load separately or simultaneously depending on the availability of the energy sources.

INTRODUCTION

As we know engineering is the application of science and technology in real life. We all must have an idea to solve the real life problems as an engineer.

Design engineering is an initiative taken by GTU in this direction with the help and guidance of the professors of IITs and the GTU Innovation Council; we are looking ahead in moving on the path of innovation. In design engineering subject we have to think about different problems that people are facing in real life and how we can minimize those problems by using engineering ideas.

While industrial designers may be responsible for the conceptual aesthetic and ergonomic aspects of a design, the design engineer usually works with a team of engineers and other designers to develop conceptual and detailed designers. He may work with industrial designers and marketers to develop the design effort.

So first to get idea of what people are facing in real life we should must have a group that finds the problem so we made a group of four members from our class for finding different problems.

Solar PV System

- **WHAT IS A SOLAR PV SYSTEM?**

A solar PV System is a system which captures the sun' s energy and converts it into useful energy i.e. electricity

PV: Photovoltaic

- **HOW SOLAR WORKS?**

›Light hits the solar panels with photons (particles of sunlight). The solar panel converts those photons into electrons; direct current.

›Electrons then flow through a conductor to the various devices.

›The material responsible for doing this conversion is calling a cell.



- **COMPONENTS OF A PV SOLAR SYSTEM**

1)A PV Solar system typically consists of 4 basic components.

:PV Array

:Batteries

:Inverter

:Charge Controller

☐ **TYPES OF SOLAR PANELS**

- a) Single-crystal or Mono-crystalline Silicon
- b) Polycrystalline or Multi-crystalline Silicon

i. MONOCRYSTALLINE SILICON MODULES

Most efficient commercially available module

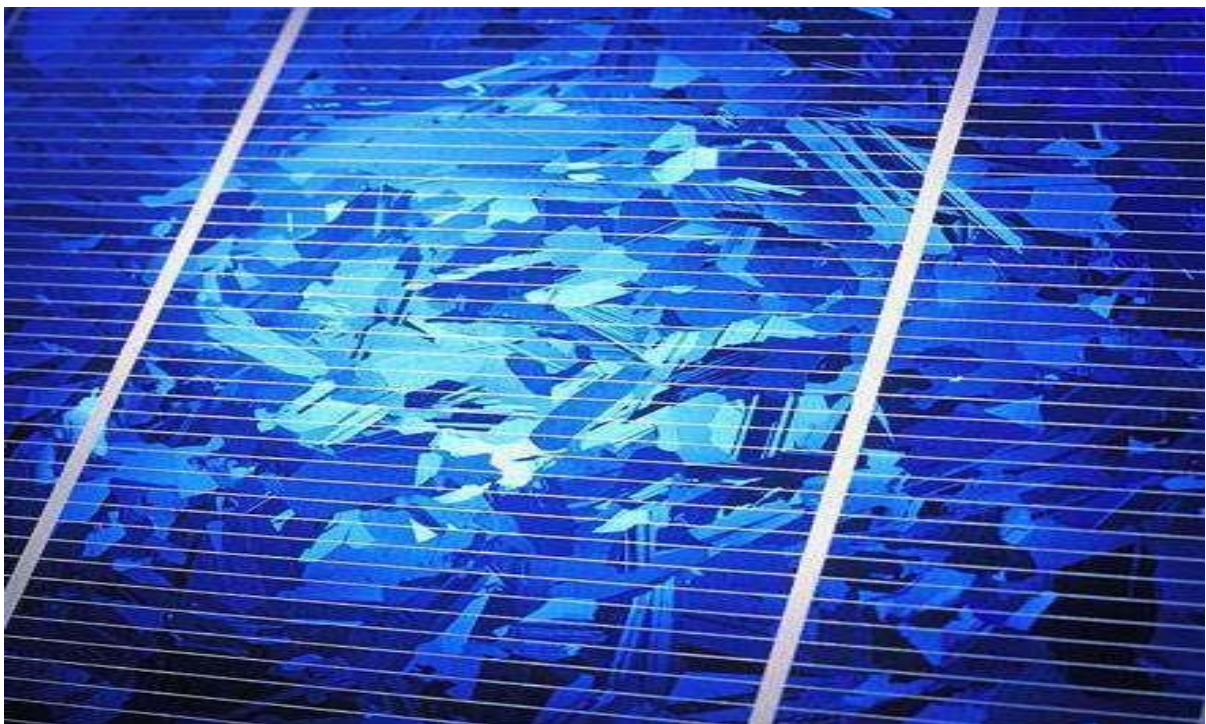
Most expensive to produce



ii. POLYCRYSTALLINE SILICON MODULES

Less expensive to make than single crystalline modules

Cells slightly less efficient than a single crystalline



- **COMPONENTS OF A PV SOLAR SYSTEM:**

- BATTERIES

- The batteries in a solar PV system stores the energy produced from the PV array and delivers it o the inverter which applies the load.
- A group of batteries in a solar PV system is called a battery bank.



- PRECAUTIONS

- Never Add Acid
- Under-watering: electrolyte level must never be dropped below the top of the plates
- Over-Watering: Diluted electrolytes, Add water only when battery is fully charged
- Under-charging: Forms sulfate on battery plates
- Over-charging: corrosion of positive plates, excess water consumption

- **COMPONENTS OF A PV SOLAR SYSTEM: CHARGE CONTROLLER**

A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may protect against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk.



- **COMMON FEATURES OF A CHARGE CONTROLLER**

- ✓ Maximum Power Point Tracking (MPPT): Adjusts the power from the solar array to deliver maximum solar energy to the battery.
- ✓ Converts excess voltage to Amperage
- ✓ Shunting: This diverts excess electricity to an auxiliary or shunt load when batteries are full. e.g., dc fan, lights and other dc loads.

- **COMPONENTS OF A PV SOLAR SYSTEM: INVERTER**

- ✓ Power produced by the PV array is direct current, or DC power. That power needs to be converted to alternating current, or AC power, before it can be connected to the utility grid or delivered to the AC Load. The inverter is the heart of the system and is responsible for performing this conversion safely and efficiently.



- **TYPES OF INVERTERS**

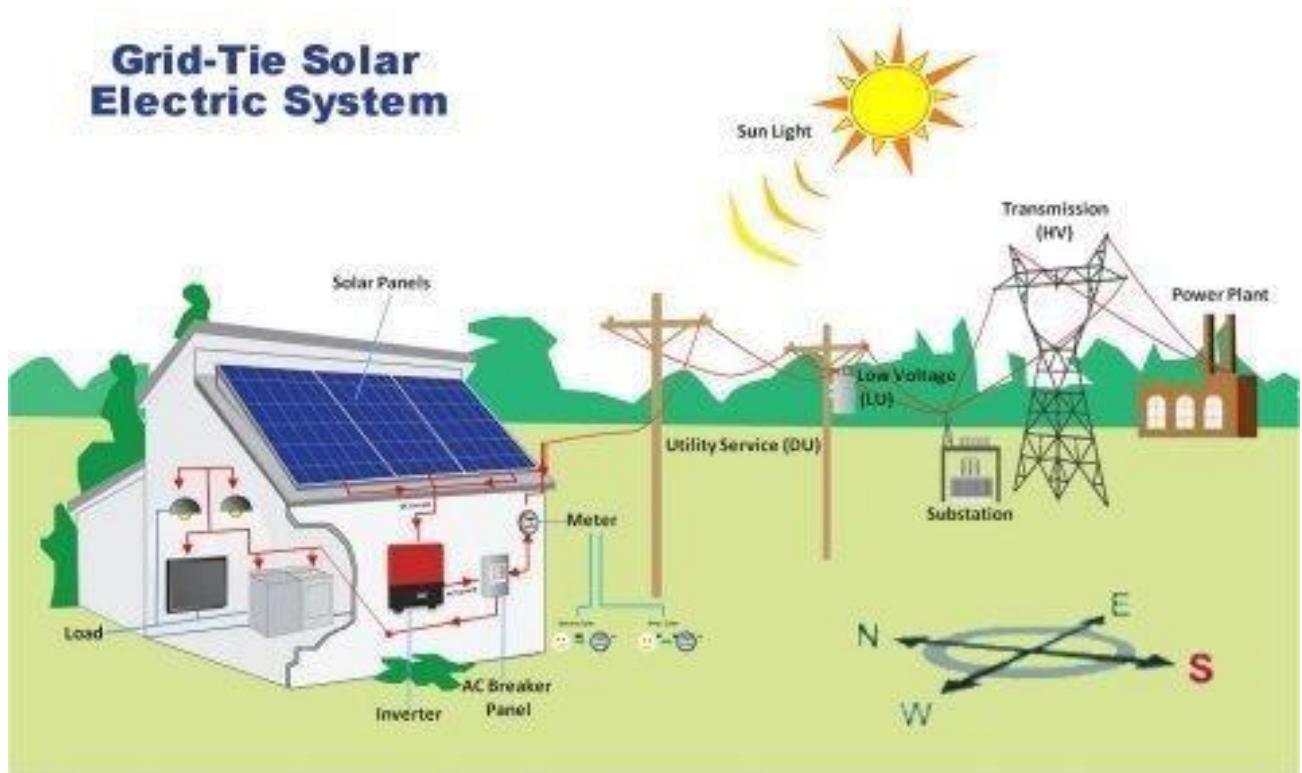
- ✓ Off Grid Inverters
- ✓ Grid-Tied Inverters

- **TYPES OF SOLAR SYSTEM**

- ✓ Grid Tie System
- ✓ Off Grid System
- ✓ Hybrid System

❖ TYPES OF SOLAR SYSTEM: GRID TIED

- Grid-tied systems are the most common type of solar PV system. Grid-tied systems are connected to the electrical grid, and allow residents of a building to use solar energy as well as electricity from the grid.



