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Off Grid Carbon Neutral Integrated EV Charging Complex

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***Abstract*: The proposed off-grid integrated system will be very useful when there is a sudden grid failure. It will continue to provide charging for two and four-Wheelers. Besides it will enable bio-CNG dispensing, sale of milk, sale of organic manure, sale of cow urine for medical usage that can even be exported, and let you claim carbon credits as well.**

***Keywords*: EV charging station, agri-voltaic farms, hydrogen generation system, compressed biogas plant.**

1. Introduction

Many new technologies are getting introduced across the length and breadth of our country, such as:

- EV charging station
- Compressed bio gas plants
- Agri-voltaic Farm
- Battery based energy storage systems
- Hydrogen generation systems

As of today, all the system are being planned in soils and are being built as independent system. But this is the right time to plan integrated systems, which can offer additional benefits, apart from their intended use it will allow to use drive multiple benefits. A brief introduction to each of these have listed technology are given in methodology.

2. Literature Review

A. Agri-Voltaic Farms

Agri-Voltaics is a combination of agriculture and the solar photovoltaic energy generation. PV power plant need large availability of land. Usually, the land selected for PV installation is barren land. If agriculture land has to be used, then agri-voltaics should be preferred. In Agri-Voltaic, the PV panne are installed at a height of more than 244com, and only 30-40% area is covered by the panels. Here the presence of plants provides cool air to the solar panels. Cooler PV panels produce increased power output. Also, the water used for cleaning the panels irrigates the plants and does not go waste. The farmer is assured of regular income by selling electric power generated by the PV panels. Also, he can do the farming and double the income.

B. EV Charging Station

The number of electric vehicles is increasing day by day, which is also increasing the need for EV charging stations. Both government and private companies have started building charging stations. These stations are of two main categories: within the city and along the highways. Here we shall focus on the charging stations being installed along the highways and major roads between cities.

1) Level 1 (L1) Charger

These are slow chargers that take eight to ten hours to charge a depleted battery. Hence these are used in residences for overnight charging.

2) Level 2 (L2) Charger

These take about four hours to charge. Such chargers are installed in housing complexes, work places, restaurants, malls, etc.

3) Level 3 (L3) Charger

These are DC superfast chargers. An L3 charger can charge a depleted battery to 80% within an hour or two. These are special chargers that are installed by the automotive manufacturers or government agencies along the highway.

C. Compressed Biogas Plants

Biogas plants are quite common. These plants use bio waste material, cow dung, etc., and produce methane gas. This gas is normally used for cooking. However, if we have to use it for CNG vehicles or for generators, the raw biogas has to be treated; it contains carbon dioxide, water vapour, and hydrogen sulphide gas. When these unwanted gases are removed, we get 90% concentration of methane, which is then compressed. Compressed biogas is a good substitute for CNG.

D. Battery based energy storage systems

Electric grid gets power from various sources, such as coal power plants, hydel generators, nuclear, solar, and wind. As a greater number of solar and wind power plants are getting installed, the renewable energy content in the mix is increasing.

Unfortunately, the renewable energy sources are highly variable and unpredictable. This poses problem for the grid stability. Sometimes there is excess power generation and other times there is sudden reduction in generated power.

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In order to stabilise the grid, there is need for short-term energy storage. A battery bank can be used in such a situation. When there is excess energy, the batteries can store the energy. When there is demand for energy from the grid, stored energy from the batteries can be used.

Even though use of batteries appears to be a simple solution, the cost of these batteries is very high. Luckily, this being a land- based application, size and weight of batteries is not very critical. Hence, even the cheaper lead-acid batteries can be used.

Another option for reducing the cost is to use discarded lithium- ion batteries from electric vehicles. Such batteries still have about 75% storage capacity.

E. Hydrogen generation systems

Hydrogen is emerging as an alternative to fossil fuels. To make green hydrogen, renewable energy is used. When current is passed through an electrolyser, it splits the water molecules into hydrogen and oxygen. Hydrogen has many uses. We can mix hydrogen with CNG up to 20%. This mixture of gases can be used in the same equipment as the original CNG generator or vehicle, without any modification to the engine. Also, the safety precautions remain the same as for pure CNG handling.

F. Flow of Working

Below block diagram gives the simple flow of working which gives the multiple useful outputs. The agri-voltaic Farm is the central to the system. As the Solar panels mounted in the farm generates the DC power in daytime. This DC power is then directly supplied to the DC super-fast Chargers as shown and the unuseful power is then converted in to AC by inverter and Supplied to the grid which cause in terms of the incentives for the system.

