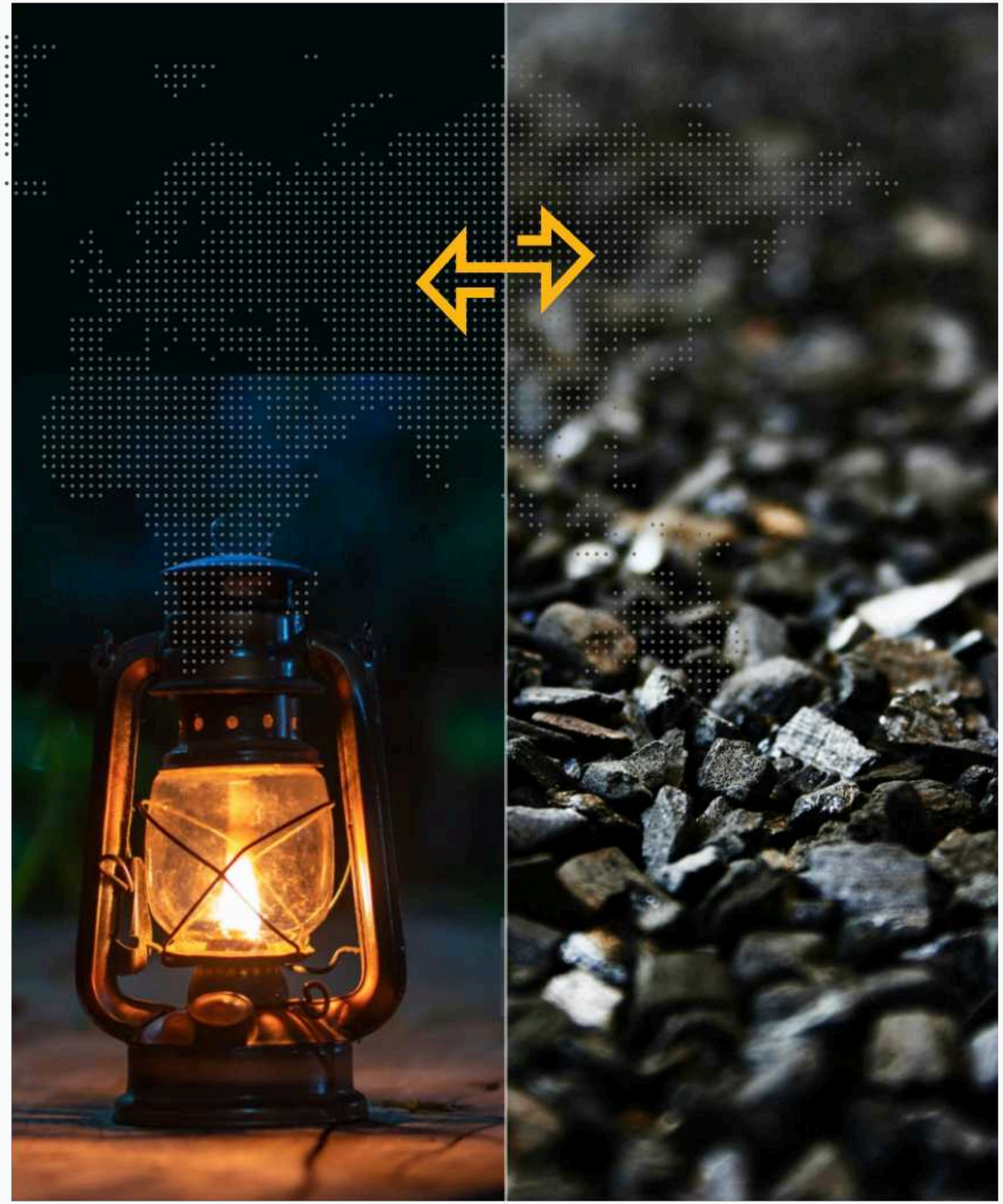
Problem Statement

Electricity demand is growing faster than clean energy generation.



News on the

Electricity and Coal crisis.

as of 2024

Severe consequences will arise from rising **air pollution.**

Deaths due to air pollution

1.7 million deaths

WHO 2020, CSE 2021

Deaths from stroke

200,000+ deaths/year

Lancet 2018, WHO 2020

Land area required

High for fossil fuels

CEEW 2021

Deaths from respiratory diseases

400,000+ deaths/year

WHO 2020, ICMR 2021

Deaths from lung cancer

100,000+ deaths/year

NCI 2020, WHO 2020.

Air quality

High PM2.5 levels

SoE 2021, CSE 2021

Deaths from heart diseases

700,000+ deaths/year

Lancet 2018, WHO 2020

Economic cost of air pollution

₹1.5 lakh crore/year

ICMR 2021, CSE 2021

Impact on health

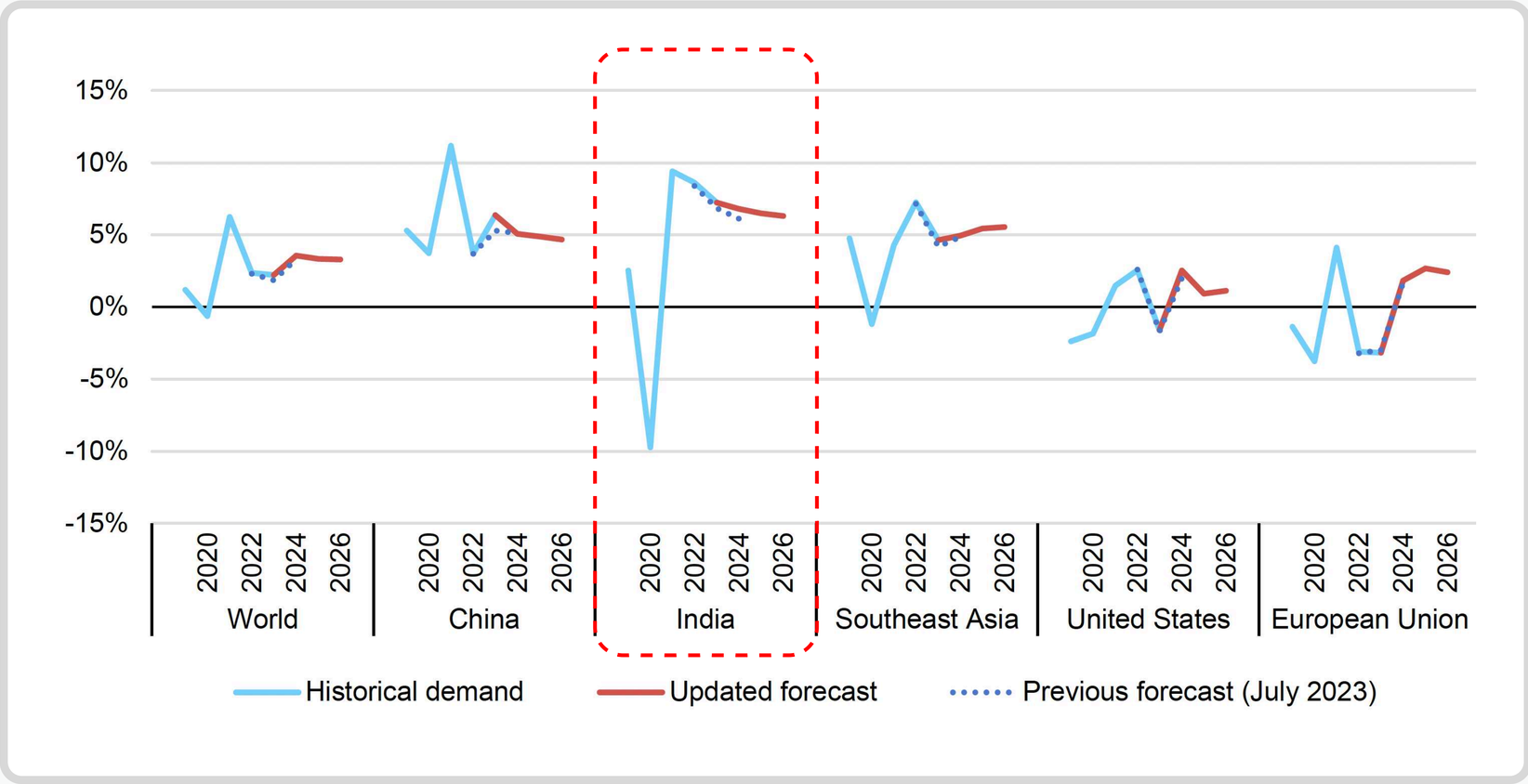
High risk

WHO 2020, Lancet 2018, ICMR 2021

Research & Analysis

Global Electricity demand.

As of 2024, approx 88.6 Terawatt per hour, electricity demand in India.