• COMPONENTS OF A GRID TIED SYSTEM

- PV panels (multiple panels make up an array)
- Inverter(s)

• ADVANTAGES OF THE GRID-TIED SYSTEM

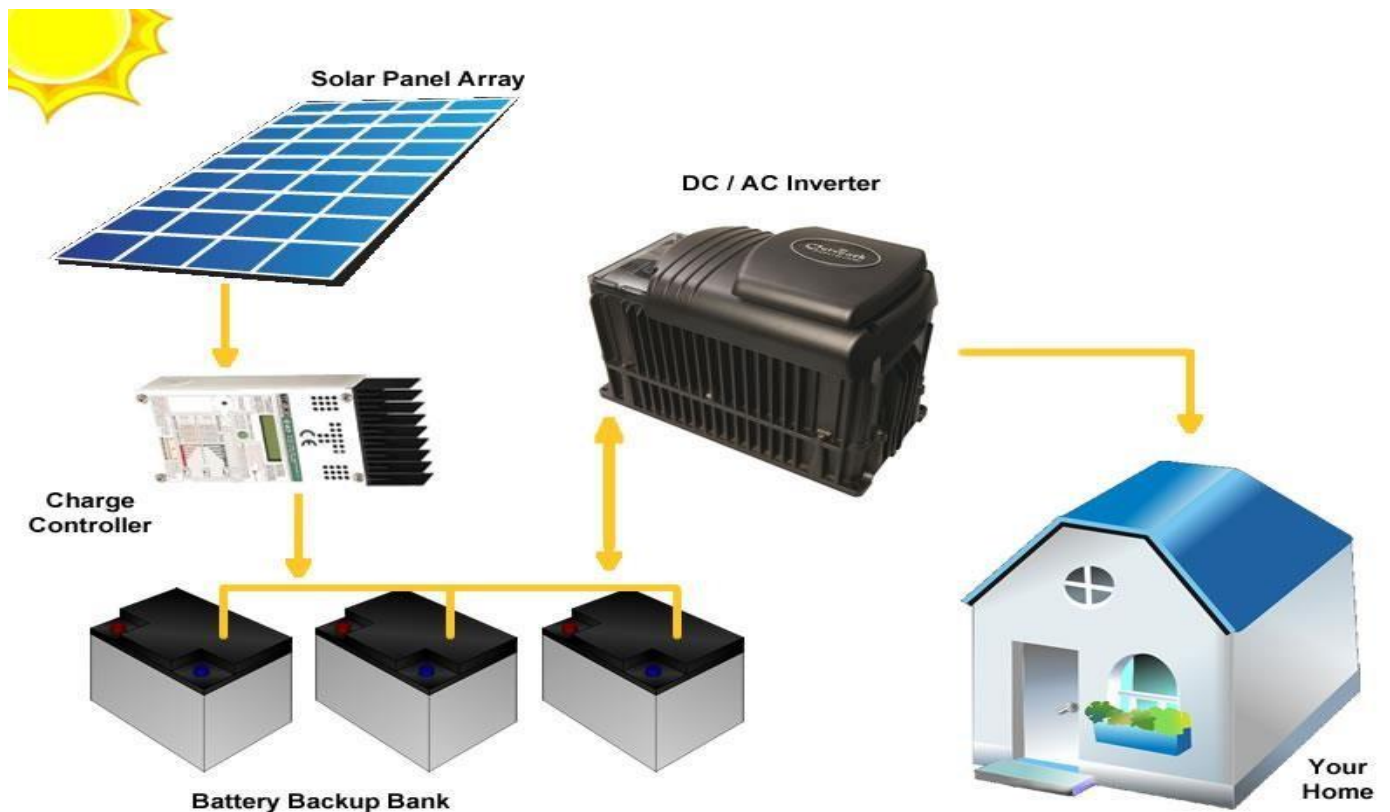
- Less expense due to no use of battery
- Little maintenance Required
- Save Money due to Net Metering

• DISADVANTAGES OF THE GRID-TIED SYSTEM

- Will not produce if there is no power from Grid

- **TYPES OF SOLAR SYSTEMS: OFF-GRID**

- An off-grid Solar system produces power independent of the grid. That is it is not connected to the grid.
- The system supplies power both day and night from a battery bank which is charged from the solar panels.



- **COMPONENTS OF AN OFF-GRID COMPONENTS OF AN OFF-GRID SYSTEM**

- PV panels
- Battery bank
- Charge controller (to protect the battery bank from overcharge) ➤ Inverter

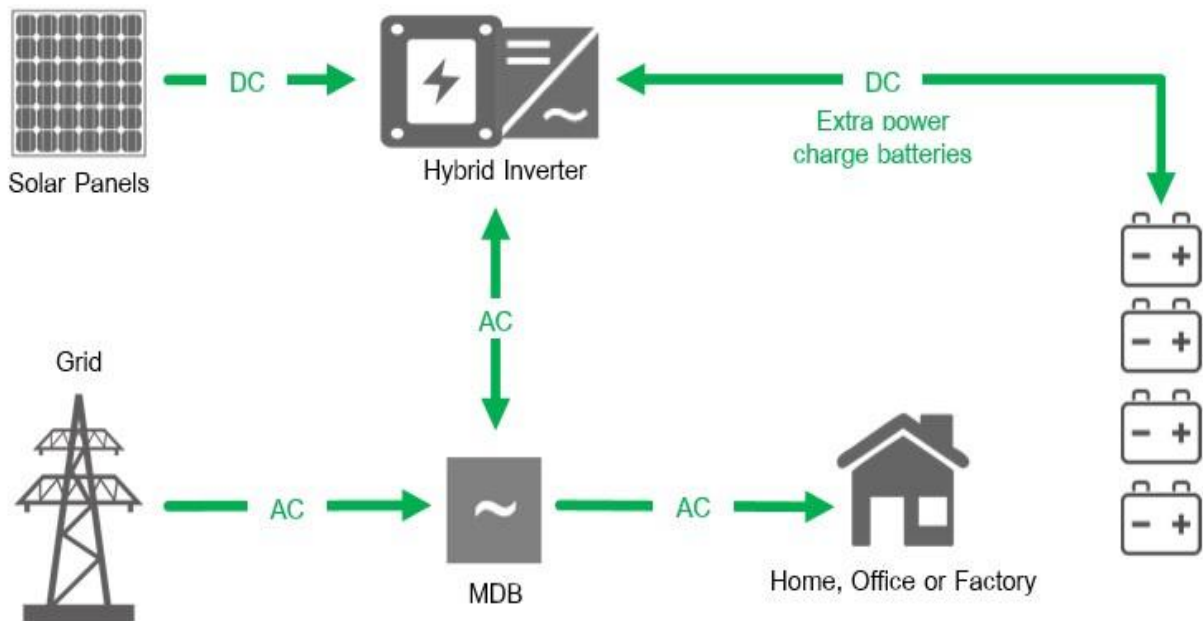
- **DISADVANTAGES OF THE OFF-GRID SYSTEM**

- More Costly to install
- Requires more maintenance

- **TYPES OF SOLAR SYSTEMS: HYBRID**

- A hybrid solar system is a combination of grid-tied and off-grid solar systems. These systems can either be described as off-grid solar with utility backup power, or grid-tied solar with extra battery storage.
- Some hybrid systems also have a backup generator tied in with the system.

Hybrid Solar System



- **COMPONENTS OF A HYBRID SYSTEM**

- PV panels
- Battery bank
- Charge controller (to protect the battery bank from overcharge)
- Inverter
- Required electrical safety gear (i.e. fuses, breakers, disconnects)
- Monitoring system to monitor energy production (optional)

- **ADVANTAGES OF HYBRID SYSTEMS**

- Less expensive than off-grid solar systems i.e. without the generator.