As the more land covered by the farm, there is the production of other substances such as the crops, vegetables, grass etc. The cultivated Grass is then given as an input to the cow shed. The two outputs were produced from the Cow shed one is Milk production and the other is Cow dung. This cow dung is then given to the Bio-gas plant.

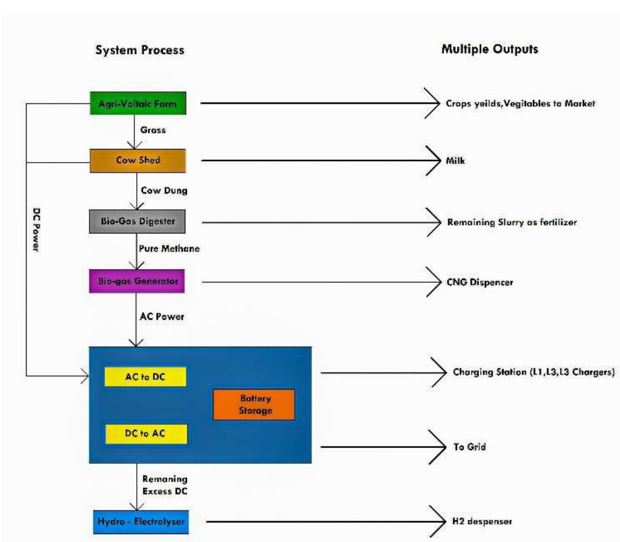

Fig. 1.

The biogas plant Consist of the Bio-gas digester and the generators. Here the Slurry from the bio-gas digester is used as a fertilizer in the Farm and the production of the methane is given to the generator. The methane is used as a CNG Dispenser for the vehicles and also it generates the AC power given to the A/D and D/A converter including the Battery Storage Banks.

After using the energy for the useful work, the remaining energy is then fed to the Hydro-Electrolyser. Here the Electrolyser splits water into hydrogen and oxygen. the hydrogen can be stored in storage tank. the simplest way to use hydrogen is to mix with CNG. up to 20% hydrogen can be mixed without needing any modification to the CNG system. Also, another way to use this hydrogen is for the Hydrogen Dispensers.

3. Calculations

A. Agri-Voltaic Farming

Total Area = 1 .5Acre (30% solar, 70% Agriculture Approx.)

Solar Panel:

Total Solar Panels = 1210

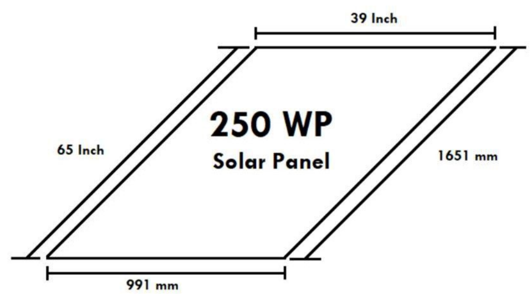

Fig. 2.

Dimension:

Length 65`[1651 mm] Width 39`[991mm]

Area 17.60 Sq.Ft.[1.6354 sq.m.]

Area Covered by Solar:

= Total no. of solar *Area of one solar

= 1210*17.60

= 21296 sq.ft.(20 gunta)

% Area Covered:

= Solar Area/Total Area *100

= 20/60 *100

= 33.33%

B. Solar Output

Electrical output form solar for 1 Hour:

= Capacity of Individual Panel * No. of Panel

= 310 w (Peak watt) * 1615

= 500 kwh

Approx Generation 8 Hours a day:

= 500 * 4

= 2000 kw/day(Ideal Condition)

= 1800 kw/day(With 90% Efficiency)

C. Biogas Plant

Area Calculation:

- Cow Shed 80(L) * 46(B) = 3680 sq.ft.
- Biogas dom 33(D) * 18(H) = 594 sq.ft. Or 10(D) * 5.5(H) = 55 sq.m.

i.e., 400 cubic meter.

400 cubic meter includes space for slurry and gas also

Biogas filter and storage:

- Space 700 cubic meter of biogas balloon
- Total area 8(L) * 8(W) * 15(H) = 920 sq.ft
- Land Area 64 sq.ft.
- Filters 10(L) * 10(W) = 100 sq.ft.
- Slurry Formation 5 (L) * 5 (W) = 25 sq.ft

Input output calculation:

- Total No. of cows 50
- Milk 1800 Liter per year/cow
- Average milk/day 5 Liter/cow
- Total milk 5 * 50 = 250 Liter/ day
- Cow Dung 10 kg/day
- Total Dung 500 kg/day

25 kg cow dung required for 1 cubic meter ($1m^3$) raw bio gas.

