# CHAPTER-1
# INTRODUCTION

## 1.1 INTRODUCTION

The project aimed to test the possibility of using innovative wind turbine in railways coaches, freight wagons and locomotives, for charging the on board accumulators. This technology would expected to reduce pollution and provide economic savings. Installing wind turbines on rail coaches would also lead to a reduction in greenhouse gas emissions. The wind turbine technologies offer two significant environmental advantages over non-renewable energy sources:

• Less greenhouse gas production: wind turbine keep the accumulators and auxiliary devices in charge, without depending on the main electrical system, with a reduction of 750 gm of carbon dioxide per KWh of produced energy compared to the traditional sources.

• Longer lifespan of the accumulators: These are subjected to less wear and tear as a result of the wind turbine being kept constantly charged. Longer lifecycles means less hazardous waste. The energy produced by the wind turbine can have different uses: they can be applied to the coaches and locomotives to charge the accumulators for the lighting and air conditioning, and they can also be installed on the freight carriages to recharge the accumulators so as to ensure the power supply for electric locks used to protect transported goods. Trials were carried out on the whole system to assess its validity.

The railways installing rooftop wind turbine on train coaches to meet their electricity needs and curb the country's diesel consumption and carbon dioxide emissions. "Given our huge oil imports, every possible option to reduce dependence on oil must be explored — this is one such option,"

While the train coaches would be pulled by conventional diesel-run power cars, the vertical wind turbines are intended to provide all the internal electricity needs for lights and fans on both AC and non-AC coaches. From estimated results shows that a single rake — made up of five air-conditioned coaches, 12 other coaches, a pantry car and two power cars — relying on vertical axis wind turbine and making 188 forty-hour trips during a year could reduce carbon dioxide emissions by 239 tonnes.

The excess energy generated by the vertical wind turbines could be stored in batteries for use during train stop. “A train moves at speeds exceeding 100kmph --- how are they going to fix the wind turbines? This will be a big challenge,”

By collaborate with railway engineers to select appropriate vertical wind turbines that could fit on rail coach rooftops and tolerate the vibrations and other forces they would encounter during high-speed runs.

From the literature calculations were made taking into account a 40-hour journey over 1,800 km by a train, comprising 19 LinkeHofman Busch (LHB) coaches that have longer span-length to accommodate more passengers and provide superior travelling comfort.

The electricity generated from the vertical wind turbines could reduce diesel consumption by 9.08 lakh litres per rake, and contribute to saving of Rs 59 lakh every year for each train. Indian Railways runs around 11,000 trains every day, of which 7,000 are passenger trains

| **Quantity of fuel consumed by locomotives 2013-14** | |
|---|---|
| Diesel oil (in kilo-litres) | 2,780.900 |
| Coal (in thousand tonnes) | 1 |
| Electricity (Million kWh) | 14,410.7 |

**STATISTICS 2013-14**

| **Locomotives** | |
|---|---|
| Steam | 43 |
| Diesel | 5,633 |
| Electric | 4,823 |
| Total | 10,499 |
| Passenger carriages | 59,600 |
| Freight cars/wagons | 2,45,267 |

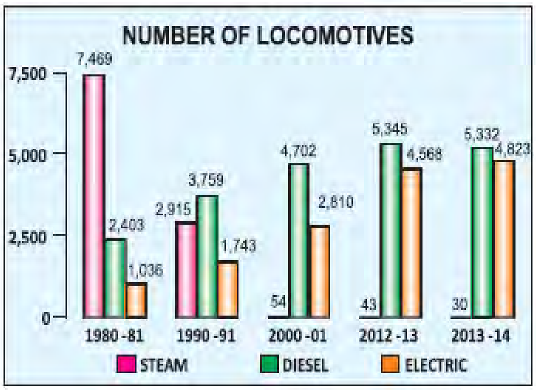
### LOCOMOTIVES

With increasing reliance on dieselisation and electrification, IR has been reducing its fleet of steam locomotives.