- **DESIGNING THE SYSTEM OF SOLAR PV SYSTEM**

- Systems are designed for worst month conditions such as December where there may be less sunlight. Also designed for worst load scenario such as a power spike from equipment.
- The best way to go about designing your system is to first make your home energy efficient, i.e. replacing fluorescent, incandescent and other bulbs to led bulbs, changing ac units to inverter, buying energy efficient TVs and refrigerators etc...
- Load requirements
- Location
- Roof suitability ☐ structure, spacing, and positioning

- **LOAD REQUIREMENTS**

- Finding the power consumption of your home or business determines the size of your system.
- Your load requirement is determined by doing an energy audit which gives the total energy consumption of your home or business.

- **PV LOCATION**

- The Location of solar panels is crucial in determining it' s reliability to acutely receive sunlight to power your system and charge it efficiently.
- The solar array must be installed in an area free of shading in order for the panels to efficiently produce.
- The panels must be installed facing south... True south vs magnetic south
- Panel should be tilted at an angle equal to the latitude of your location. Jamaica is 18degrees latitude so panels are tilted at an 18degree angle.

- **PV MOUNTING**

- Panels are tilted to get maximum sunlight and for self cleaning effects
- Racking

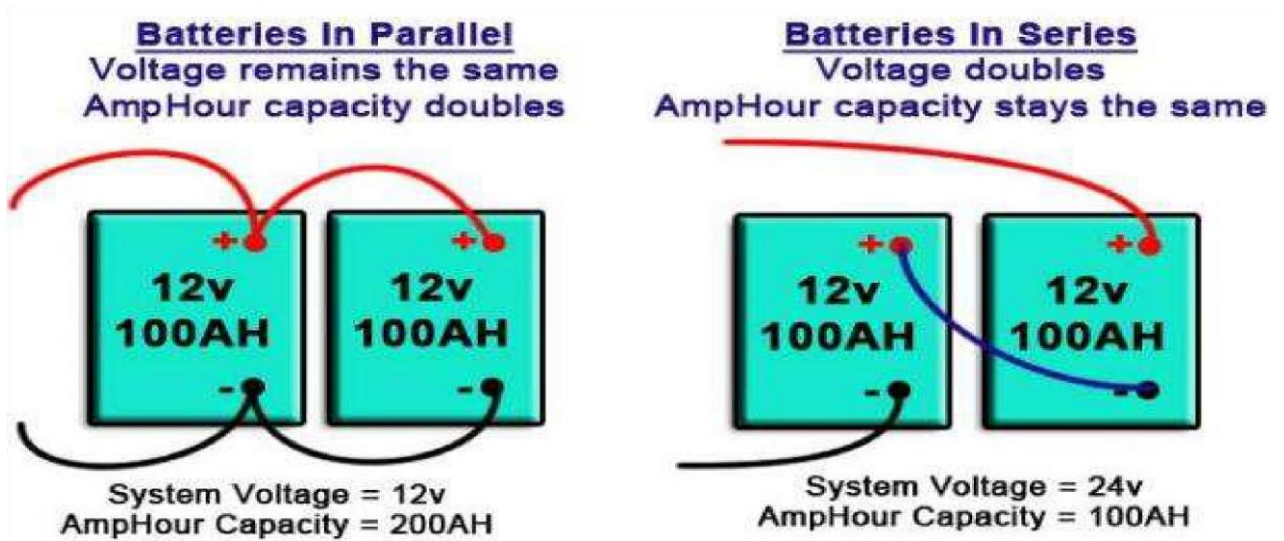
- **ROOF SUITABILITY-STRUCTURE, SPACING, AND POSITIONING**

- If panels are to be installed on the roof. The roofing structure must be stable and of suitable materials.
- A type of roofing materials is also crucial.

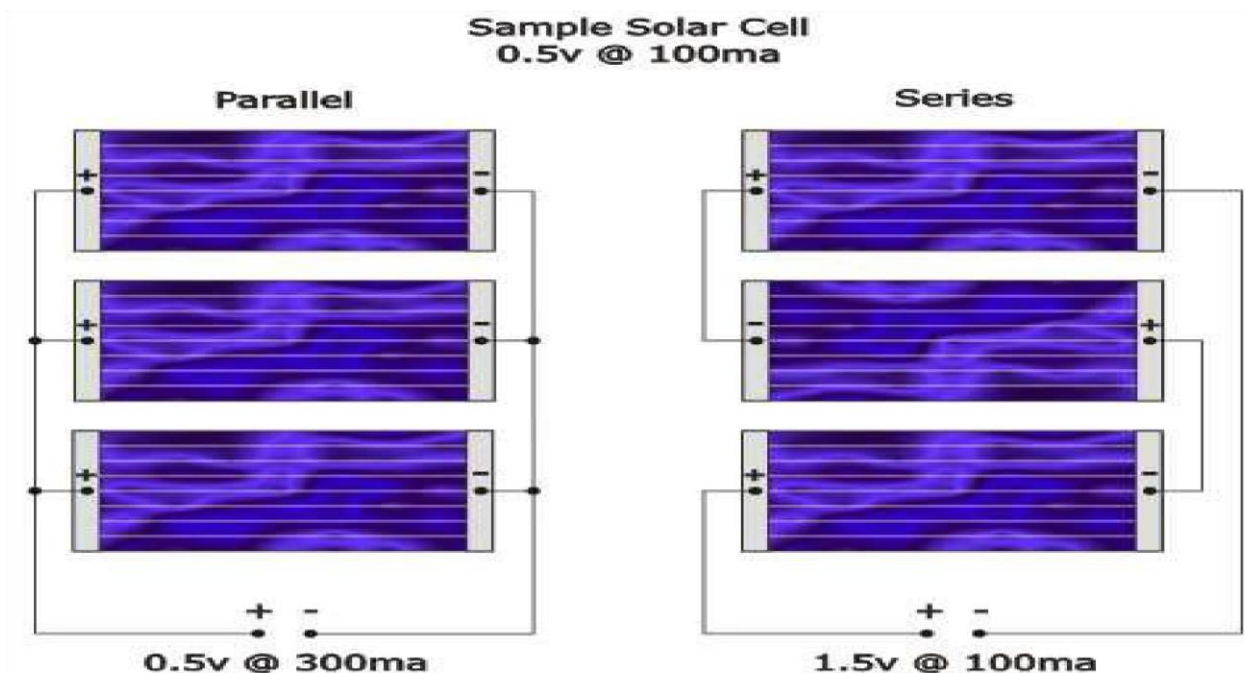
- **SAFETY!!!**

- Grounding of PV System
- Disconnects
- Overloads
- PPE: Gloves, Hard Boot, Harness and Rope
- Double checking connections
- Danger of DC Voltage

- **BATTERY WIRING**



- **PV WIRING**



Wind-Mill

- **What are Wind Turbines?**

- Wind turbines are devices that convert the wind's kinetic energy into mechanical energy.
- If it further converts the Mechanical energy to electricity, then we call it a wind generator.
- For convenience, whenever you see the word:
 "Wind turbine" after this slide, it will refer specifically to a wind generator.
- Wind turbines have a variety of shapes and sizes



- **Basic Parts**
 - A. Rotor Blades
 - B. Shaft
 - C. Generator

✚ Rotor Blades:

- The rotor blades are the “wind catchers” of a wind turbine. They’ re long projections that have aerodynamic designs.
- When wind passes, it forces these rotor blades to turn.

✚ Shaft:

- The shaft is a rod that connects the rotor blades to the generator.
- Its main purpose is to transfer the rotational mechanical energy of the rotor blades to the generator.

✚ Generator:

- Finally, the generator is a device designed to convert mechanical energy into electrical energy.
- It uses the principle of electromagnetic induction.
- Now that you know its basic parts, let’s understand how wind turbines generate electricity.

● **Basic Processes**

- A) **Capturing Wind Energy**
- B) **Converting to Electricity**

A) Capturing Wind Energy:

- ✓ Wind energy is captured using the wind turbines rotor blades.
- ✓ When wind passes through the blades, two aerodynamic forces are at work.
- ✓ These two forces cause the rotor blades to turn, depending on how much force the wind exerts on them.
- ✓ The process converts the wind’ s kinetic energy to mechanical energy (turning of rotor blades).
- ✓ After this, it’ s time to convert the mechanical energy into electricity.



B) Converting to Electricity:

- ✓ The turning of the rotor blades would simultaneously cause the shaft to turn, which is connected to a generator.
- ✓ When the rotor blades turn, the shaft also turns. This makes the generator produce electricity!
- ✓ In this process, the rotational mechanical energy of the shaft is converted to electricity by the generator.

