Solar Powered Tank – A Prototype Developed For Border Patrolling For Indian Army

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Abstract

In the paper, detailed work on solar powered defence tank is given, it is capable of doing similar task as our conventional defence tank does. The prototype of solar powered defence tank was designed, developed and tested at different locations. It can be scaled up and further modified for patrolling on our borders on any uneven terrain. It can defend as the conventional tank. As there are no electric powered defence vehicles are available the main benefit of the vehicle is that it can be used for patrolling of border areas which need to be defended well.

INTRODUCTION

Energy:

Energy plays a vital role in our day to day life. Growth and economy are largely dependent on adequate supply of energy. With the increase in population, industrialisation, economic growth and technological advances the consumption of energy in the developing countries is increasing very fast. In spite of the maximum harnessing of the available fossil fuels and their import from the other countries, the supply of power is not becoming cost effective [1-3].

Renewable Energy and Non-Renewable Energy Sources

The energy sources can be divided into two broad categories: Renewable and Non-renewable Energy Sources. Both of them are derived from the nature but they are different from the prospective of availability.
The non-renewable energy sources such as coal, petroleum, oil and natural gas take thousands of years to form naturally as their production rate is low as compared to the rate of consumption. Fossil fuels due to their limited availability are considered as Non-renewable Energy Sources. In contrast, the renewable energy sources are continuously produced by natural processes occurring in our environment [4]. Few renewable energy sources are Solar energy, Winds, Geothermal, Biomass, Biogas etc.

Solar Energy: This is the prime driver for renewable energy in current context. With huge natural advantage with abundant solar radiation across the nation, the government intends to achieve solar revolution and have capacity in excess of 100 GW with 40 GW of this coming from rooftop and off-grid segment. There is strong fiscal and financial incentive being provided by government to develop solar projects. The recent focus and trend has seen solar tariff in country drop to record low creating grid parity between solar and conventional sources faster than earlier envisaged.

Wind Energy: With wind capacity in excess of 25,000 MW, India is ranked 5th globally in installed wind capacity. While these installations are primarily in on shore wind, government has recently notified its offshore wind policy indicating its interest in exploiting its offshore wind potential. In addition, opportunities exist in renovation and modernization of old

inefficient wind turbines. Opportunities in engineering solutions, wind resource assessment technologies, operation and maintenance shall be the prime drivers for business opportunities in this area.

Biomass and Waste to Energy: This source is also expected to increase its importance. India already has a significant capacity and technological competence in this sector. Any advanced product or technology will be welcome. Environment / Green Technology India's environmental challenges are diverse and wide-ranging, requiring quick solutions to: 1) Prevent further degradation of the environment 2) Employ technologies to reduce use of natural resources, reduce emission and waste [5].

Solar Energy Resources in India

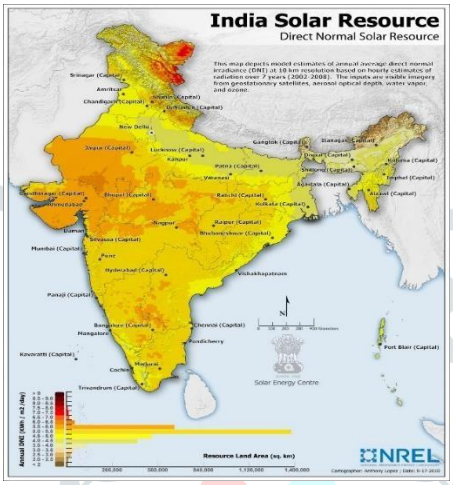

Fig.1 Solar Resources in India [6]

Fig.1 shows the solar resources of India. In India some states are blessed and have ample of solar energy like Rajasthan, Gujarat, Maharashtra and Tamilnadu.

- **Solar radiation in Rajasthan:**

Rajasthan, the largest state in India receives maximum solar radiation intensity in India. According to US Department of Energy,
Rajasthan receives the second largest amount of solar radiation in the world. Rajasthan is best suited for solar power generation since average rain fall is minimum. Solar radiation in Rajasthan is similar to California and Nevada in USA. Rajasthan has around 208,110 Sq.km of desert land. Rajasthan has more than 325 sunny days in a year with solar radiation of about 6-7Kwh/sqm/day. The direct normal insolation over Rajasthan varies from 1800 Kwh/m2 to 2600Kwh/m2. Mostly the western part of
Rajasthan is blessed with abundant solar energy. Jodhpur in Rajasthan is receiving maximum solar radiation which is known as Sun City of India. Rajasthan is also blessed with abundant land, so it would be ideal for solar PV.