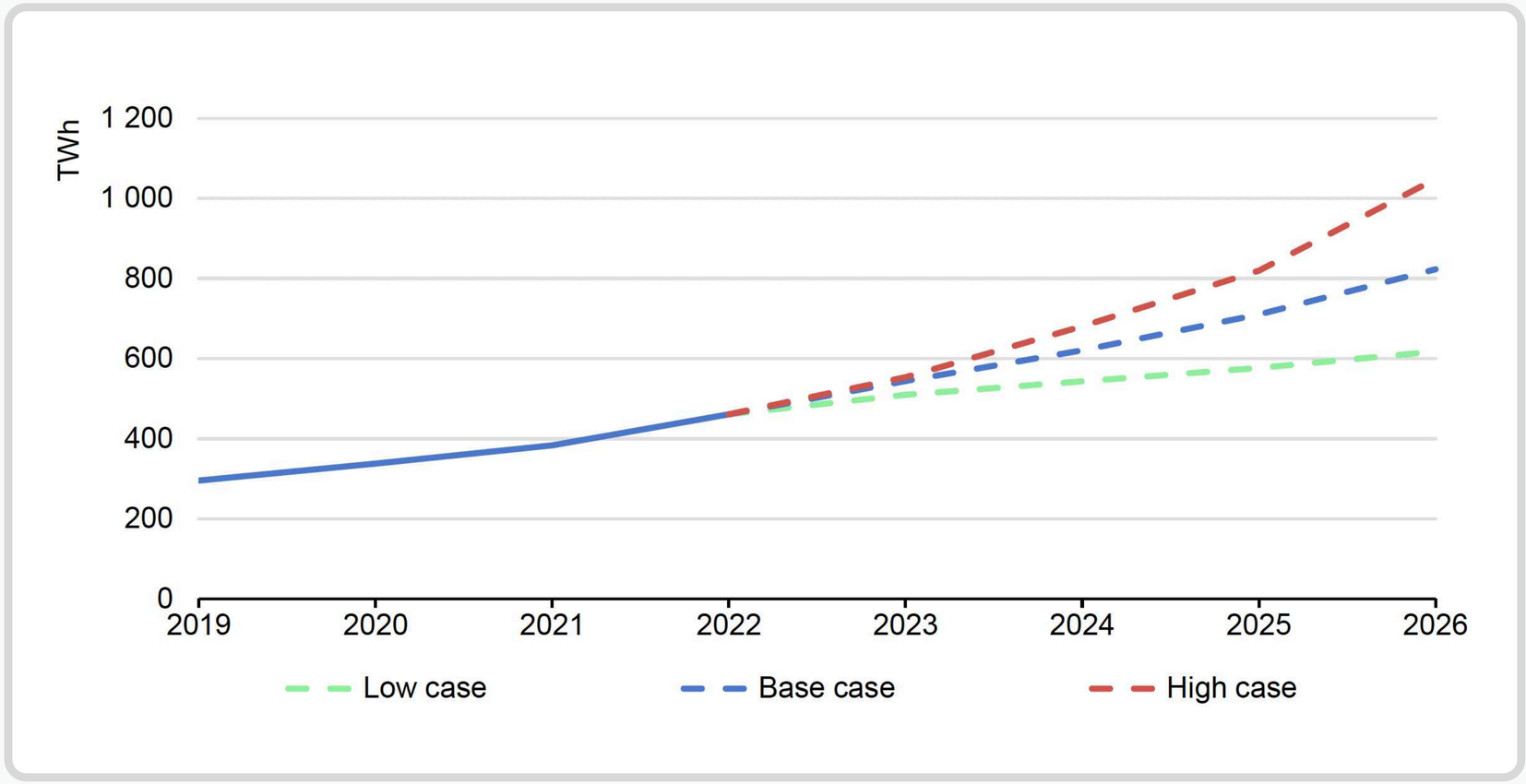


Source: International Energy Agency (IEA)

Research & Analysis

Data centers, AI, and crypto are increasing electricity demand.

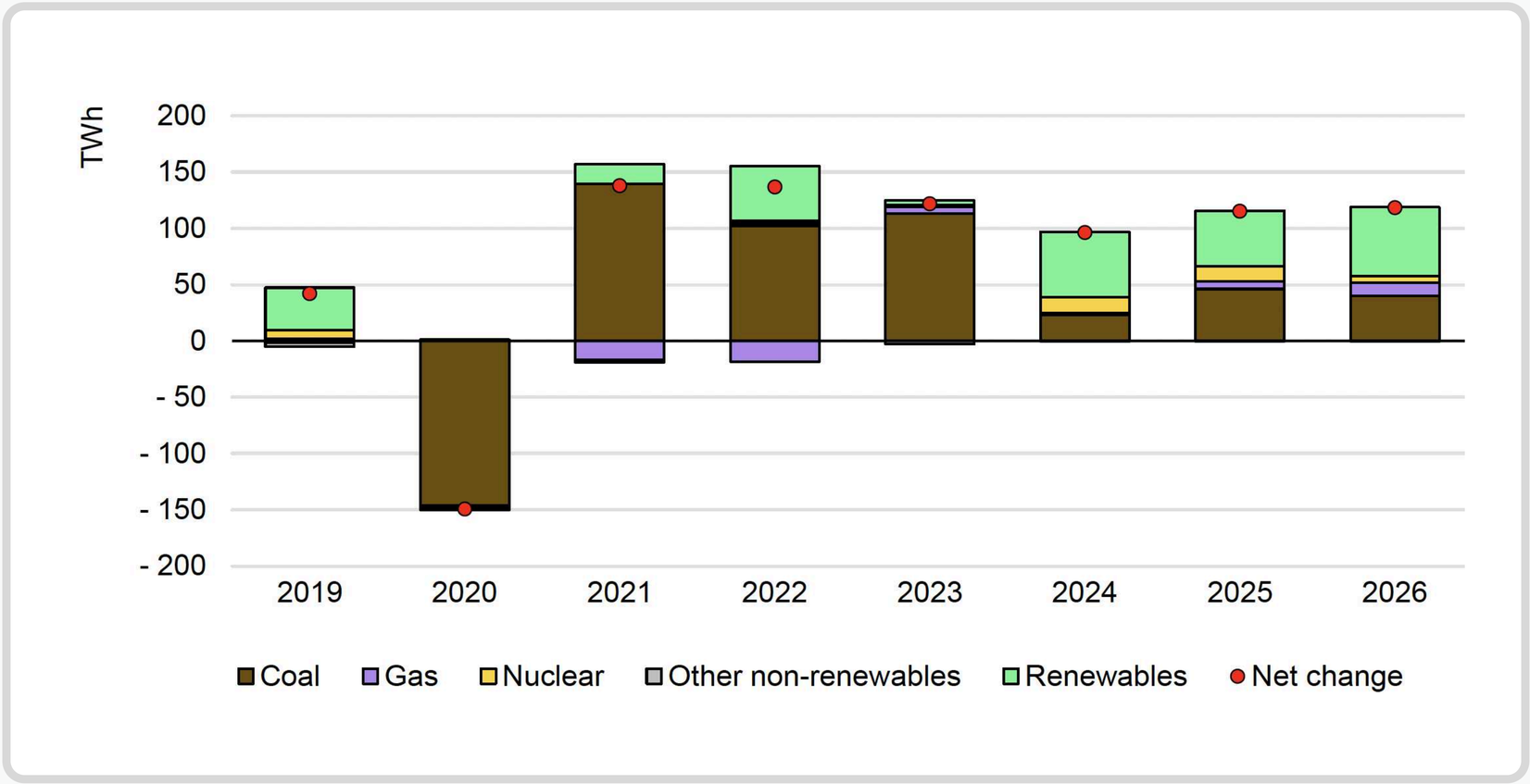
(2019 - 2026)



Source: International Energy Agency (IEA)

Electricity generation in India.

Electricity demand rose by 7% in 2023, and coal usage is expected to increase significantly going forward.

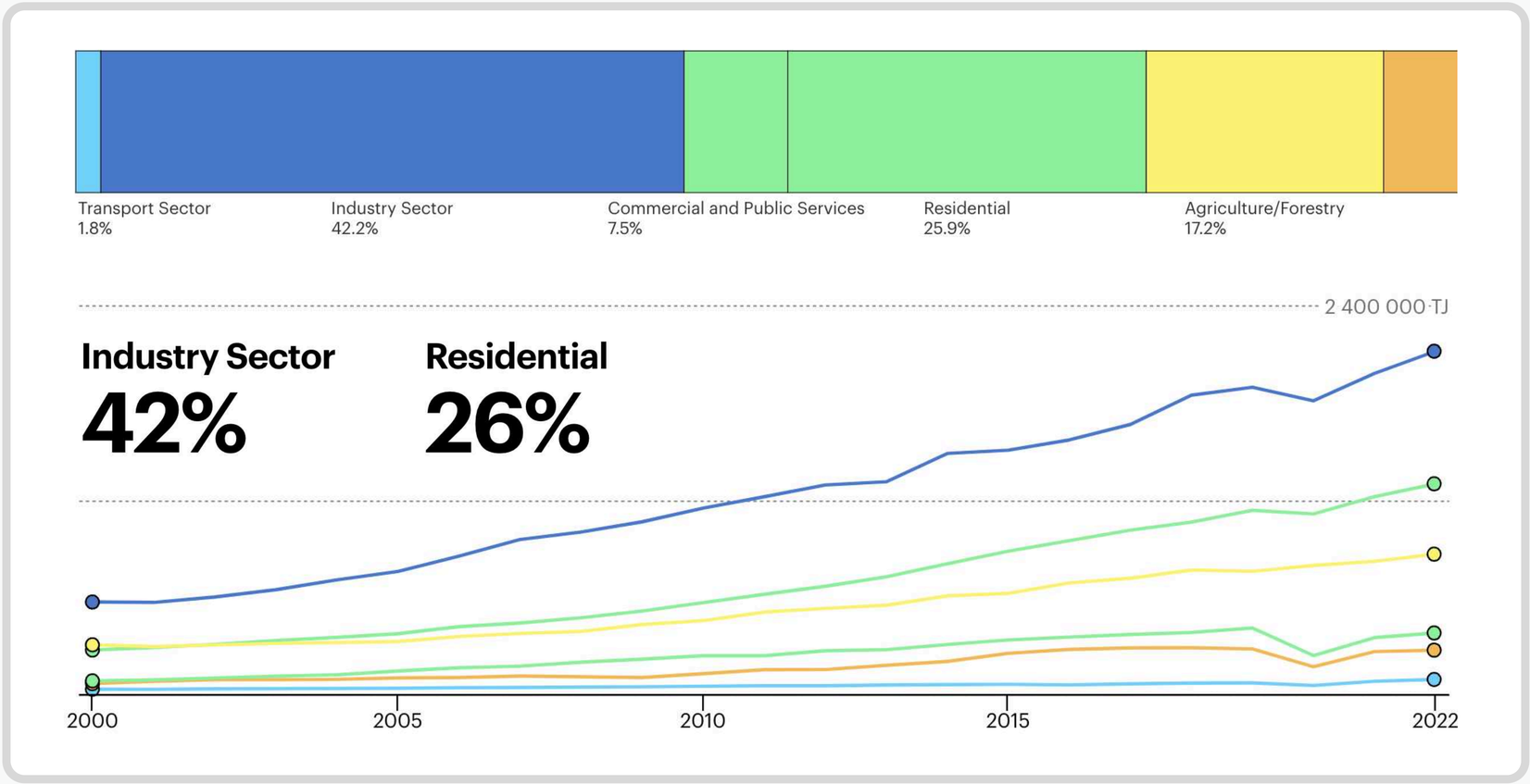


Source: International Energy Agency (IEA)

Research & Analysis

Electricity consumption in India.