**NUMBER OF LOCOMOTIVES**

| | Broad Gauge | | | Metre Gauge | | | Total (including NG) | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Steam | Diesel | Elec. | Steam | Diesel | Elec. | Steam | Diesel | Elec. |
| 1980-81 | 4,361 | 1,866 | 1,016 | 2,763 | 470 | 20 | 7,469 | 2,403 | 1,036 |
| 1990-91 | 1,295 | 2,893 | 1,723 | 1,482 | 731 | 20 | 2,915 | 3,759 | 1,743 |
| 2000-01 | – | 3,881 | 2,791 | 33 | 657 | 19 | 54 | 4,702 | 2,810 |
| 2010-11 | – | 4,688 | 4,033 | 30 | 310 | – | 43 | 5,137 | 4,033 |
| 2012-13 | – | 4,939* | 4,568 | 30 | 267 | – | 43 | 5,345 | 4,568 |
| 2013-14 | – | 5,232 | 4,823 | 30 | 262 | – | 43 | 5,633 | 4,823 |

* revised



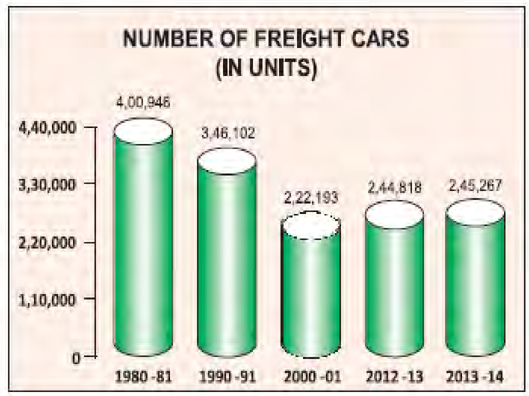

### FREIGHT CARS/WAGONS

The total number of freight cars including brake vans and railway service wagons in 2013-14 was 245,267.

**NO. OF FREIGHT CARS/WAGONS**

| Year | Broad Gauge | Metre Gauge | Total (incl. N.G.) |
|---|---|---|---|
| 1980-81 | 309,194 | 86,839 | 400,946 |
| 1990-91 | 284,362 | 58,576 | 346,102 |
| 2000-01 | 205,959 | 15,294 | 222,193 |
| 2010-11 | 225,259 | 4,538 | 229,997 |
| 2012-13* | 240,923 | 3,731 | 244,818 |
| 2013-14 | 241,577 | 3,531 | 245,267 |

* revised




Efficiency of a wind turbine is increased, then more power can be generated thus decreasing the need for expensive power generators that cause pollution. This would also reduce the cost of power for the common people. The wind is literally there for the taking and doesn't cost any money. Power can be generated and stored by a wind turbine with little or no pollution. If the efficiency of the common wind turbine is improved and widespread, the common people can cut back on their power costs immensely.

Ever since the Seventh Century people have been utilizing the wind to make their lives easier. The whole concept of windmills originated in Persia. The Persians originally used the wind to irrigate farm land, crush grain and milling. This is probably where the term windmill came from.

Since the widespread use of windmills in Europe, during the Twelfth Century, some areas such as the Netherlands have prospered from creating vast wind farms.

The first windmills, however, were not very reliable or energy efficient. Only half the sail rotation was utilized. They were usually slow and had a low tip speed ratio but were useful for torque.

Since its creation, man has constantly tried to improve the windmill. As a result, over the years, the number of blades on windmills has decreased. Most modern windmills have 5-6 blades while past windmills have had 4~8 blades. Past windmill also had to be manually directed into the wind, while modern windmills can be automatically turned into the wind. The sail design and materials used to create them have also changed over the years.

In most cases the altitude of the rotor is directly proportional to its efficiency. As a matter of fact, a modern wind turbine should be at least twenty feet above and three hundred feet away from an obstruction, though it is even more ideal for it to be thirty feet above and five hundred feet away from any obstruction.