● Other Processes Involved

❖ Increasing RPM

- ✓ You might notice that large wind turbines turn slowly.
- ✓ On average, their rotor blades rotate at a speed of 20 rpm (rotations per minute).
- ✓ 20 rpm is too slow to power up a generator!
- ✓ Large wind turbines use a gearbox to increase the rpm from 20 rpm to as much as 2000 rpm!
- ✓ In large wind turbines, they use a variety of gears (hence the name, gearbox) to multiply the rpm of the shaft.

❖ Yaw Adjustment (HAWT only)

- ✓ HAWTs (horizontal-axis wind turbines) should be directed the same direction as the wind to maximize the energy collected.
- ✓ Wind direction isn't constant though, so modern HAWTs use a yaw adjustment system.
- ✓ To position the rotor blades in the correct direction.
- ✓ The system usually consists of a sensor to monitor wind direction and a motor to adjust turbine direction.

❖ Braking Mechanism

- ✓ Finally, there are places where wind speeds can reach extremely high levels.
- ✓ Overspeeding of the rotor blades can cause malfunctions on the wind turbine's system.
- ✓ This is why a braking mechanism should exist to limit the maximum speed of the rotor blades.

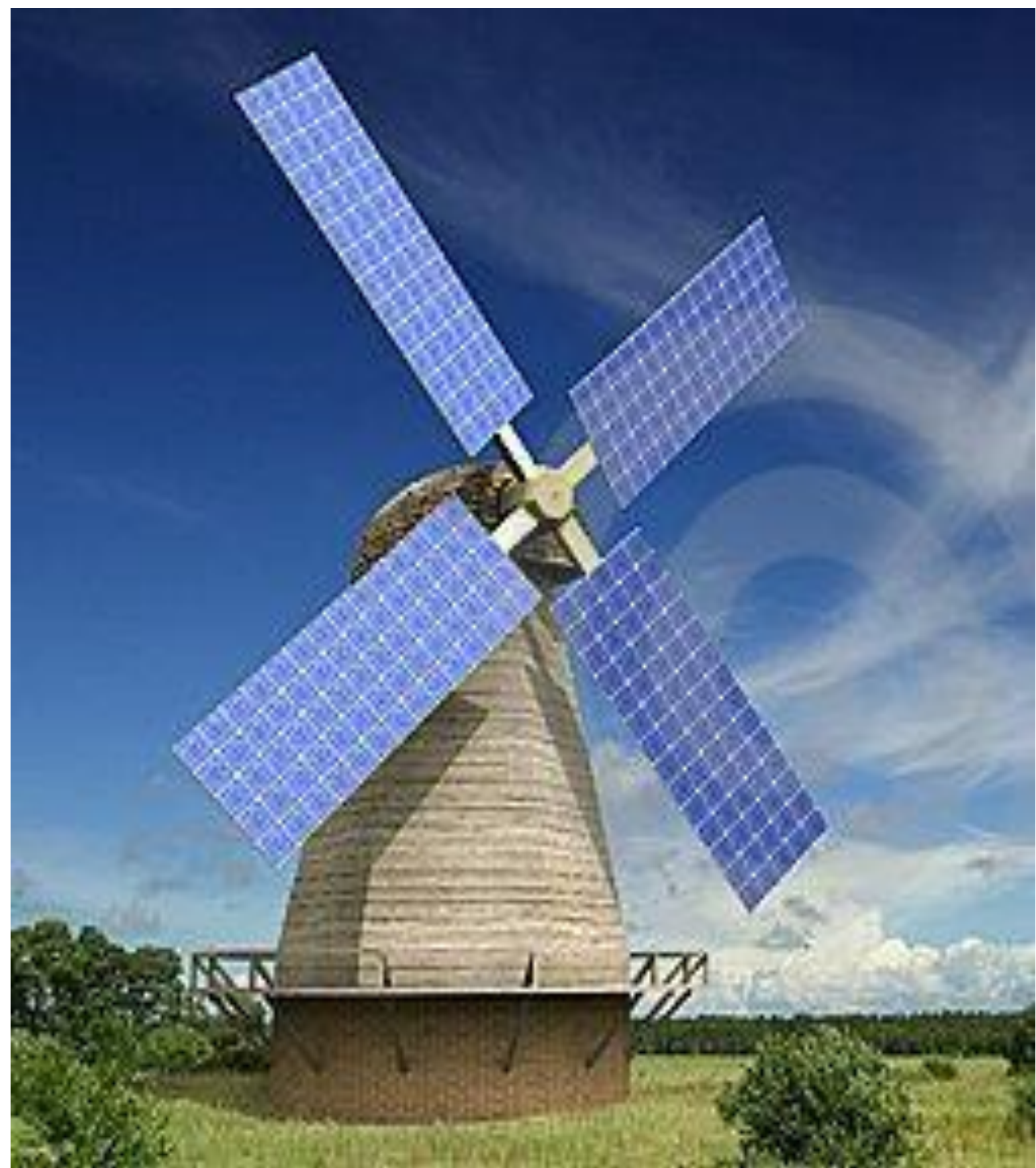


Fig. 1 Solar-Windmill

• MIND MAPPING & AEIOU

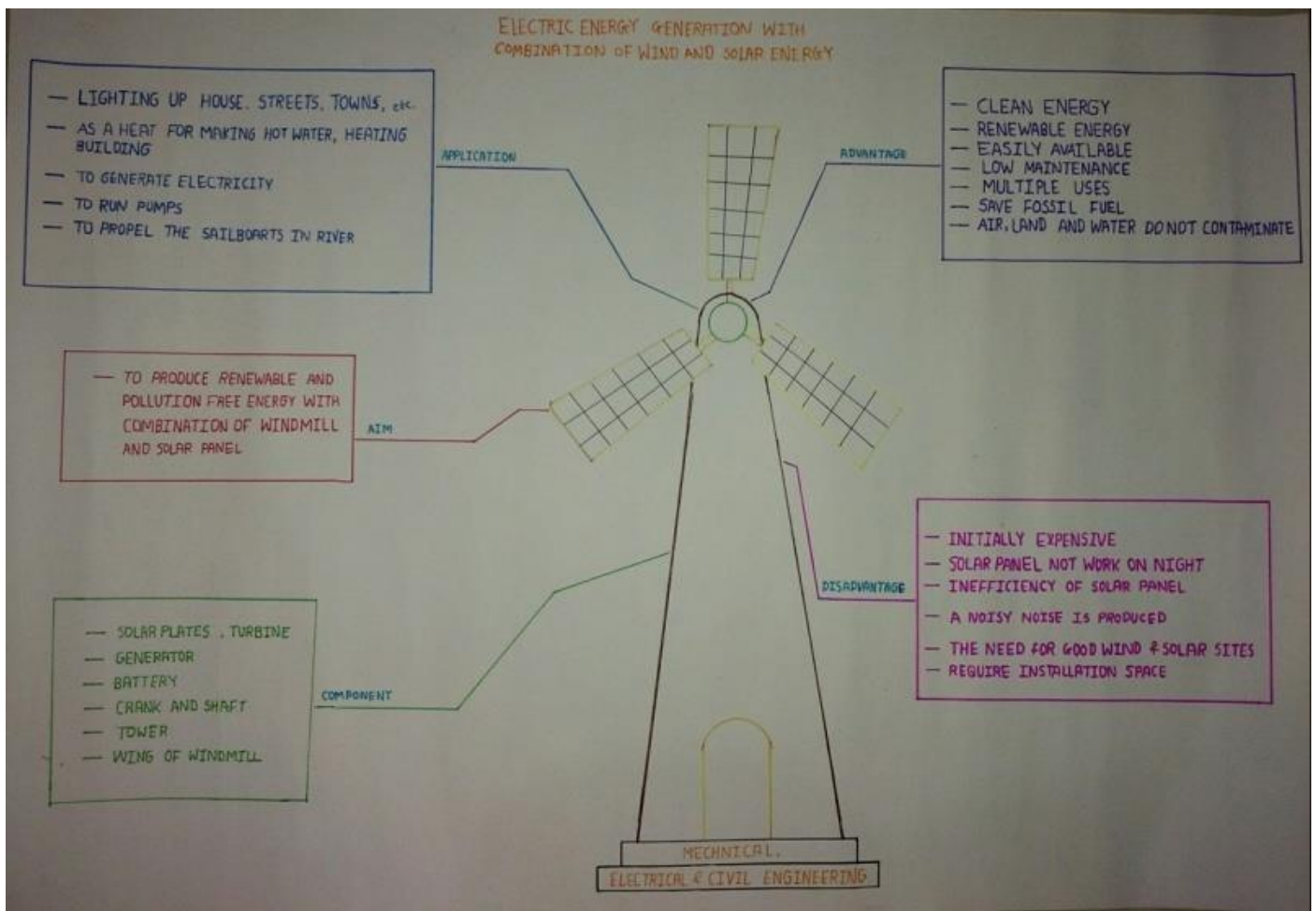


Fig. 2 MIND MAP

- › The domain of project is “ Solar-Windmill ” which means using solar and wind system simultaneously or together produces conventional electricity.
- › The mind map indicates different advantages, disadvantages, components and application.
- › It also describes aim of this project why we make.
- › Aim of this project is ,” To produce and pollution free energy with combination of solar system and wind system.
- › The project is base on different engineering branches such as Mechanical is related with machinery which use in project, Electrical is related with wire connection and Civil is related with set-up infrastructure.
- › AEIOU canvas shows the project effect on environment, interactions with different field people, which are the objects use in project, which activity occur before project complete and what is application of project.