(2000 - 2022)

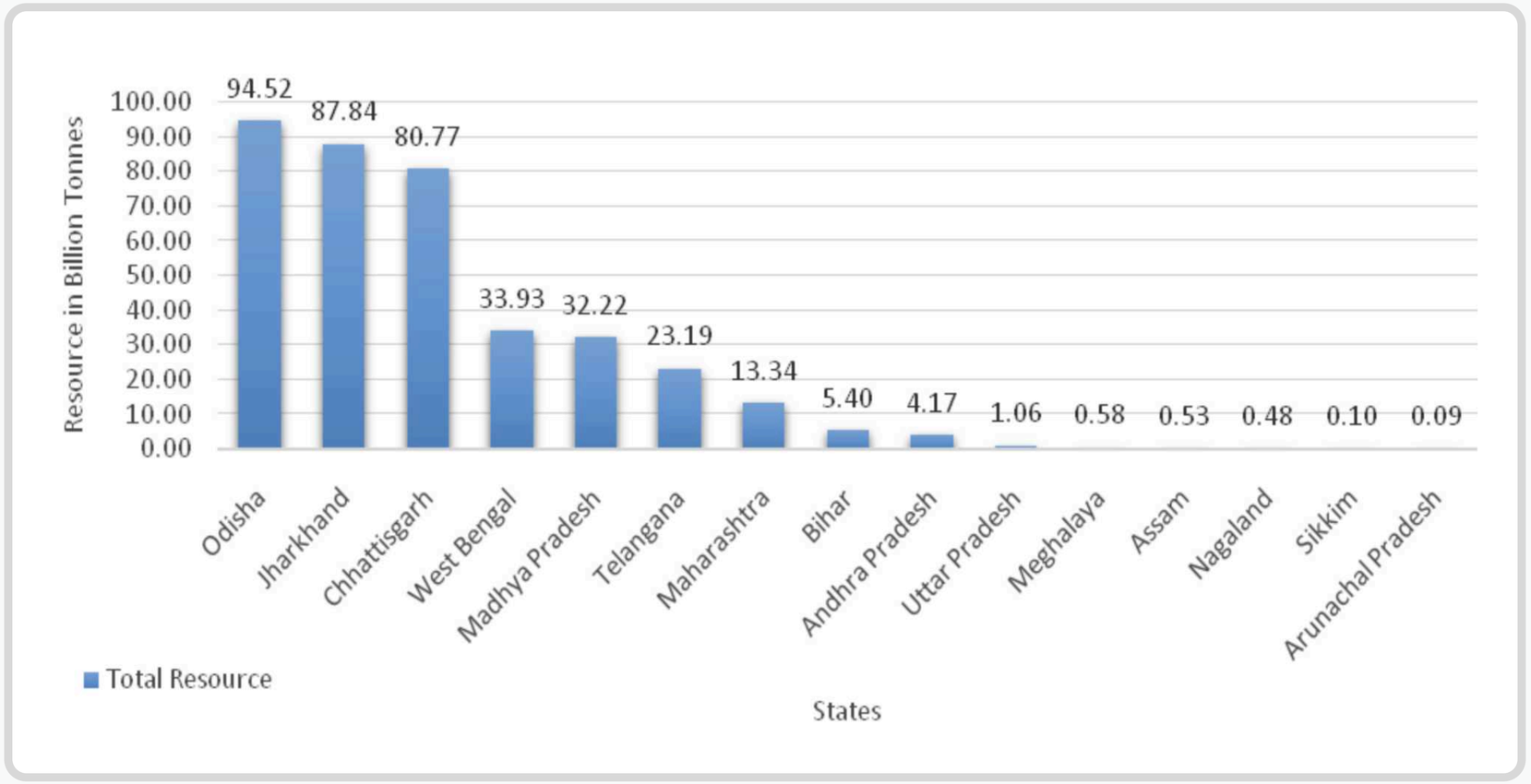


Source: International Energy Agency (IEA)

Coal resources in India.

as of 01.04.2023

https://coal.gov.in/en/major-statistics/coal-reserves



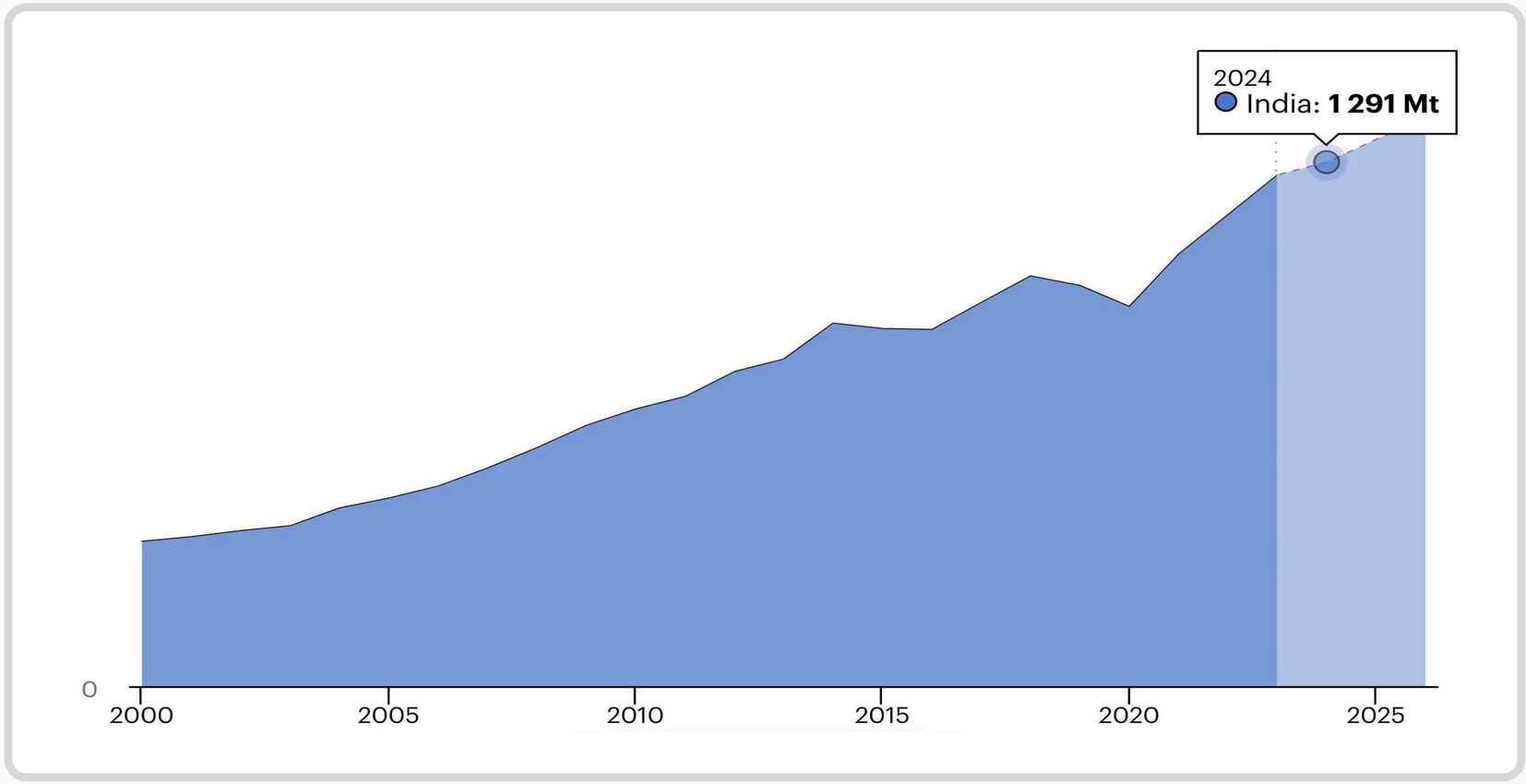
Source: Ministry of Coal, Statistics

Coal consumption in India

(2000 - 2025)

As per the data in the year

- **2022 : 1162 Mt**
- **2023 : 1260 Mt**
- **2024 : 1291 Mt**

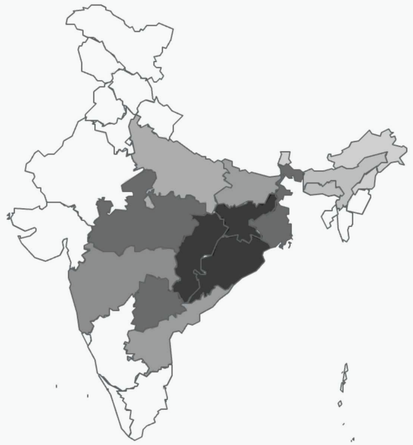


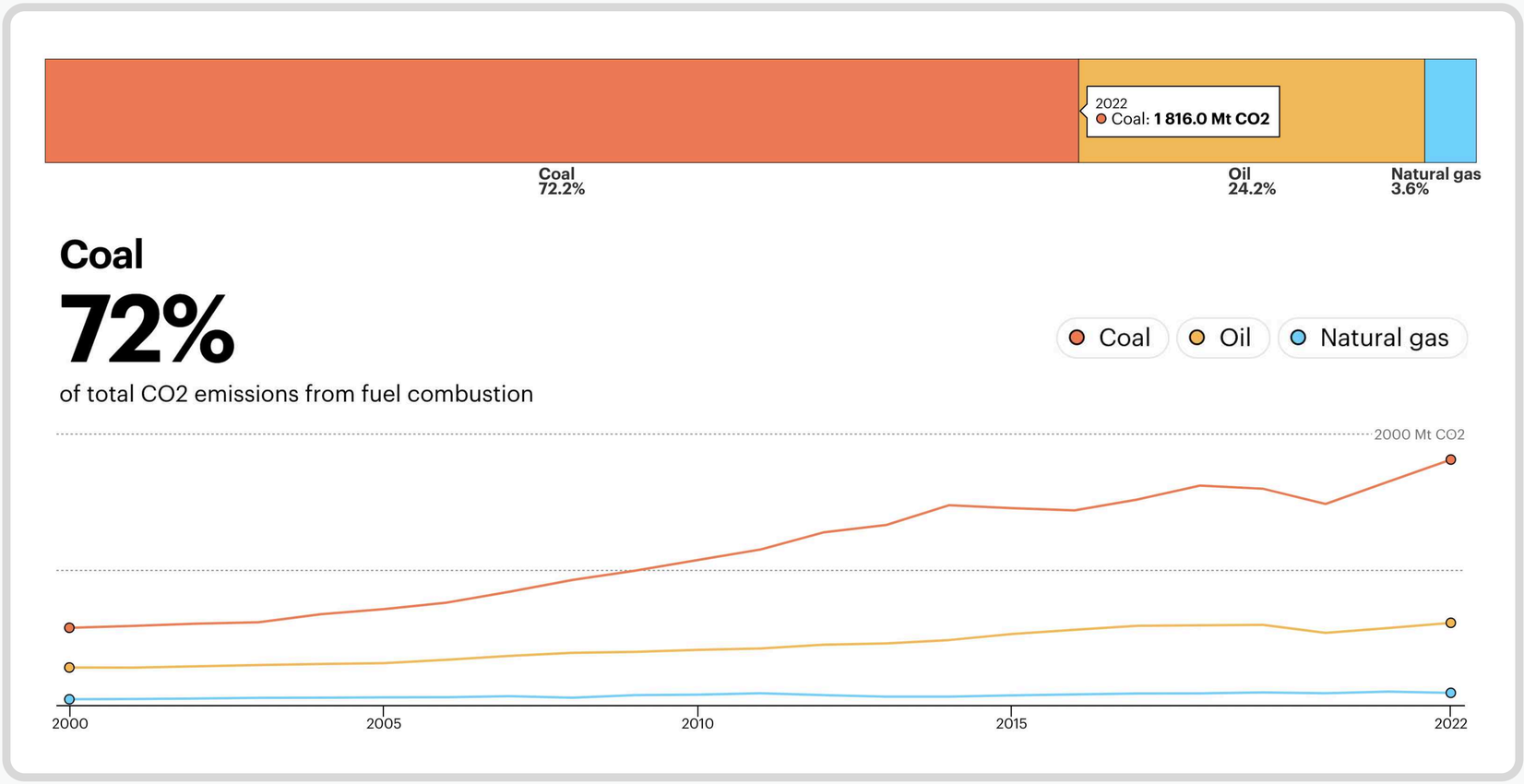
Source: International Energy Agency (IEA)

Research & Analysis

CO_2 emissions in India.