Different locations have various wind speeds. Some places, such as the British Isles, have few inhabitants because of high wind speeds, yet they are ideal for wind generation. The world's largest wind farm is located in California, and the total wind power generated there exceeds 1,400 megawatts of electricity? (A typical nuclear power plant generates 1,000 megawatts.)

Some geographic features such as mountains also have an influence upon wind. Mountains can create mountain breezes at night, because of the cooler air flowing down the mountain and being heated by the warmer valley air causing a convection current. Valleys are affected in much the same way. In the daytime, the cooler air is above the valleys and the hot air is above the mountains. The hot air above the mountain rises above the valleys and cools, thus creating a convection current in the opposite direction and creating a valley wind. The oceans create convection currents, as well as they mountains or valleys. In the day, the hotter air is above the same and the cooler air is above the ocean. The air heats up over the sand and rises above the ocean and then cools, creating the convection current. At night, the cooler air is above the sand and the warmer air is above the ocean, so the air heats up over the ocean and cools over the sand. As you can clearly see, the time of day also affects the wind.

We know that for windmills to operate there must be wind, but how do they work? Actually there are two types of windmills -- the horizontal axis windmills and the vertical axis windmills.

The horizontal axis wind mill shave a horizontal rotor much like the classic Dutch four-arm windmill. The horizontal axis windmills primarily rely on lift from the wind. As stated in Bernoulli's Principle, "a fluid will travel from an area of higher pressure to an area of lower pressure." It also states, "as the velocity of a fluid increases, its density decreases." Based upon this principle, horizontal axis windmill blades have been designed much like the wings of an airplane, with a curved top. This design increases the velocity of the air on top of the blade thus decreasing its density and causing the air on the bottom of the blade to go towards the top ... creating lift. The blades are angled on the axis as to utilize the lift in the rotation. The blades on modern wind turbines are designed for maximum lift and minimal drag.

Vertical axis windmills, such as the Durries (built in 1930) use drag instead of lift. Drag is resistance to the wind, like a brick wall. The blades on vertical axis windmills are designed to give resistance to the wind and are as a result pushed by the wind. Windmills, both vertical and horizontal axis, have many uses. Some of them are: hydraulic pump, motor, air pump, oil pump, churning, creating friction, heat director, electric generator, Freon pump, and can also be used as a centrifugal pump.

There are many types of windmills, such as: the tower mill, sock mill, sail windmill, water pump, spring mill, multi-blade, Darrieus, savonis, cyclo-turbine, and the classic four-arm windmill. All of the above windmills have their advantages. Some windmills, like the sail windmill, are relatively slow moving, have a low tip speed ratio and are not very energy efficient compared to the cyclo-turbine, but are much cheaper and money is the great equalizer.

There have been many improvements to the windmill over the years. Windmills have been equipped with air breaks, to control speed in strong winds. Some vertical axis windmills have even been equipped with hingedblades to avoid the stresses at high wind speeds. Some windmills, like the cyclo-turbine, have been equipped with a vane that senses wind direction and causes the rotor to rotate into the wind. Wind turbine generators have been equipped with gearboxes to control [shaft] speeds. Wind turbines have also been equipped with generators which convert shaft power into electrical power. Many of the sails on windmills have also been replaced with propeller-like airfoils. Some windmills can also stall in the wind to control wind speed. But above all of these improvements, the most important improvement to the windmill was made in 1745 when the fantail was invented. The fantail automatically rotates the sails into the wind.

Most wind turbines start to generate power at 11 m/s and shut down at speeds near 32m/s. Another variable of the windmill's efficiency is its swept area. The swept area of a disk--shaped wind wheel is calculated as: Area equals pi times diameter squared divided by four (pi equals 3.14).

Another variable in the productivity of a windmill is the wind speed. The wind speed is measured by an anemometer.

Another necessity for a windmill is the tower. There are many types of towers. Some towers have guy wire to support them and others don't. The towers without guy wires are called freestanding towers. Something to take into consideration about a tower is that it must support the weight of the windmill along with the weight of the tower. Towers are also subject to drag.

Scientists estimate that, by the 21st Century, ten percent of the world's electricity will come from windmills.