"MICRO WIND TURBINE TECHNOLOGY" TO ENHANCE SELF GENERATIVE SYSTEM IN PASSANGER TRAINS

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Abstract:

The power supply technology used in train interiors specifically for Hotel loads have four different options i.e. Self Generating Unit (SGU), Head-On Generation (HOG), Mid-On Generation (MOG) and End-On Generation (EOG). To trap the self generating energy resources the Axle coupled power system is in use, which have not become a self sufficient and reliable mechanism in terms of quantity and durability. The demand for the renewable resources of energy is highly essential for sustainability economy including locomotives. The researchers in this paper try to elaborate how the micro wind turbines can be used as an alternate energy source of energy in locomotives, especially in the passenger trains. The objectives are to analyze the use of Micro Wind-Turbines in producing power for locomotives by using mathematical calculations. The finding suggest that Roof-Top installation of micro wind turbines can generate enough power to support the hotel load requirements including light, fan and Ac. Also it can be in isolation or coupled with the existing Axle linked technology for more self generating productivity.

Key- words: Hotel Load, Roof-Top, Self Generating Unit, Head-On Generation, Mid-On Generation, End-On Generation, Micro Wind-Turbines, Sustainable economy.

INTRODUCTION:

"Railways, perhaps is one of the major institutions in India with a biggest network which if used cautiously it could be self generative and self sustained. It is the single sector having its own budget and gives the highest number of employment opportunities directly or indirectly. It is also the backbone of Indian transport system on which half of the populations are dependent.

Roughly it consists of a huge network of approximately 19,000 trains including passenger and freight. It carries 25 million passengers per day with 9500 stations distributed across the country from urban to rural. Along with above the network or route is about 65,000 kms consumes a huge quantity of fuels per hour, and the fuel system is mostly based on diesel and coal. The train transport system consumes about 2.5 billion liters of diesel annually which is 70 percent of total fuel. Along with diesel the consumption of electricity amounts to be 14 billion units of electricity which is 2 percent of total electricity production.

OBJECTIVE OF THE STUDY:

The researchers in this paper tried to analyze the present scenario of energy resources and its sustainability for future use in the transportation industry. Hence the proposal was to introduce the Micro wind turbine s in locomotives, specifically in the passenger trains as a source of alternate sustainable energy.

The main objective is

- To find out, how micro wind turbines (MWT) can be used in passenger trains to achieve the hotel load target of both Ac and Non Ac coaches

The sub objectives are to find out the followings

- What shall be the size of the MWTs
- How much power is produced from each MWT
- How many numbers of MWTs shall be installed so that the Hotel load can be achieved
- How it can be accompanied with axle linked power generation system
- How MWTs can be used to overcome the disadvantages in functioning of different power generation systems in passenger trains.

BACKGROUND OF THE STUDY:

Due to globalization and rapid industrialization the depletion in the non-renewable conventional sources of energy at a very high rate made us to think for the sustainable and renewable sources. Out of these renewable sources , water, air and light are prominent one, while others like geo thermal, tidal &wave, Bio-energy etc are with very little scope at present.

At present the technology for hydro power are almost reached its saturation where the further scope cannot be expected to make any great difference. The trap of hydro power has almost done by almost all the countries across the globe. Whatever new projects are done is revitalizing the existing ones with new technology or new extensions.

Speaking about the solar energy is concerned; it is 7% more effective than coal or oil based plants and 10% more effective than nuclear plants. But its scope is limited to those areas where the intensity and duration of sun light is more. It is not suitable for the low sunlight area and also to rain-fed areas. Alternatively there is no other way out to produce sunlight by using any device or technology.

Coming to the wind energy, the work is going on like that of solar energy but the researcher presumes that the scope for wind energy is more than that of sun. the reasons is beside it is a planetary activity which is available as per the time, place and situation as a part of natural phenomenon. Along with it is also can be trapped from artificial or human induced activities like locomotives.