CO_2 : Carbon dioxide



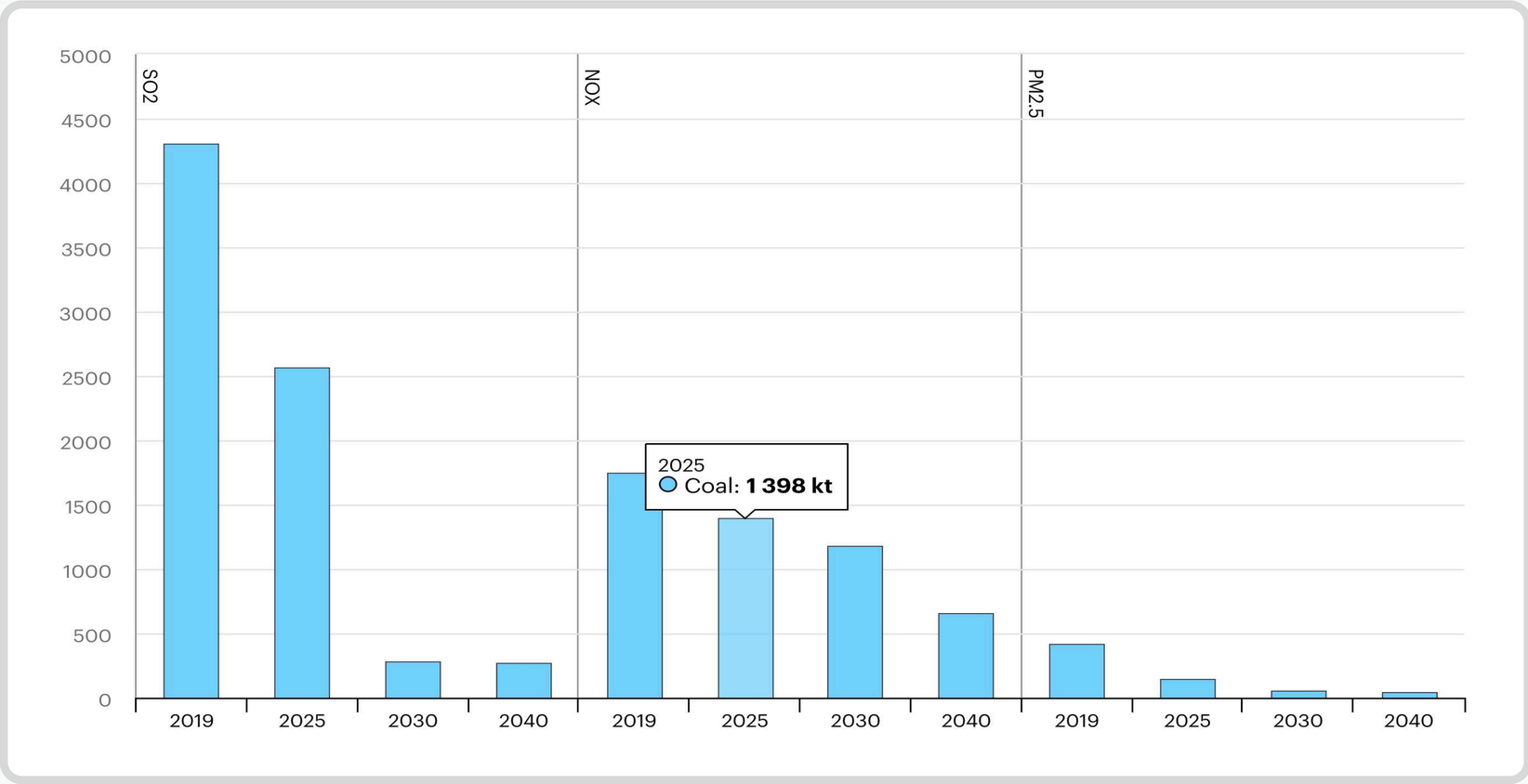


Source: International Energy Agency (IEA)

SO_2, NO_x, $PM_{2.5}$ emissions from coal.

SO_2 : Sulphur dioxide
NO_x : Nitrogen oxides
$PM_{2.5}$: Particulate Matter 2.5

As of 2025, emission is 1,398 kilo tonnes

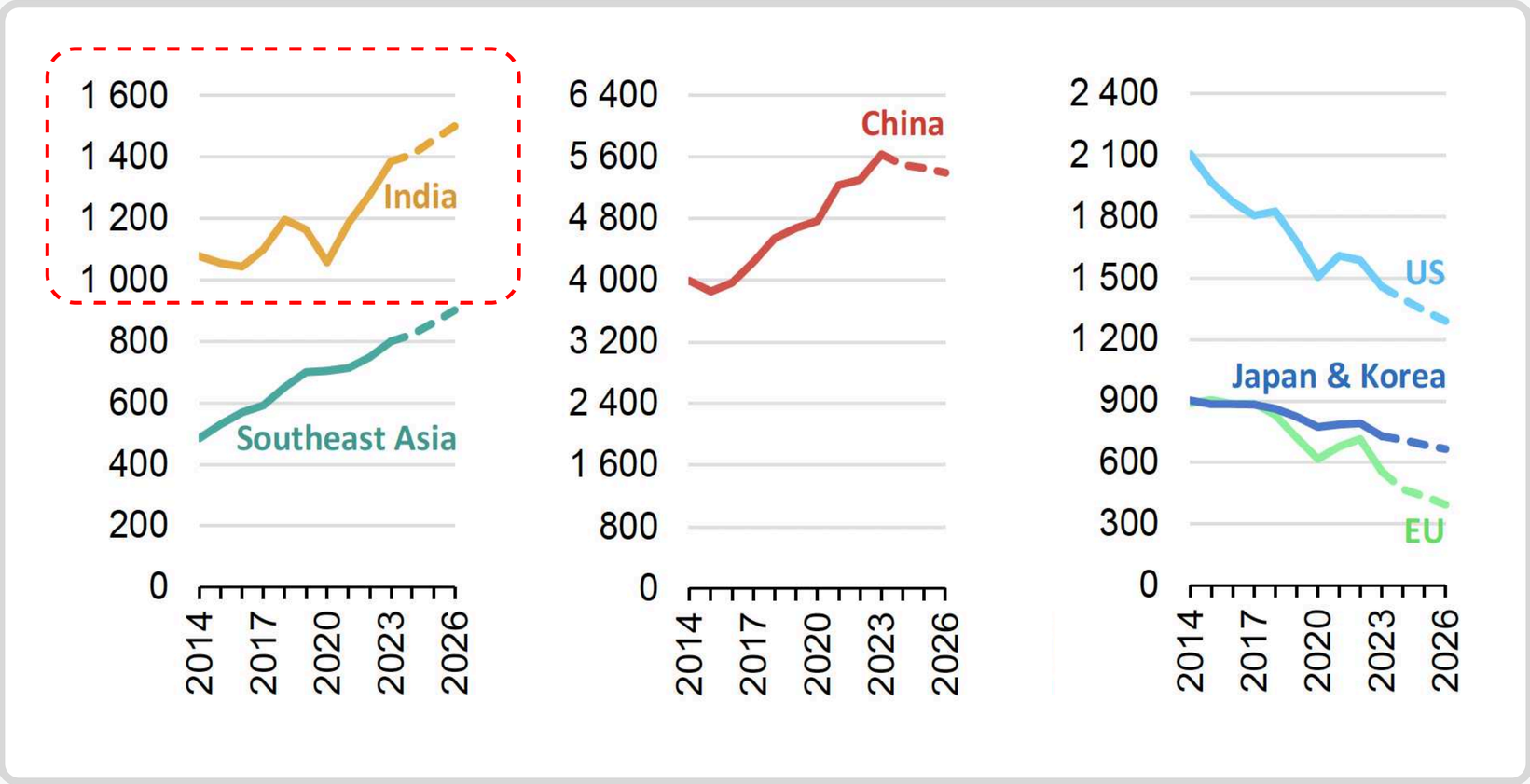


Source: International Energy Agency (IEA)

CO_2 emissions from electricity generation.

CO_2 : Carbon dioxide

(2014 - 2026)



Source: International Energy Agency (IEA)

Research & Analysis

Asia Pacific electricity supply verses emissions.