- **Solar Radiation in Gujarat:**

Gujarat receives second largest amount of solar radiation in India. Gujarat receives 5.5 to 6 Kwh/sq./day with 300 sunny days/year. Most locations in Gujarat receive an annual Direct Normal Incidence (DNI) in between 1,800 -
2,000 Kwh/m2. Waste land of about 14.40
Million Acres is receiving largest amount of solar radiation. Northern part of Gujarat is receiving more solar radiation. The locations connected by the Rann of Kachchh region of Gujarat receive the maximum DNI in the state.

DEFENCE SECTORS OF INDIA:

India has mainly six departments in defence namely Army, Navy, Air force, Directorate
General of Ordnance Factories (DGOF), Director General of Quality Assurance (DGQA) and Research and Development (R&D).

Defence of India has 3rd largest armed forces in the world and is the 8th largest spender on defence. The goal of "Make in India" is to increase the share of manufacturing from 15% to 25% and is very much encouraged in the defence sector. While huge progress has been made in achieving ambitious goal of power to all and India can boast of one of largest Grid in world with capacity in exceed of 288 GW. The energy mix for future growth of India shall be driven by Coal, Hydro, Solar and Wind. There is a strong focus to make a transition from being a coal-based economy to become a cleaner and greener economy. The segment is open to private participation and all major projects are allocated through tariff based competitive bidding. India is looking for Technology, Engineering Solution and Equipment aimed at reducing power theft and losses. In addition, any technology that helps reduce the gestation period is need of hour for Indian power sector.

With the ability to generate its electricity with the alternate renewable source that is sun; the working efficiency of military has increased many folds. This also cuts off the cost which money can be used for better arms. As the energy is now generated in the local area only thus there is less dependency of energy supply chain which process was otherwise quite non-reliable. A solar energy system, coupled with battery backup, a diesel generator or thermal energy storage, can also be operated in island mode. This allows the solar project to continue to provide power independent from grid, which provides an extra layer of redundancy and reduces the risk posed by black outs and potential cyber-attacks.

DEFENCE EXPENDITURE:

Fig.2 shows department-wise estimated expenditure for six sectors.

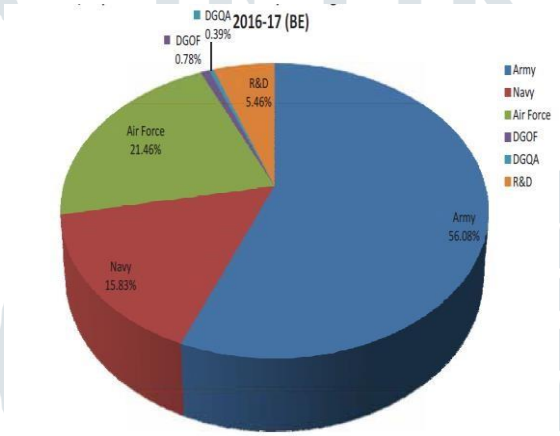

Fig.2 Department wise Defence Expenditure [7]

Main Battle Tanks (MBT):

Fig.3 Arjun MBT (Main Battle Tank)

Fig.3 shows the Arjun which is third generation battle tank developed by Defence Research and Development Organisation (DRDO). This main Battle tank was manufactured by Heavy Vehicles Factory in 1974. It was powered by a single Motor and Turbine Union (MTU) multi-fuel diesel engine rated at 1400hp and can achieve maximum speed of 67km/h. It has four main crew: commander, gunner, loader and driver [8].

Fig.4 Arjun MKII [9]

Fig.4 shows Arjun MKII which is improved version of Arjun main battle tank. It is fitted with upgraded systems and has improved protection, firepower and mobility over Arjun main. It uses LASER systems to shoot enemy's helicopter [10].

Fig.5 FMBT (Futuristic Main Battle Tank)

Fig.5 shows the Futuristic Main Battle Tank (FMBT) is an Indian program to develop a completely new tank which is lighter, faster and smaller than present tanks. It will be possibly a two-man crew with the roles of gunner and loader being completely automated [11].