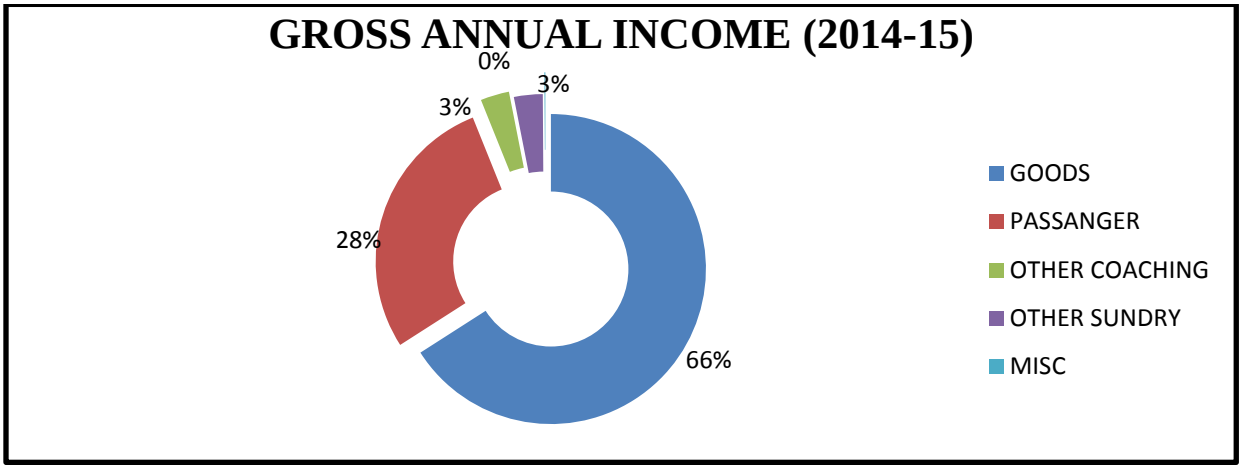
Speaking about the locomotives we will find everywhere around us in a global village. The need is that we must find the technology or process to trap the wind to make it as an energy resource.

FINANCIAL STATUS OF INDIAN RAIL:

Indian rails financial status can be determined in terms of two heads, i.e. source of income from different heads and the pattern of expenditure on different heads.

Indian Railway expenditure as percentage of transport sector expenditure used to be about 30% in 11th Plan (2007-12).

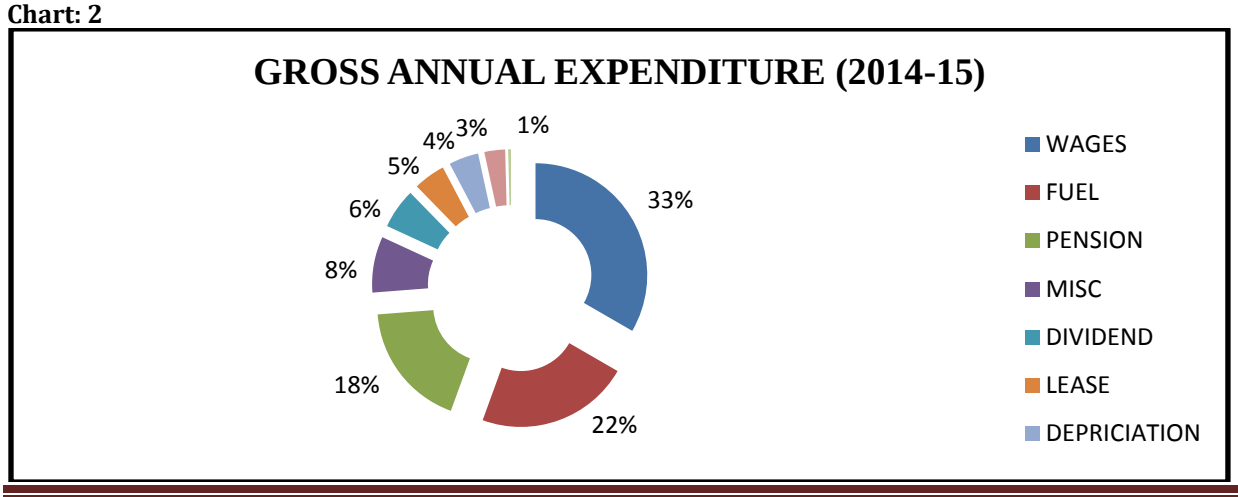
Chart: 1



Source: Ministry of Railways, Government of India

The above figure represents the gross annual income of Indian Rail for the year 2014-15, it says that 66% of the income are generated from the Goods trains i.e. fright, carrier services. Passenger accounts for only 28% as compared to the goods