(2021 - 2026)

Total Generation

4.7%

Verses

Total Emissions

4.9%

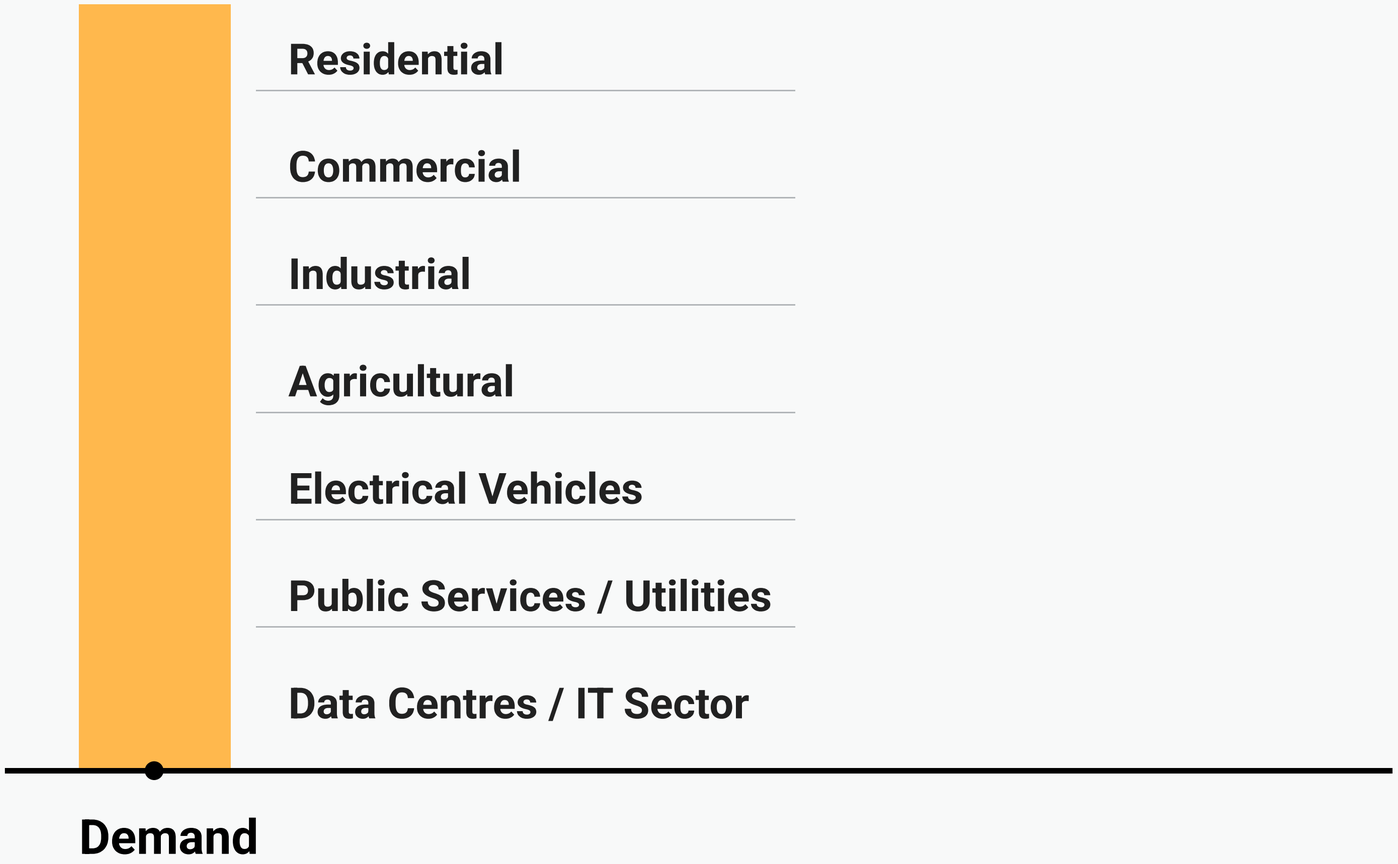
TWh	2021	2022	2023	2026	Growth rate 2021-2022	Growth rate 2022-2023
Nuclear	727	746	792	916	2.6%	6.1%
Coal	8 000	8 196	8 675	8 542	2.5%	5.8%
Gas	1 517	1 481	1 471	1 600	-2.4%	-0.7%
Other non-renewables	203	198	155	126	-2.2%	-21.9%
Total renewables	3 554	3 946	4 155	6 136	11.0%	5.3%
Total Generation	14 001	14 568	15 248	17 321	4.0%	4.7%

Mt CO_2	2021	2022	2023	2026	Growth rate 2021-2022	Growth rate 2022-2023
Total emissions	8 420	8 589	9 011	8 929	2.0%	4.9%

Source: International Energy Agency (IEA)

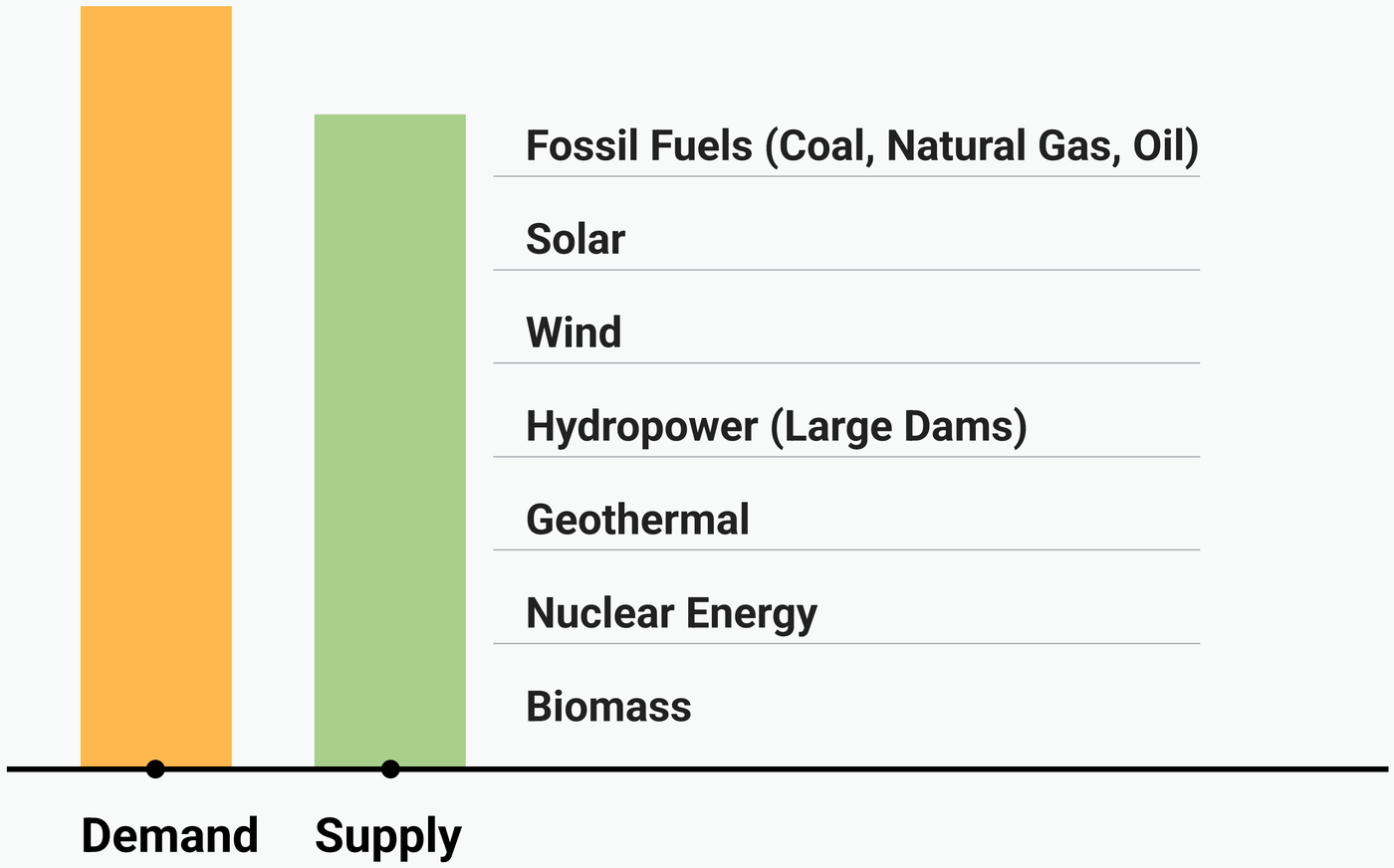
At a glance,

Electricity demand by sectors.



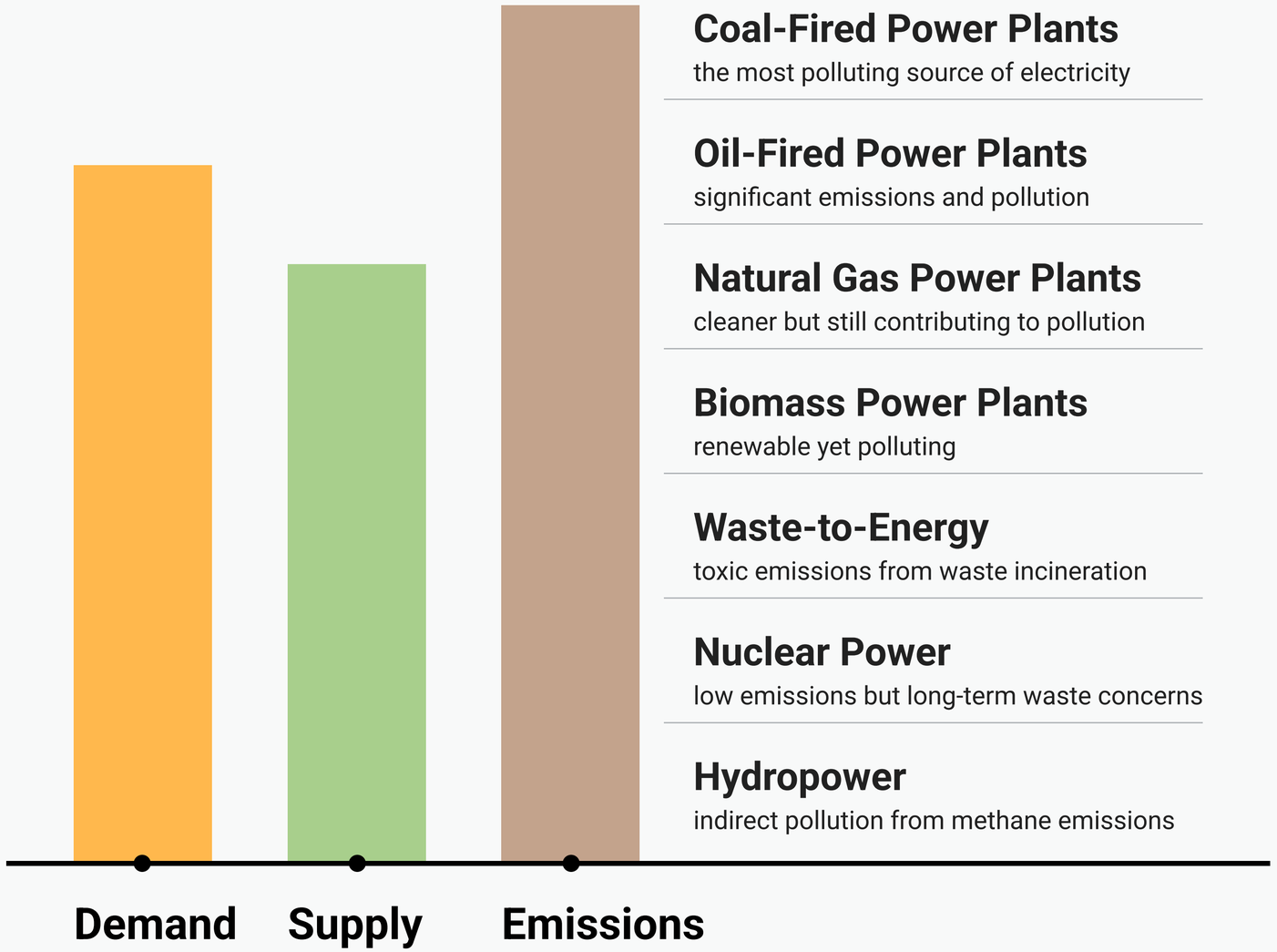
At a glance,

Sources of electricity supply.