1)Mention scene of interaction.

- Interaction with people
- Interaction with student
- Interaction with professional engineer
- Talking with Professor

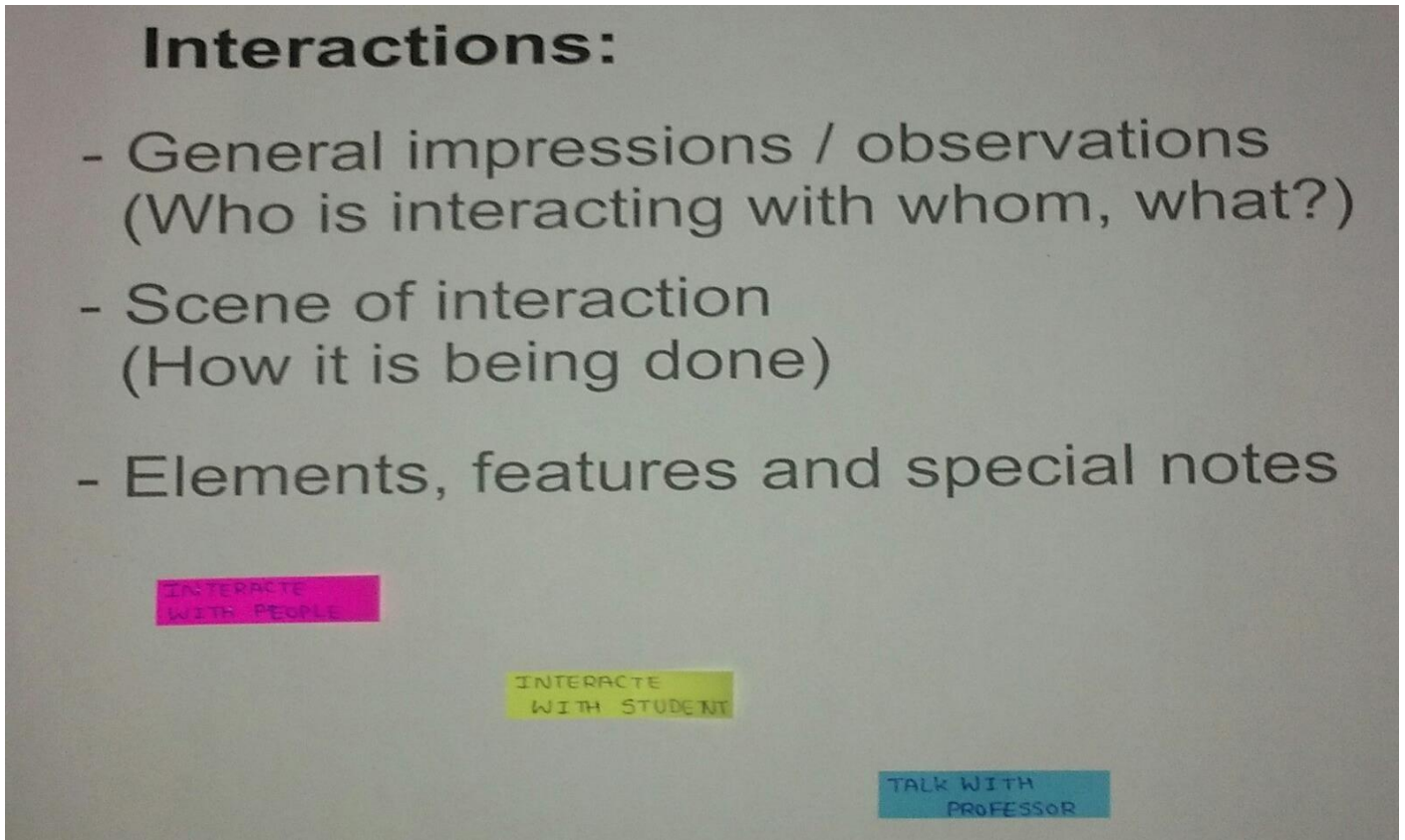


Fig. 4 INTERACTION FOR PROJECT

2)What is environment style before and after set-up Solar-Windmill?

- Before:
 - Everywhere Pollution
 - Overuse of fossil fuel
- After:
 - Clean and keep environment
 - Slowly-slowly no pollution environment

·EMPATHY MAPPING

1) What domain area or prerequisite we started with empathy canvas ?

- ❖ After getting the important instruction from our faculty guide during the DE lab session, we had a healthy discussion with the people of all age group regarding our project. The reviews and suggestions were noted down in the log book and then we started compilation of empathy canvas.

2) Enlist all the activities of the user mentioned in the canvas and write briefly about them.

- ❖ Discuss various topic for design social and environment healthy project.
- ❖ Selecting solar-windmill project
- ❖ Create different canvases like AEIOU, Empathy, Ideation and Product development
- ❖ To prepare design for model
- ❖ Preparing infrastructure for set-up real model
- ❖ Making model for use

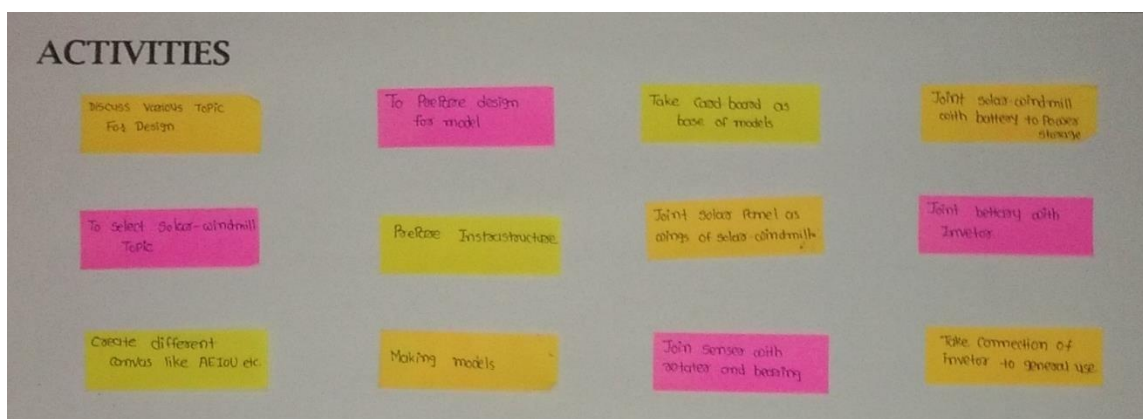


Fig. 5 ACTIVITIES

3) Who was the selected user? Who were the stakeholders?

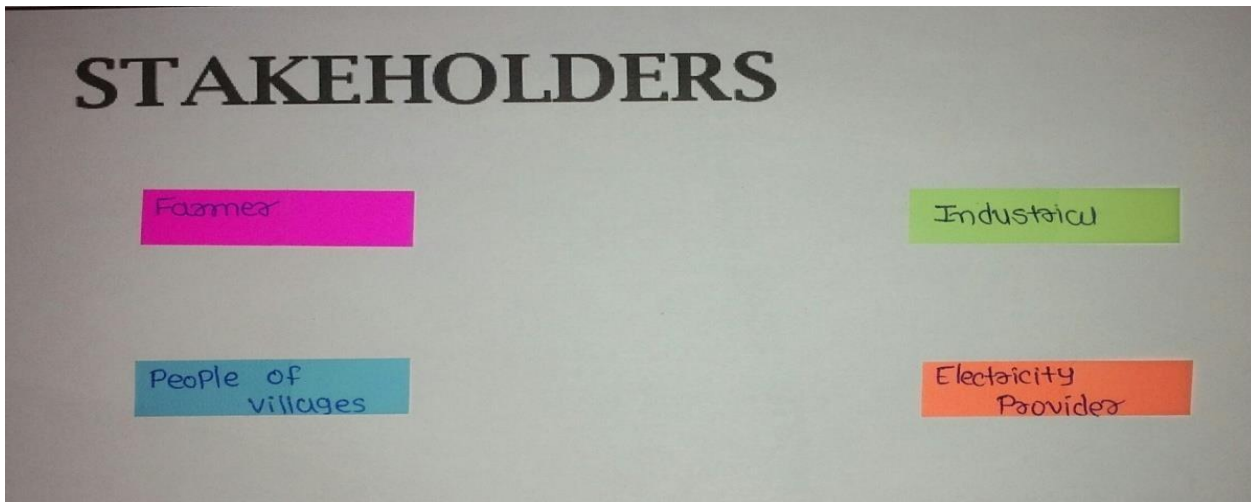


Fig. 6 STAKEHOLDERS

4) Enlist all the uses of project.