Cow dung needs to be contained in anaerobic digester for 20 days (minimum) hence the digester is designed such as it should carry a cow dung for 20 days Digester Continuous feeding type floating Dome biogas digester (Anaerobic).

Per day cow dung 500 kg

2520-day dung 500 * 20 = 10,000 kg According to (1) capacity of biogas digester is – 10,000 kg cow dung = 400 Cubic meter /day 25

Hence for 50 cows, 400 cubic meter ($400m^3$) biogas plant is required.

Row biogas contains 70% methane

Since, in 400m3 biogas 280 cubic meter ($280m^3$) methane 1m3 pure bio gas produce 6 kwh energy.

So, Total electrical output form biogas plant 280 * 6 =1680 kwh/day

D. Total electrical output per day

= Solar output + Biogas Plant output
= 1450 + 1680
= 3130 kwh

E. Investment Calculation

1) Agri-voltaic

Investment =

- Solar Plant = 2.5Cr.(500kw)
- Land = 7500000 (2.5Cr.)

Running Cost =

- Maintenance = 20000/month
- Labour Cost = 112000/month

Income:

Agriculture output = 10000/month (average via various crops) Electricity Generated = 1800kw (installed capacity-500kw)

- Rate = 4rs/unit
- Solar Plant =1800*4 = 7200rs/day
- Output = 7200*30 = 216000/month
- Total = 226000rs/month

Profit = Income – Running Cost
= 226000 – 132000
= 94000/month

Total electrical output possible per day
= Solar output + Biogas Plant output
= 1800 + 640
= 2440 kw/day

F. Biogas plant

Civil construction - 60,00,000

1) Running

- Cow dung - 2rs/kg
- Requirement- 500kg/day (expandable)
- Cost- 30,000/month
- Labour- 65,000/month
- Light bill- 25,000/month
- Transportation- 5,000

2) Income

- Biogas-50rs/kg
- Output = 130*50*30
- Gas production/day*cost/kg*day in month

Running Total income=4,09,500 Running cost - 1,25,000

Profit - 2,84,500

- Fertilizer Plant Investment
- Machinery = 3,50,000/-
- Civil Construction = 2,00,000/-

Running

- Electricity Bill = 10,000/
- Labour Cost = 45000/-

Income

Organic Fertilizer = 10/kg
= 500*10
= 5000/day
= 150000/month

Profit = 150000 – 45000
= 1,05,000/-

G. Cow shed Investment

- cow- 1,00,000/cow
- 50 cow- 50,00,000
- Civil construction - 8 L

1) Running cost

- 100rs/cow/day
- 1,50,000 per month
- Labour cost-1,05,000/month
- Light bill -5000/month

2) Profit

- Milk- 6lt/day/cow
- Total- 9000 ltr
- Cost/ ltr= 40
- Milk outcome - 3,60,000
- Cow dung - 2rs/ kg
- Dung per day = 10kg/cow

- Dung outcome = 30,000rs/month
- Cow Urine = 2rs/ltr.
- Urine per day = 7ltr/cow
- Urine Outcome = 21000rs/month

Running cost= 2,60,000 rs/month
Income = 4,11,000 rs/month
Profit=1,51,000 rs/month

H. Control Room

- Construction = 3000000/-
- SCADA = 400000/-
- CCTV = 84000/-
- Screen = 58000/-
- Battery Storage (250Ah- 40 units) = 640000/-
- Bio-gas Generator (12kva) = 150000/-

Total = 43,32,000/-

I. Running

- Labour = 80000/-
- Electricity bill = 10000rs/month

Total Investment = 7,76,62,000/-

Total Running Cost = 8,73,400/-month
Income = 20,70,500/-
Profit = 12,17,100/-
Payback Period = 5 Year 4 month

4. Conclusion

Along the highways there is enough land available for implementing the proposed scheme. An integrated systems offers many more advantages. The return on investment is high. Most of the inputs for running the system is freely available hence there is minimum fuel cost as well as minimal movement of material.

In future, more advanced technologies, such as fuel cells, could be used for more efficient and silent operation. Also, there is a Crowd or Mob of numbers of vehicles for Filling the CNG, So This off-grid system will give very fast operation and reduces the vehicles crowd and be very useful when there is a sudden grid failure as it is independent. It will continue for two-four wheelers.

References

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