At a glance,

Electricity demand, supply, and emissions.



Coal-Fired Power Plants
the most polluting source of electricity

Oil-Fired Power Plants
significant emissions and pollution

Natural Gas Power Plants
cleaner but still contributing to pollution

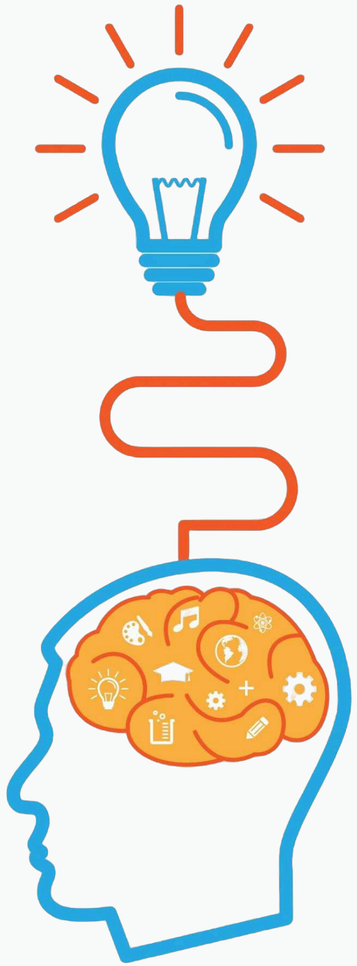
Biomass Power Plants
renewable yet polluting

Waste-to-Energy
toxic emissions from waste incineration

Nuclear Power
low emissions but long-term waste concerns

Hydropower
indirect pollution from methane emissions

This is the triggering point for me...



to design a unique, secure, sustainable, product.

So, with this vision,

I want to introduce my unique, secure, sustainable, scalable, reliable, and portable product...

Vaayurath®

the future of sustainable wind energy

India Granted Patent No. 555950
International PCT No. IB2024/055273
Trademark Registered No. 6299231

And,

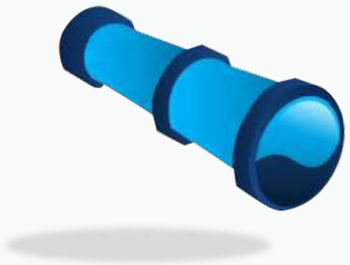
Vaayurath is a combination of two words.

Vaayu + **rath**

Vaayu term is used to describe the movement of air or wind.

Rath term in sanskrit refers to a vehicle.

Vaayurath’s

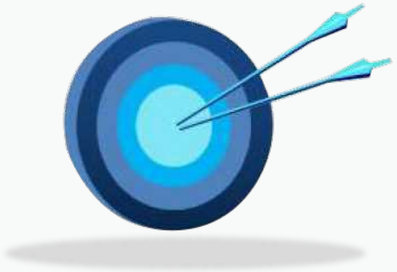


Vision

To drive carbon-free electricity by following life-centered design principles.

Mission

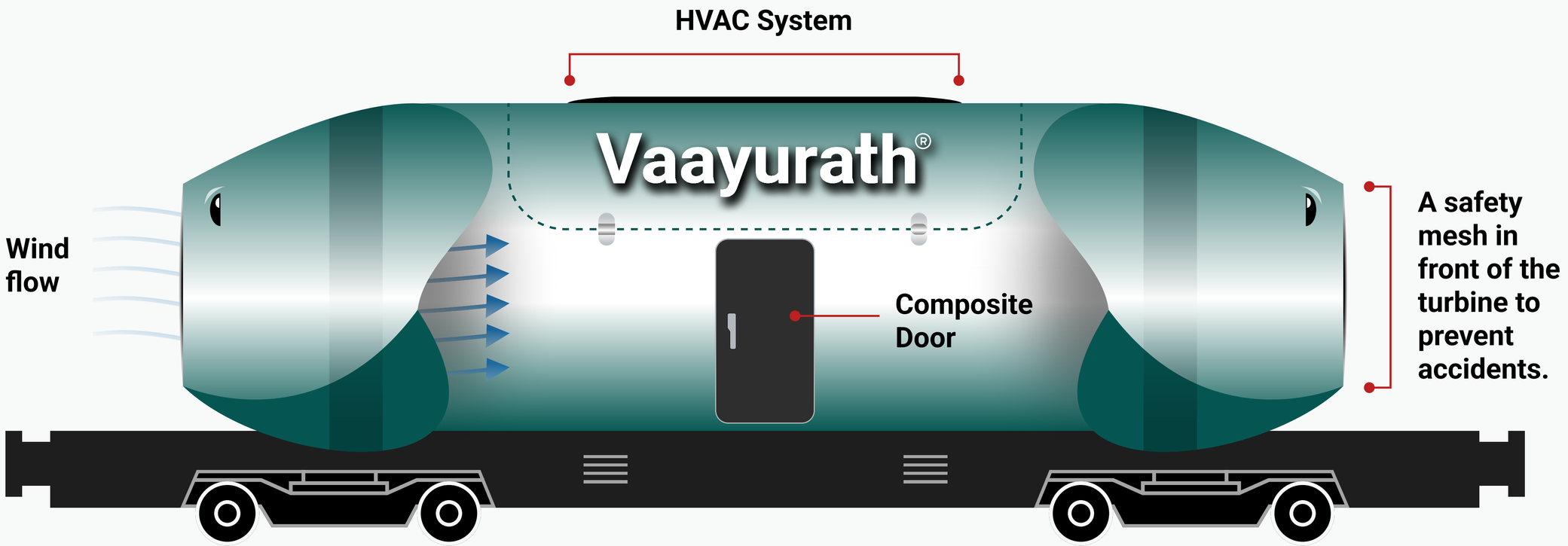
Is to raise awareness on electricity crises and energy access.



Goal

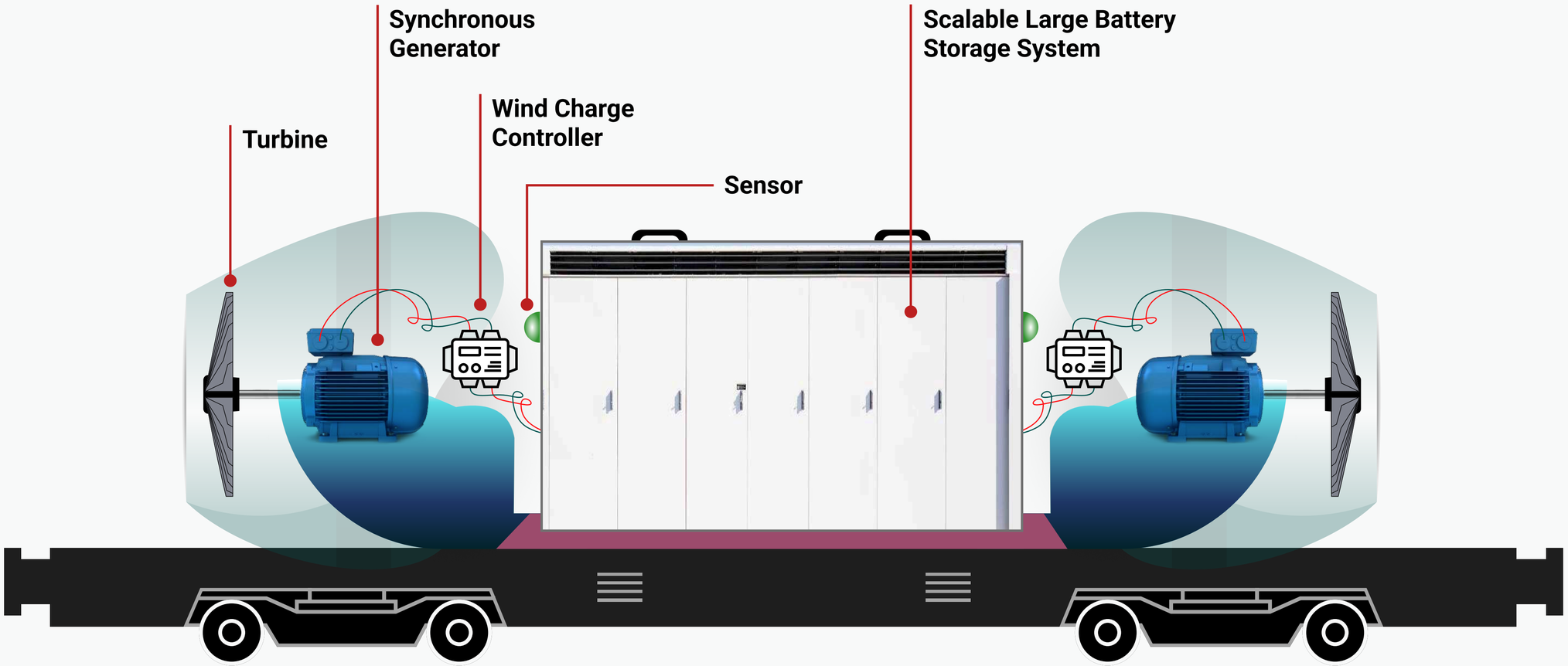
Want to be part of RDSO and support the Make in India initiative.

An isolated, two-sided aerodynamic railway-integrated system.