- ❖ To run water pump
- ❖ To generate electricity
- ❖ Lighting up houses, streets, villages and city etc.
- ❖ To heat water for bathing and general house use etc.
- ❖ Heating building in cold season
- ❖ To propel boat in river



Fig. 7 USER

5)Mention the stories in the canvas.

❖ Happy story:

There was a very happy and green village whose name was Rampur. The village was rapidly growing. The honorable sarpanch of this village was Shri Gadhiya, awakened the people of the village about Solar-Windmill. So all the people of village collected the fund from villagers for solarwindmill, a few miles away. So that the problem of this village was reduced and much money was saved in the village. This thing happened to the people of village around this area. So all the people of Rampur organized an honor ceremony to the sarpanch.

❖ Happy story:

Shortly, before we setup a solar windmill in our village. Because of this our saving in home and farm vapolized. Lighting generates electricity through monsoon and winter by wind and solar energy in the summer. We all happy that there is a windmill in our village. All the people of the village say this about the happiness of their village and advise to setup solar-windmill.

❖ Sad story:

All were happy with the coming of solar-windmill in our village. Solar-windmills were monitored at two month interval. But one day the person with a bug supervisor broke the wires connecting the wires in the power storage room and died of a wire shredded short shirk. Apart from the fire there and the fire spread out in the entire room. Power storage will be burned to ashes the crop of Manubhai' s farm in the side of the fire was burnt. There was a sense of mourning in the whole village.

❖ Sad story:

We were all happy with solar-windmills, but there was a rainy season. There were thick clouds in the sky. Then suddenly a strong wind blew. Hurricanes caused solar-windmills to fail. That' s why our village was having electricity. Besides, there is loss in the field of Ravjibhai in the adjoining area. The additional burdens of repairing costs of solarwindmills have been overcome by the people of village.

Design For **GOVERNMENT**

Design By **ANURAG K. SINGH**

Date **02/09/2019**

Version **1**

USER

- To have better power
- To have better electricity
- To have better building
- To have better internet

STAKEHOLDERS

- Government
- People of villages
- Industrial
- Electricity Provider

ACTIVITIES

- Discuss various topic for design
- To prepare design for model
- Take good board as base of models
- Joint solar windmill with battery to power storage
- To select solar-windmill parts
- Prepare Infrastructure
- Joint solar panel as wings of solar windmill
- Joint battery with inverter
- Create different models like AETOU etc.
- Making models
- Join sensor with motor and battery
- Take connection of inverter to general use

STORY BOARDING

HAPPY

There was a very happy and green village whose name was Rampur. The village was happily growing. The honorable goddess of this village was Shri Gadhigo, who told the people of the village about solar-windmill. So all the people of village collected the fund from the villagers of solar windmills, a few miles away. So that the problem of this village was reduced and the money money was saved in the village. This thing happened to the people of village around this area. So all the people of Rampur organized an honor ceremony to the goddess.

HAPPY

Shortly, before we set up a solar windmill in our village. Because of this our saving in home and farm was reduced. Lighting generates electricity through monsoon and winter by wind and solar energy in the summer. We are all happy that there is a wind mill in our village. All the people of the village say this about the happiness of their village and advises to set up solar-windmills.

SAD

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SAD

We were all happy with solar-windmills, but there was a rainy season. There were thick clouds in the sky. Then suddenly a strong wind blew. Hurricanes caused solar-windmills to fail. That's why our village was having electricity. Besides, there is a loss in the field of Rajubhai in the adjoining area. The additional burden of repairing costs of solar windmills have been over come for the people of village.

Fig. 8 EMAPATHY CANVAS

· IDEATION CANVAS

1)Mention the set of people in ideation canvas.

✓ Farmer



✓ Industry



✓ People of village



✓ Electricity provider



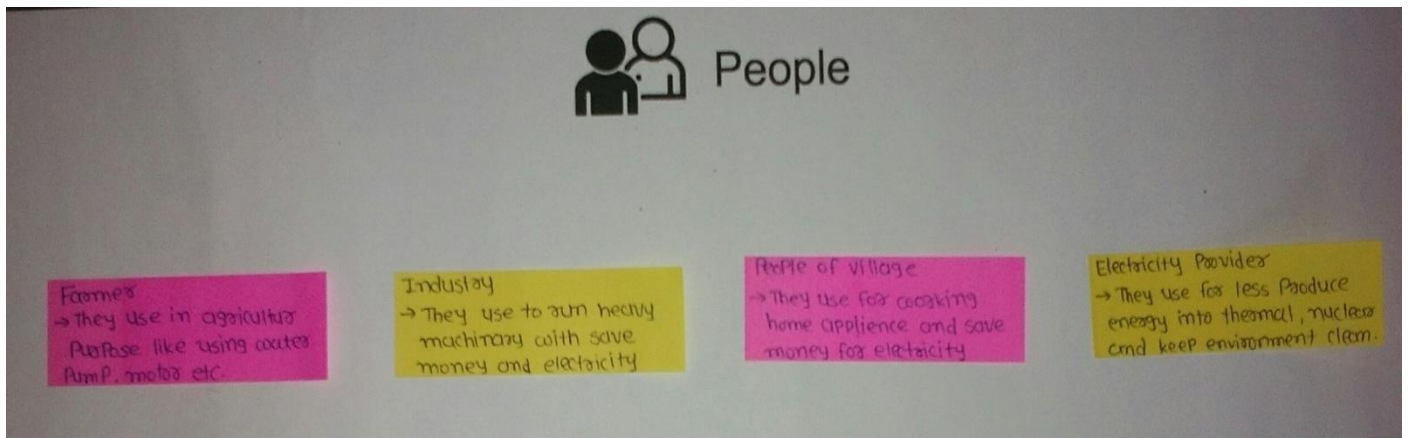


Fig. 9 WHICH PEOPLE USE

2) List down every single activity mentioned in the canvas.

- ✓ farmer use to start water pump for drinking of crop ✓ Heavy machinery start with saving money ✓ Lighting up houses, streets etc.
- ✓ Less use of coal, diesel, gas and other fossil fuel for producing electricity

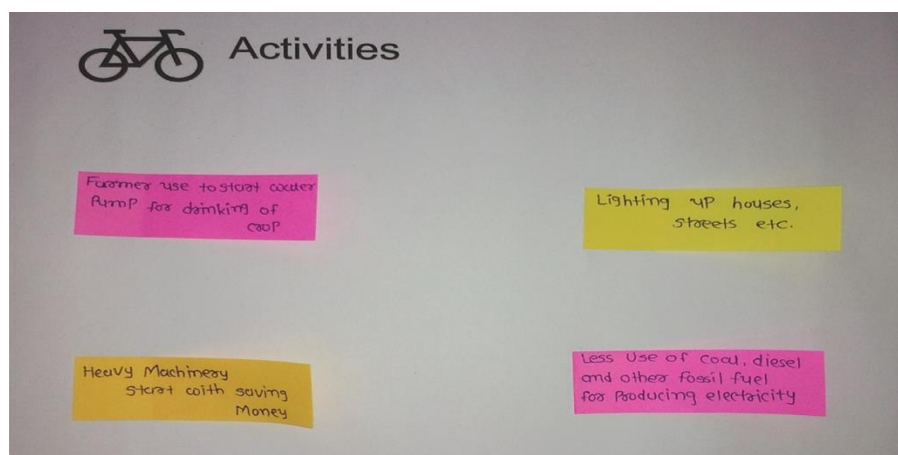


Fig. 10 ACTIVITY

3) List down various situation, locations and contexts in the canvas.