Troops engaged in modern asymmetric warfare are often exposed to high risk threats including surprise attacks by well-planned and camouflaged ambushes involving automatic firing and sniping etc. To cope with such lethal traps, military forces must be equipped with necessary tools for surveillance, locating hostile forces and responding effectively and rapidly with minimum exposure to the threats. A device that provides a signature of the enemy's optical devices will augment the security / surveillance grid. The threat could be in terms of a sniper equipped with a day sight, any passive night vision device, or any other optical / electro optical surveillance device, viz., binocular, surveillance cameras, laser range finders, designators etc [12].

Environment Protection:

All the divisions of army have certificates from pollution control boards of respective states for operation as statutory requirements. Sewage Treatment plants (STP) have been built for factories and townships. The company has plan of setting up renewable energy plants with capacity of 50 MW over the next 5 years. Solar power plants with total power generation of 0.5 MW have been commissioned.

DEVELOPED PROTOTYPE FOR LAND DEFENCE

As we see a conventional defence tank consumes nearly 200 litres of fuel in 3 hours. Which can be utilised somewhere else. When needed in for air force if solar energy is used for solar defence tank. Instead in the defence vehicle used for patrolling can have electric powered system which can save lot of fuel.

Sr.	Specification	Conventional tank	Electric powered tank
1	Fuel consumption	60 litres/hour	405 kwh
2	Horse power	1500	1000

3	Weight	60 ton	30 ton
4	Carrying capacity	4 persons	3 persons
5	Capacity to travel	200 km	100 km
6	Cooling system	By air	By air
7	Fuel capacity	800 litres	2500 Ah
8	Maximum speed	40 kmph	35 kmph
9	RPM	800	800

Table 1- Comparison of conventional tank and Electric powered tank **[13]**.

Types of batteries:

Each battery set composes of 126 cells. While comparing with a car battery, a 12-volt car battery contains 6 cells, each producing nearly 2.25 volts when fully charged, with a maximum power output of about 45-50 amps. Each cell in a nuclear-powered battery produces from 1.06 volts when fully discharged, to 2.75 volts at optimum output, so connecting the 126 cells in each battery in series gives a usable output of from about 210 to 350 volts, and a power output of as much as 15,000 amps when both the batteries are connected in parallel. Dimensions of each cell are 54 inches high, 15 inches deep, and 21 inches wide, its weight is about 1,650 pounds. Each battery cell is kept in a separate acid-proof tank as a precaution against leakage, as the electrolyte is highly corrosive and can seriously weaken the pressure hull if a leak is not detected at time.

The battery cells are made up of lead plates, suspended in a sulphuric acid/water solution, exactly like that used in car batteries. As the cells are charged, the breakdown of the water portion of the electrolyte can produce hydrogen gas. This is removed through an elaborate ventilation system and discharged outside the pressure hull.

If allowed to accumulate, this gas can constitute an explosion hazard.

An additional hazard, which can be encountered in unusual circumstances, is salt water contamination of the batteries. If salt water mixes with the electrolyte, chlorine gas can be produced, with obvious dangers to the crew.

The battery cells require daily service. Because of the quantities of distilled water needs to keep the cells topped up, it is supplied through a hose from large tanks adjacent to the battery compartments [14, 20].

THE SOLAR POWERED TANK:

Figures 6, 7 and 8 shows front view, top view and side view of prototype of solar powered tank respectively. Fig.9 shows solar powered tank with monochromatic type solar panel.

Fig.6 Front view of solar powered tank

Fig.7 Top view of solar powered battle tank

Fig.8 Side view of solar powered battle tank

Fig.9 solar powered battle tank with solar panel

Aims and objectives of the electrically powered tank

1. To reduce usage of renewable resources of energy.
2. Saves money which can be utilised for buying more ammunition.

Challenges for Solar Powered Tank

1. Should be able to carry more ammunitions.
2. Efficiency of the batteries
3. Cruising Range

Solutions for Solar Powered tank

1. It can be utilized for patrolling of the border areas rather than using in actual war.
2. Cruising range can be increased by increasing the efficiency of the batteries or by installing charge stations at certain path interval.
3. As the tank is only going to be used for patrolling of the border areas, ammunition requirement will be less
4. Transportation of these tanks would be easier as their weight would be less than the conventional tanks.
5. It requires less maintenance than the regular conventional tanks as the maintenance is only of the batteries.

CONCLUSION

The usage of Non-Renewable resources can be reduced and the use of Renewable resources can be increased and promoted. Army can get the advantage of more efficient, less weighed Tanks. Also, the finance which is given to the defence sector is higher, maximum of the finance is utilised for buying the fuels so we can save money by opting this tank for buying more ammunition instead of using money on buying fuels.

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