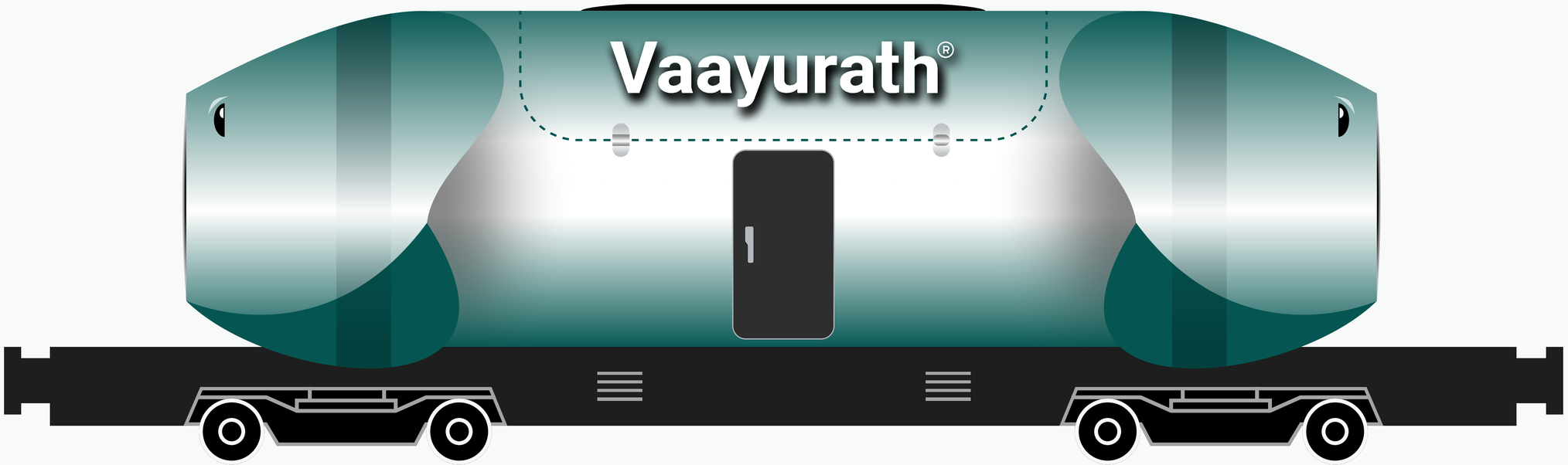
Vaayurath®
the future of sustainable wind energy

Vaayurath components.



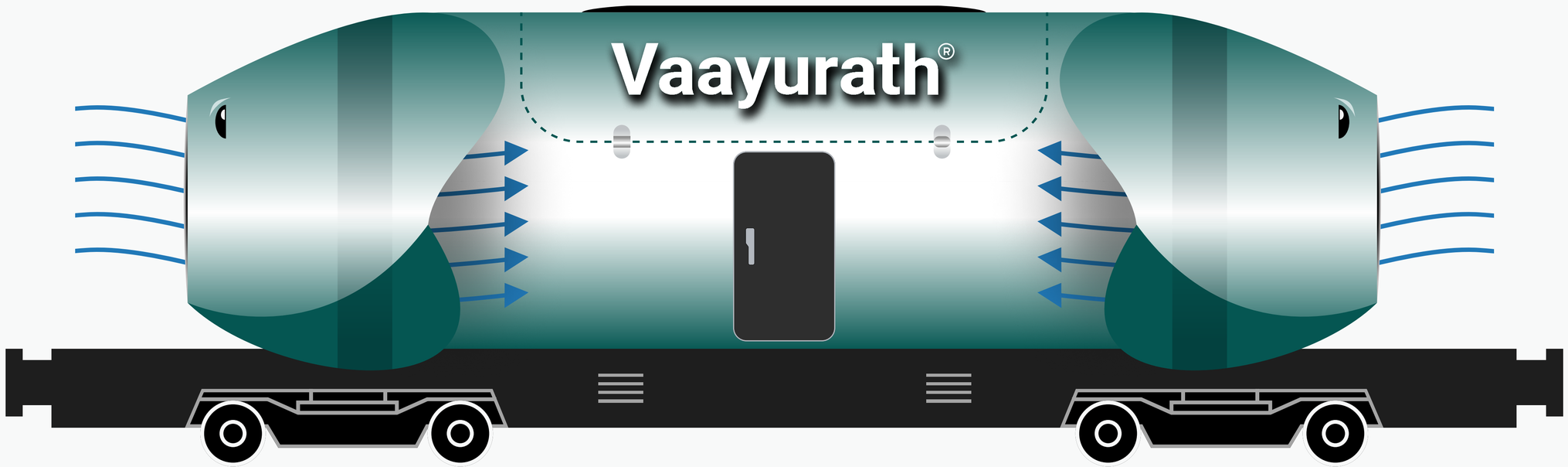
Vaayurath®
the future of sustainable wind energy

The fish fin-like structure facilitates the flow of wind easily without putting pressure on the engine.



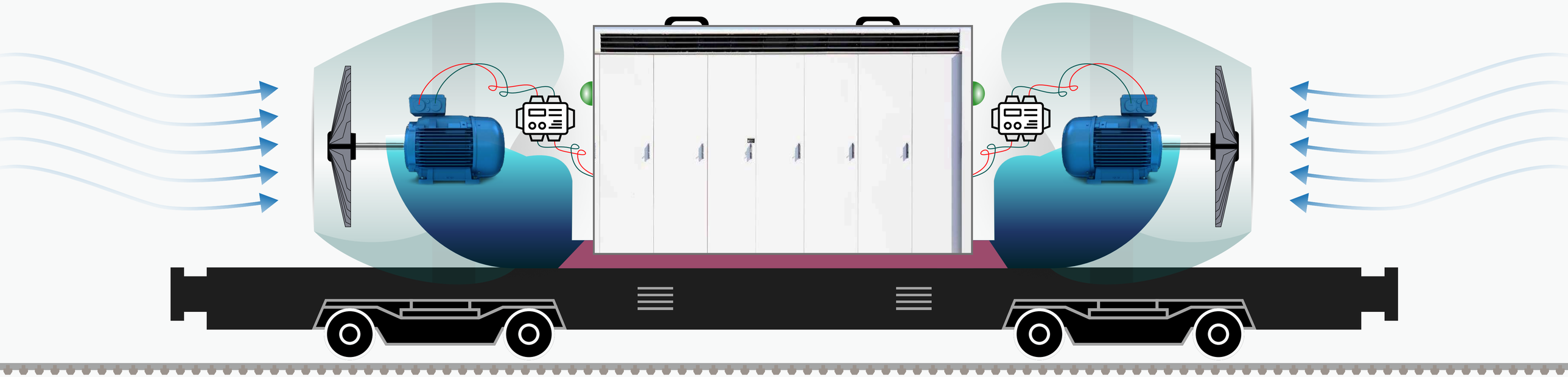
Vaayurath®
the future of sustainable wind energy

The fish fin-like structure facilitates the flow of wind easily without putting pressure on the engine.



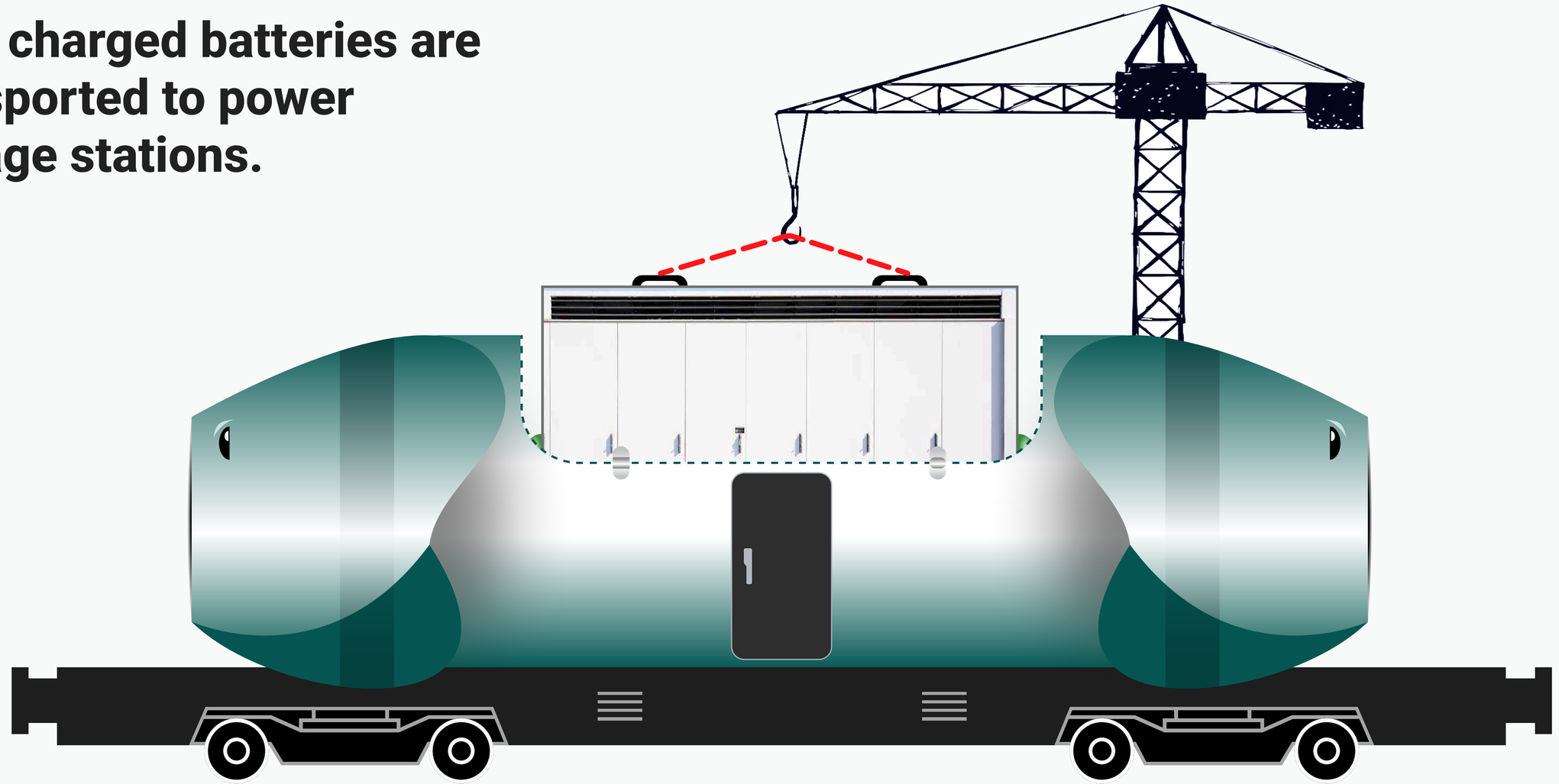
Vaayurath®
the future of sustainable wind energy

Captures wind energy from moving trains, converts it into electricity, and stores it in large battery energy storage systems.