- ✓ Location: At high Position where power is not come
- ✓ Situation: Save money and environment clean electricity
- ✓ Context: Natural resource and availability of 24 hours electricity

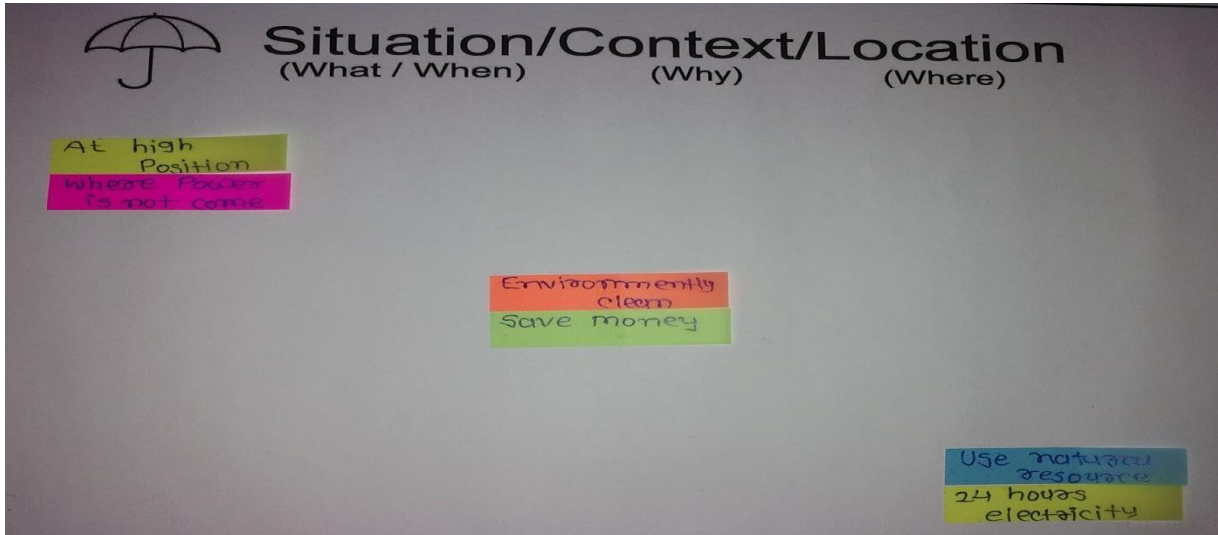


Fig. 11 SITUATION, CONTEXT, LOCATION

4) Mention all the objects/equipments include in your canvas.

- ✓ Inverter
- ✓ Transformer
- ✓ Solar panel as wing of windmill
- ✓ Rotor hub
- ✓ Lead acid battery
- ✓ Anemometer
- ✓ Power storage

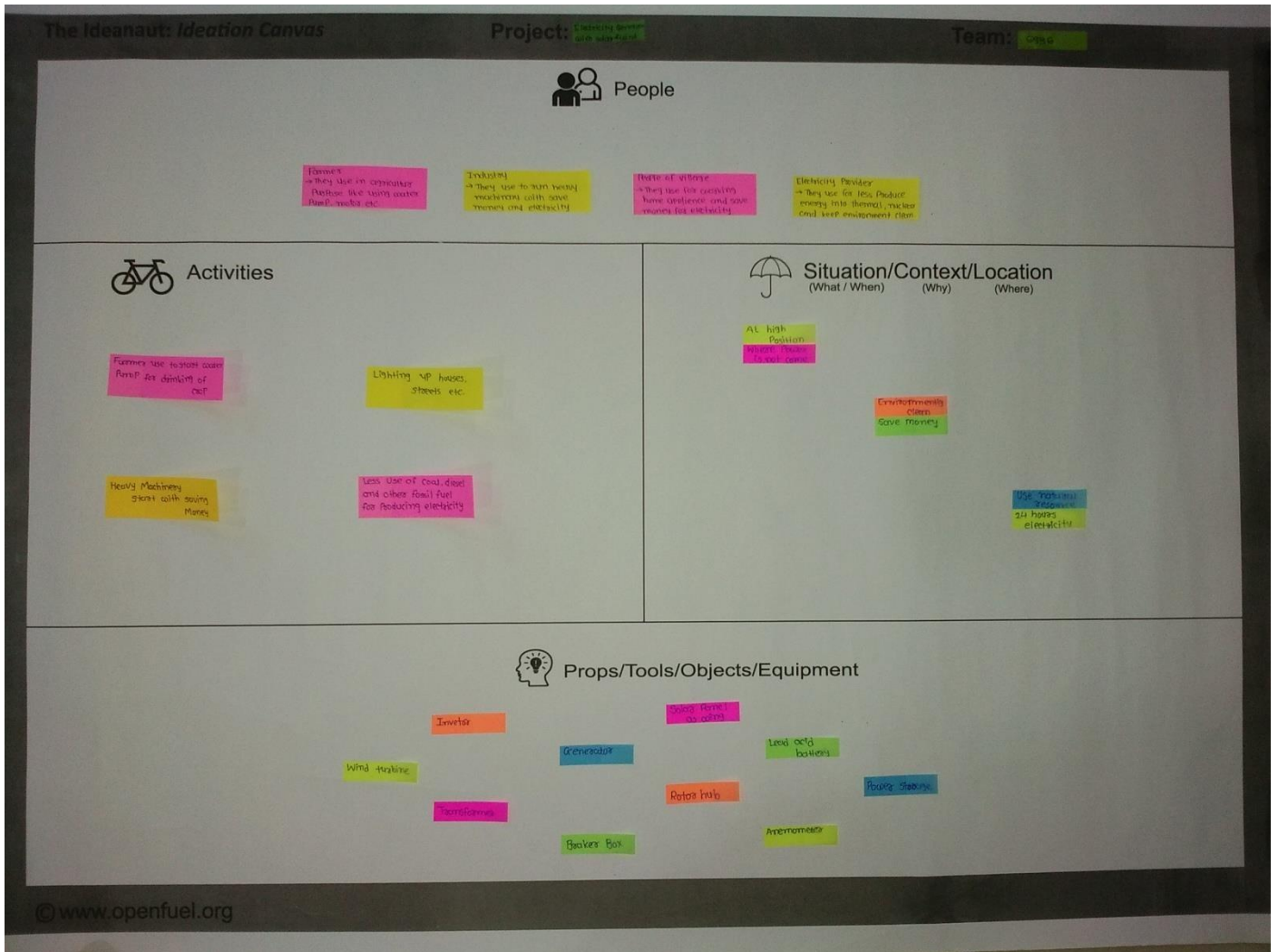


Fig. 12 IDEATION CANVAS

·PRODUCT DEVELOPMENT

1) Purpose:

- ✚ Solar system is conversion of sunlight into electricity and use of airflow through wind turbine for electricity
- ✚ Using conventional, natural and renewable energy more and more
- ✚ Reduce use of thermal and non-conventional energy source
- ✚ Keep environment clean and healthy clean and healthy

2) Product experience:

- ✚ Customers convince for product reliability and efficiency
- ✚ Product cost is more initially but after it save money
- ✚ Not spread Pollution

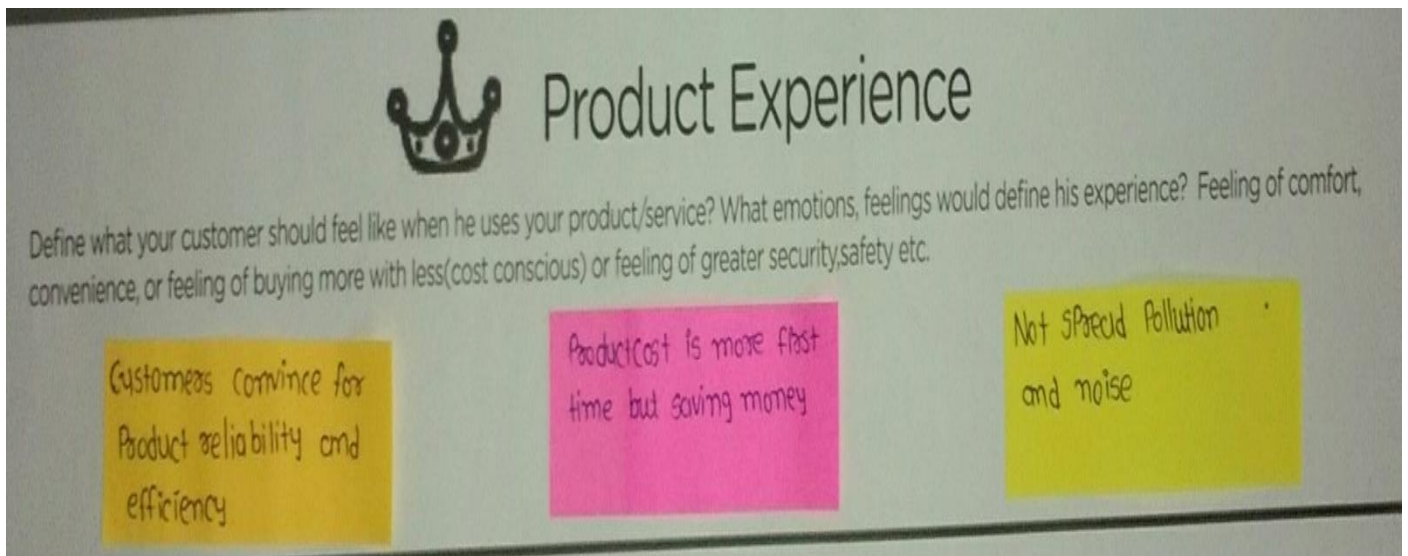


Fig. 13 PRODUCT EXPERIENCE

3) Product function:

- ✚ Solar panel and windmill do not have to set up separately
- ✚ It is useful in every season such as winter, summer and monsoon

4) Product feature:

- ✚ A good grounding system plays a critical role against catastrophic damage to blades, transformers, nacellers
- ✚ To ensure turbine operate at peak-efficiency, technical teams on call around the clock to clock
- ✚ After a storm, do not attempt to reconnect solar PV system if your roof may be live or residual moisture may have become live
- ✚ The blades of wind turbine are most susceptible to weather conditions and cracking
- ✚ Lead acid batteries are a tested technology that has been used in off-grid energy system for decades

Product Functions

Functions are a products answer to user problems/need. They do something that user wants. They are often verbs in nature. Every function is powered by many features. Multitasking is a function. Browser tabs is a feature that powers the multitasking feature. A function can have one or more features powering it. Functions are very generic in nature, features are often more specific. Functions can be similar to product experience. Safety (product function) provides a feeling of safety (product experience)

Solar Panels and windmills do not have to be set up separately.