Chart: 2



Source: Ministry of Railways, Government of India

The above figure represents the expenditure pattern of Indian rails on different heads. The chart says that wages accounts for 33% of its total expenditure, while the expenses on fuel was 22% in 2014-15, which remains almost same as a trend.
Fuel bill has witnessed a steady increase on account of Tariff, Consumption and increase in Activity. Decisions such as introduction of stoppages also add to the fuel bill and consumption. The major contributor to the increase in fuel outlays has been the steady increase in prices based on global cues and high domestic prices which are illustrated below:
Alternate fuels like Bio-diesel, CNG/ LNG are cheaper than diesel and have potential to replace diesel as a preferred choice for traction fuel globally. Unless there is an aggressive push towards alternate fuels, IR will continue to live with the uncertainties of a higher priced fuel.

POWER GENERATION SYSTEM IN INDIAN TRAINS:

Indian Railways have been using following systems for power supply in mail/exp trains:

- Self-generating
- Mid-on-generation
- End-on-generation
- Head-on-generation

Self Generation system:

The power supply in a SG coach are generated by the running axles of the coach with the belt of the coach.

EOG (End-on – generation)

It has power cars at end of the train, which supports the power system to tha coaches.

MOG (Mid-on–generation)

The trains have one power car in the middle of the train, which fed power supply to the coaches at either side of power car.

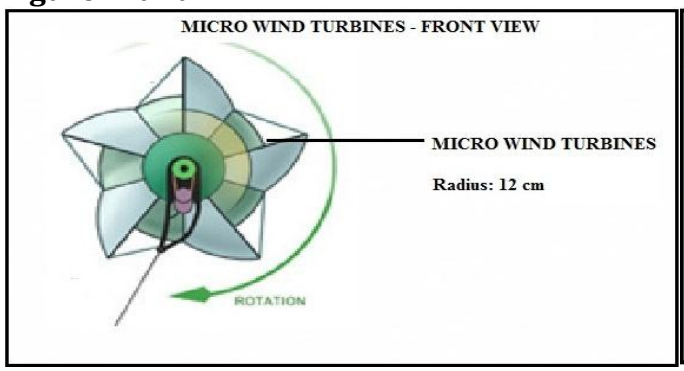
HOG (Head- On-Generation):

Power is collected from the supplies from the over head system of trains which is mostly with the electric trains.

THE STRUCTURE AND COMPONENTS OF MICRO WIND TURBINES:

At this juncture to reduce the un-certainties in fuel price in future due to change in demand and consumption, which leads to price hike and sustainability of transport system the researcher introduce the model of “Micro wind-turbine technology” to reduce or replace the hotel cost of coaches in passenger trains.
Micro Wind Turbine energy systems generally comprise a rotor, a generator or alternator mounted on a frame, a tail (usually), a tower or base, wiring, and the “balance of system” components: controllers, inverters, and/or batteries. Through the spinning blades, the rotor captures the kinetic energy of the wind and converts it into rotary motion to drive the generator, which produces either AC or wild AC (variable frequency, variable voltage), which is typically converted to grid-compatible AC electricity.
In the above figure, the radius of the blades taken are normally 10 cm to 20 cm, so that it could resists the wind velocity of 100 Km/ hr. the model selected is Horizontal Axis (HAWT) type turbine, but a vertical axis turbine (VAWT) also can be considered.

Figure: 1 and 2.



Micro Wind Turbine: (Horizontal Axis –HAWT Type)

Source: authors (Micro Wind Turbine Front View) (Micro Wind Turbine Lateral View)

CALCULATIONS OF POWER GENERATED FROM THE MWTS:

Power generation from a MWT is calculated from the mathematical formula

$P = ½.\rho.A.V^3$ Where, P = Power of wind, ρ = density of air, A = Area of turbine, V = Velocity of wind

Normal assumptions:

Let the density (ρ) = 1.0 kg/m3 (kilograms per cubic meter)
Velocity of wind with respect to train (V) is 20 m/s (meters per second)
Area of turbine (A) = ΠR^2, where radius (R) is different as per our need is given below

Calculations:

Hence the power (P) generated by the wind for different radius are given below

Case No. 1
If radius is 20 cm, then
R = .2m (A = .125 m^2)
Power = (.5) (1.0) (.125) $(20)^3$ = 500 watts per second

Case No. 2
If radius is 15 cm, then
R = .15 m (A = .070 m^2)
Power = (.5) (1.0) (.070) $(20)^3$ = 280 watts per second

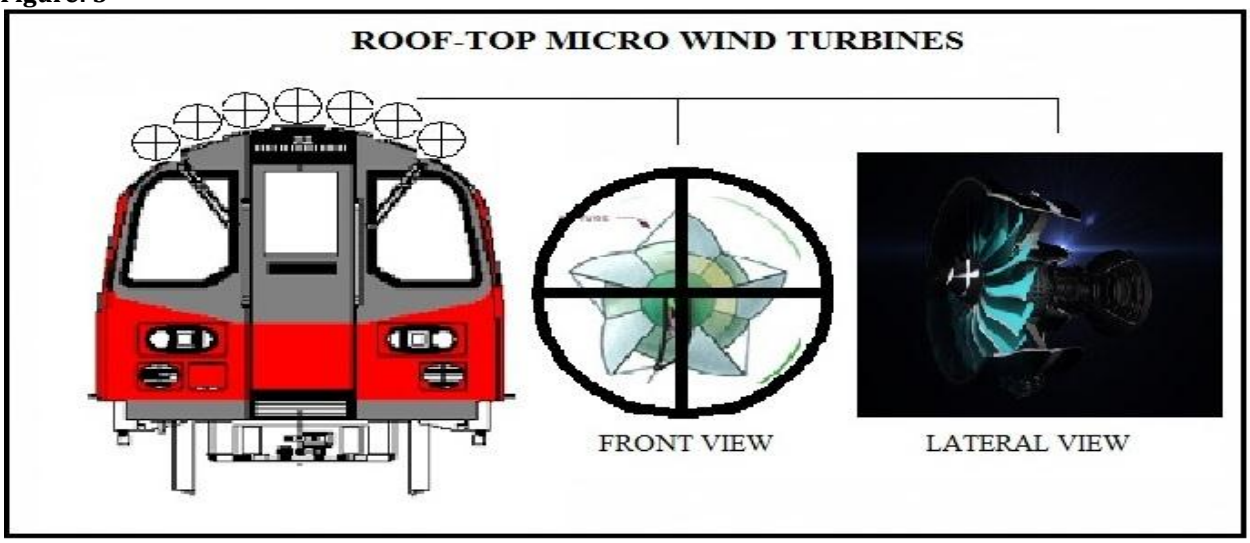
Case No. 3
If radius is 12 cm, then
R = .12 m (A = 0.045 m^2)
Power = (.5) (1.0) (.045) $(20)^3$ = 180 watts per second

Case No. 4
If radius is 10 cm, then
R = .10 m (A = 0.031 m^2)
Power = (.5) (1.0) (.031) $(20)^3$ = 124 watts per second

PHYSICAL ARRANGEMENT AND POWER GENERATION:

The picture depicts the positioning and arrangement of Micro Wind Turbines (MWTs) along with its front and lateral view.

Figure: 3



Source: Author

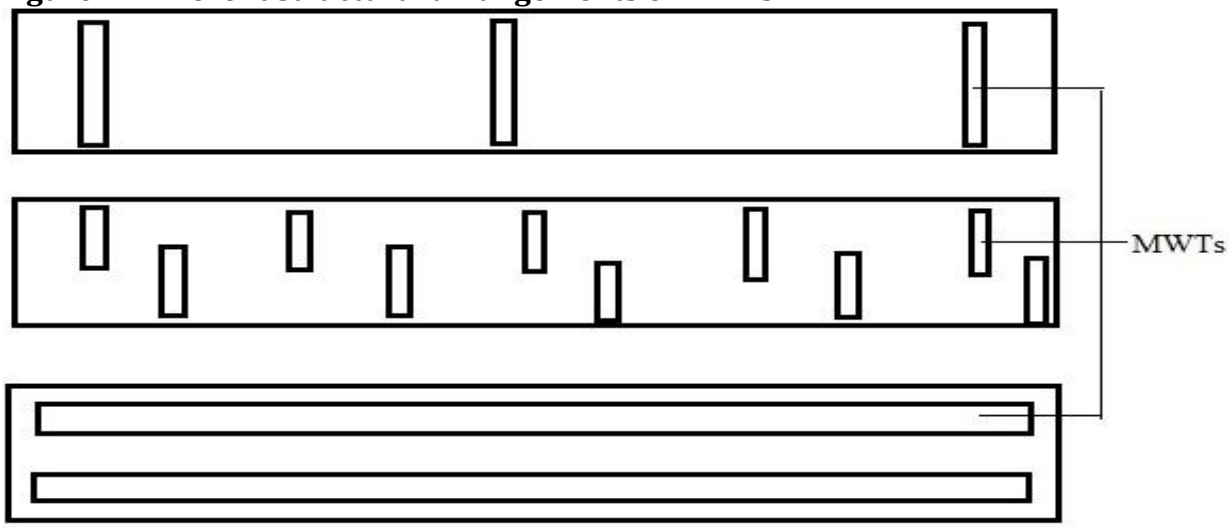
In an average train, the average length is 60 feet while the breadth is 10 feet (314 cm)