It is useful in every season such as winter, summer and monsoon.

Product Features

Product features are specific. One or more features will power a function. Antilock Brakes, Airbags are fetures that power the safety function. Browser tabs, Apple's home button to multitask between apps are features powering the multitasking function. Each feature will have many components/sub components powering it. Sometimes a very popular component becomes a feature in itself. Like car stereo is a major components and a feature at the same time powering the in car entertainment function powering entertainment as a product experience.

A good grounding system plays a critical role against catastrophic damage to blades transformers, nacelles.

To ensure turbines operate at peak-efficiency, technical teams on call around the clock to clock.

The blades of your wind turbine are most susceptible to weather conditions and cracking.

After a storm, do not attempt to reconnect solar PV system if your roof may be live or residual moisture may have become live.

Lead acid batteries are a tested technology that has been used in off-grid energy system for decades.

Fig. 14 PRODUCT FUNCTIONS & FEATURES

5) Components:

- ✚ Wind turbine
- ✚ Inverter
- ✚ Transformer
- ✚ Generator
- ✚ Breaker box
- ✚ Battery
- ✚ Solar panel

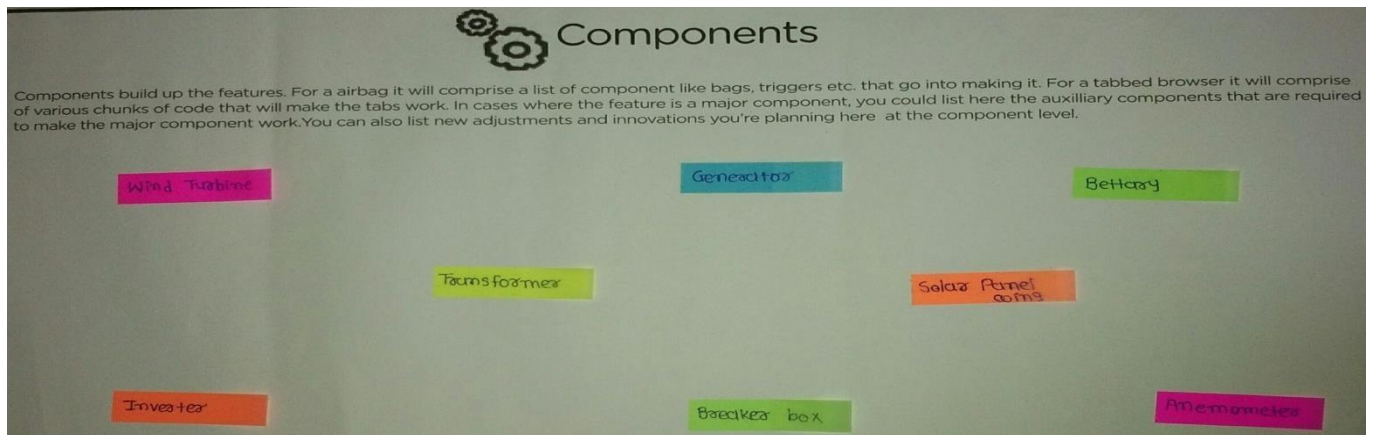


Fig. 15 COMPONENT

6) Customer revalidation:

- ✚ Initially expensive
- ✚ Noise is produce by wind turbine
- ✚ Required good wind
- ✚ Required good sunlight
- ✚ Required more installation space

7) Reject, Redesign:

- ✚ Noise produce by wind turbine. So, oiling turbine time to time
- ✚ Set up solar-windmill on high position
- ✚ Use high efficiency material for solar-windmill and daily check

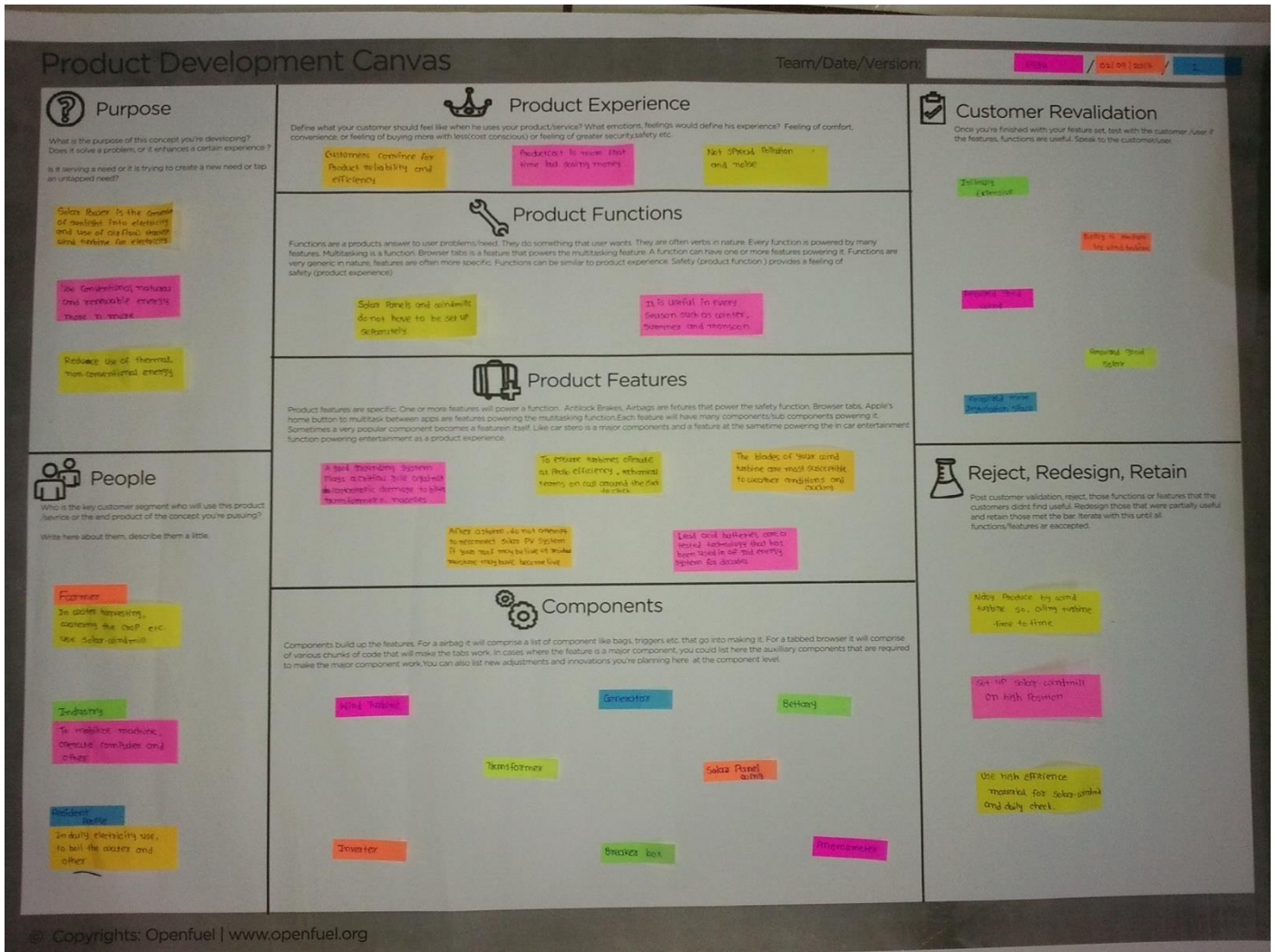


Fig. 16 PRODUCT DEVELOPMENT CANVAS