- If the radius (R) is 20 cm then 16 MWT can be placed horizontally side by side for two rows, they can produce 8000 watts of power
- If the radius (R) is 15 cm then 21 MWT can be placed horizontally side by side for two rows, they can produce 5880 watts of power

- If the radius (R) is 12 cm then 26 MWT can be placed horizontally side by side for two rows, they can produce 4680 watts of power
- If the radius (R) is 10 cm then 31 MWT can be placed horizontally side by side for two rows, they can produce 3844 watts of power

The above calculation is for a single MWT; hence as per the requirement of the Hotel load the numbers of the MWTs can be installed in multiples.

Figure: 4 Different structural arrangements of MWTs



Source: Author

The above figure represents different arrangement of the MWTs as per the specific need of the self generating power system (SGS) of the coaches in the train.

The arrangements can be of three types i.e. horizontal, vertical or mixed type as per the need .

passenger train.

FINDINGS:

The above technology have multiple applicability concerning to different sectors across the globe, these could be as a direct solution to a technical problem or an indirect solution to socio-economic problems like Carbon credit, green house gases, air pollution, noise pollution and many others.

Practical applicability of the technology:

Although this is a part of self generating system of power generation in trains, still it has multiple uses in contributing to the power generation system in a train and those are given below.

Applicability in SGS:

- The present electrical load of the coach is restricted by the limitation of capacity of generation i.e. 2 x 25kw per coach is less generation power of the axle linked SGS. By addition or replacement of MWT systems the capacity can be increased to a greater extend.
- The present axle linked system has very poor efficiency of 57% for power it receives from the locomotive, hence by replacing or coupling with MWT system the overall efficiency can be maintained
- As this system ex externally mounted i.e. Roof-Top mounting system, hence can be introduced to all the coaches including the both new and old ones.

.Applicability in EOG and MOG:

- The cost of energy is high due to high fuel cost in EOG system, in coupled with MWT system the running cost can be reduced to a great extend.
- The smoke or air pollution is associated with fuel can be reduced due to MWTs and along with fuel conservation it contributes to national Carbon Credit policy.

Applicability in HOG

- As an alternate to head on supply or accompanied with it to strengthen the power generating system for better performance and less electric consumption.

SCOPE FOR FURTHER RESEARCH:

The above research paper leaves many un touched areas for further research, few are mentioned below.

- The research is based on assumptions and calculations many of the factors are not considered, for example what shall be the resistance created by the roof-top MWTs etc.
- Further the economic value of the MWT system as an alternative fuel.

CONCLUSION:

In the older rakes Self Generating method was used which is mounted beneath the coach near axle. However as the design of new LHB rakes don't permit installment of Self Generating units underneath the coach that's why they are using End on Generation. Some efforts have been given to introduce self generating units in LHB rakes have been tried however none was successful. Also the efficiency of Self Generating unit is quite low (50%) as compared to EOG (80%) & HOG (80%). HOG is the most efficient system as the cost of power is about 25% less as compared to EOG, but the system is still under development for the last 30 years. This research paper conclude with citing the reasons and as per mathematical calculations that the given structure and system of MWTs can be used an alternate source of energy in locomotives.

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