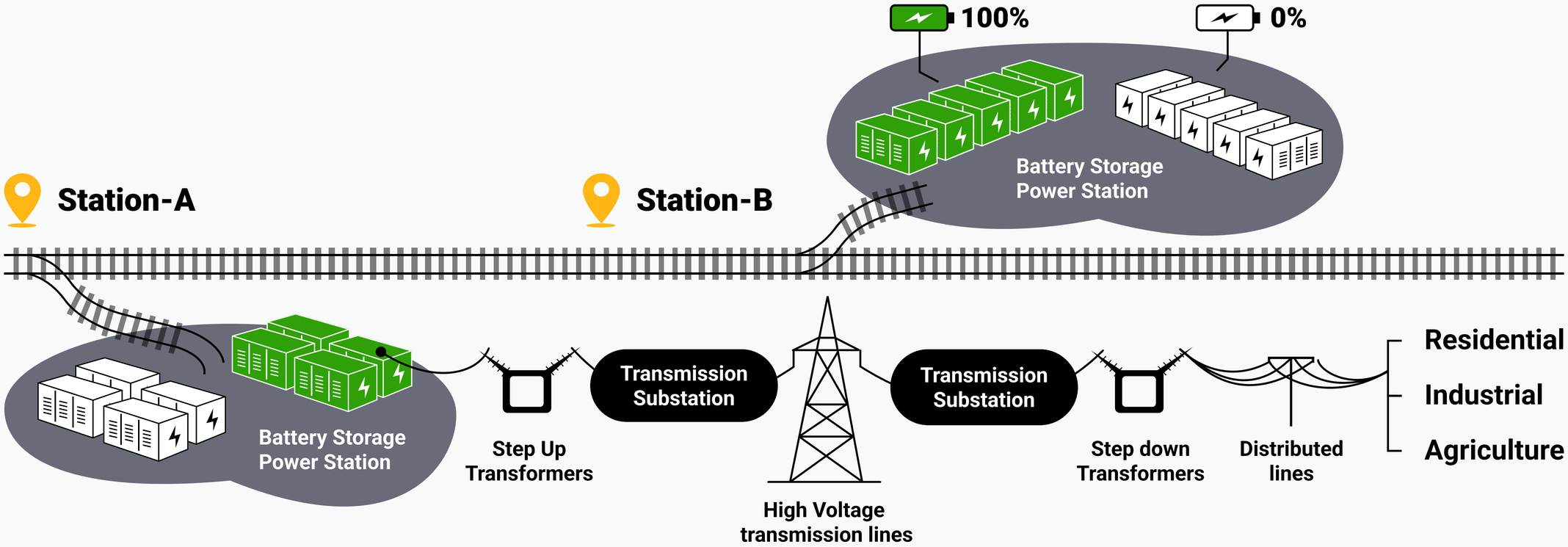
Vaayurath®
the future of sustainable wind energy

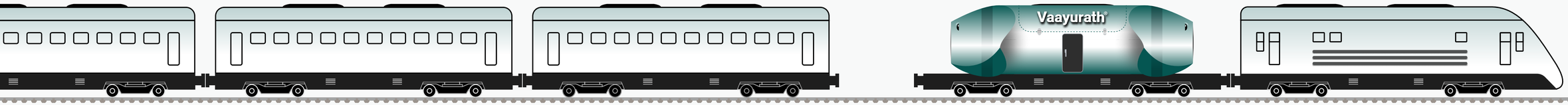
Fully charged batteries are transported to power storage stations.



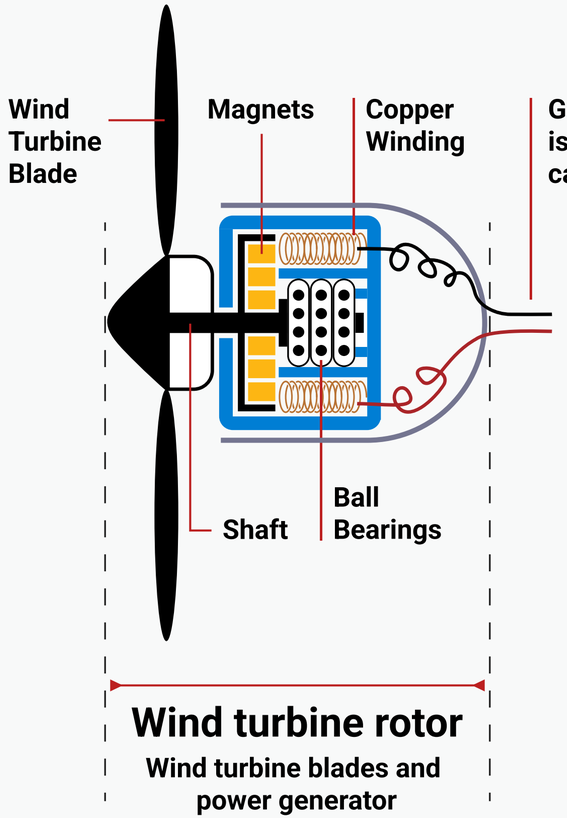
Vaayurath®
the future of sustainable wind energy

Vaayurath's working principle.





Vaayurath flow chart.



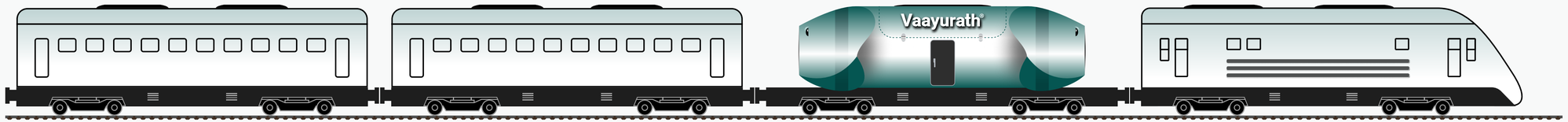
Charge Controller → Large Battery Storage System → Transported fully charged batteries to Battery Storage Power Stations

Step Up Transformers → Transmission Substation → High Voltage transmission lines → Transmission Substation → Step Down Transformers

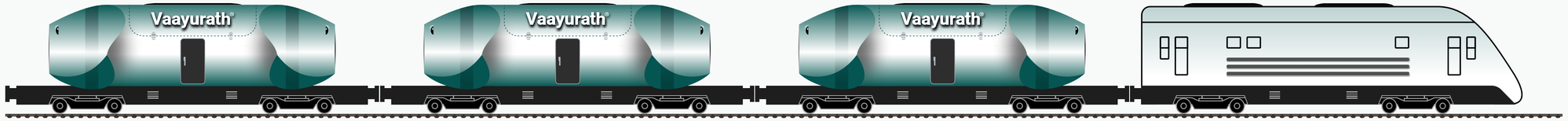
Distributed lines → Residential, Industrial, Agriculture & Other required utilities

Two effective methods to implement Vaayurath

1. Vaayurath as one of their train coaches.



2. Dedicated trains running with Vaayuraths, 24/7, 365 days a year.



Vaayurath’s

AI-driven, predictive analysis and real-time sensors based monitoring.

Set to lead,

Sustainable energy.

What makes Vaayurath unique among other energy solutions?

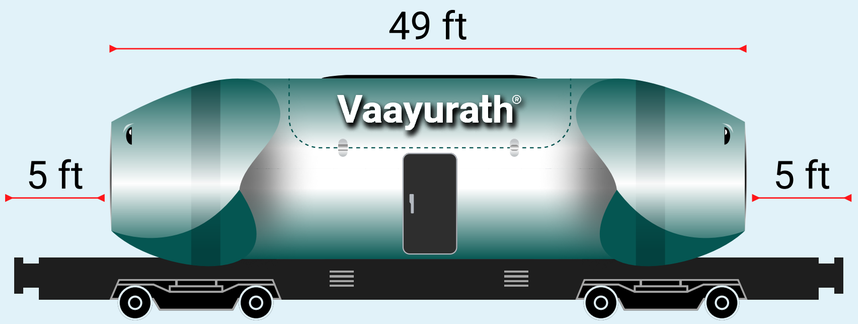
- Zero carbon emissions
- 24/7 electricity generation
- 100% secure, scalable, portable and reliable
- 90% leverages existing railway infrastructure
- Prevents 99% coal crises & power shortages
- Weather independent and no climate impact
- AI based predictive analysis
- Sensors based real-time monitoring
- Align with 5 sustainable development goals

Vaayurath,

aligning with...

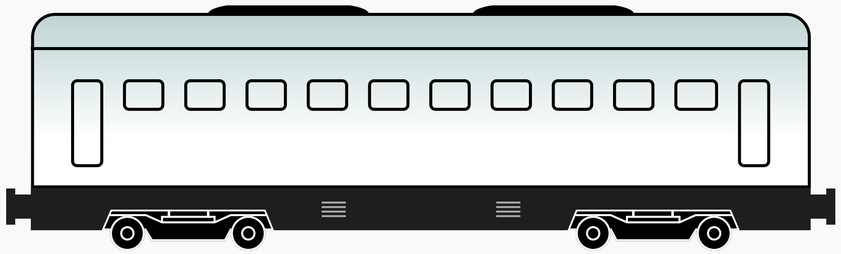
SDGs 7, 8, 9, 12, & 13 by ensuring affordable energy, driving economic growth, promoting sustainable industries, improving resource efficiency, and supporting climate action.

Vaayurath **specifications.**



Length	Width	Height	Weight (approx.)
49 ft	**10 ft**	**13 ft**	**61.2 tons**

- Polycarbonate 48 fan blades (2 units) : 160 kg
- 3.9 MW synchronous generators (2 units) : 4 tons
- Wind charge controllers (2 units) : 5 kg
- 3.9 MW battery storage system : 32 tons
- Upper body, HVAC system, and interiors : 15 ton
- 59 foot bogie : 10 ton

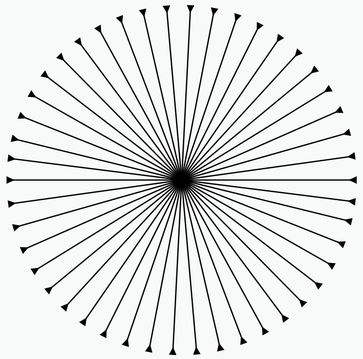


Length	Width	Height	Weight
59 ft	**10 ft**	**13 ft**	**63.5 tons**

Typical dimensions of an Air-Conditioned Passenger Coach in India.

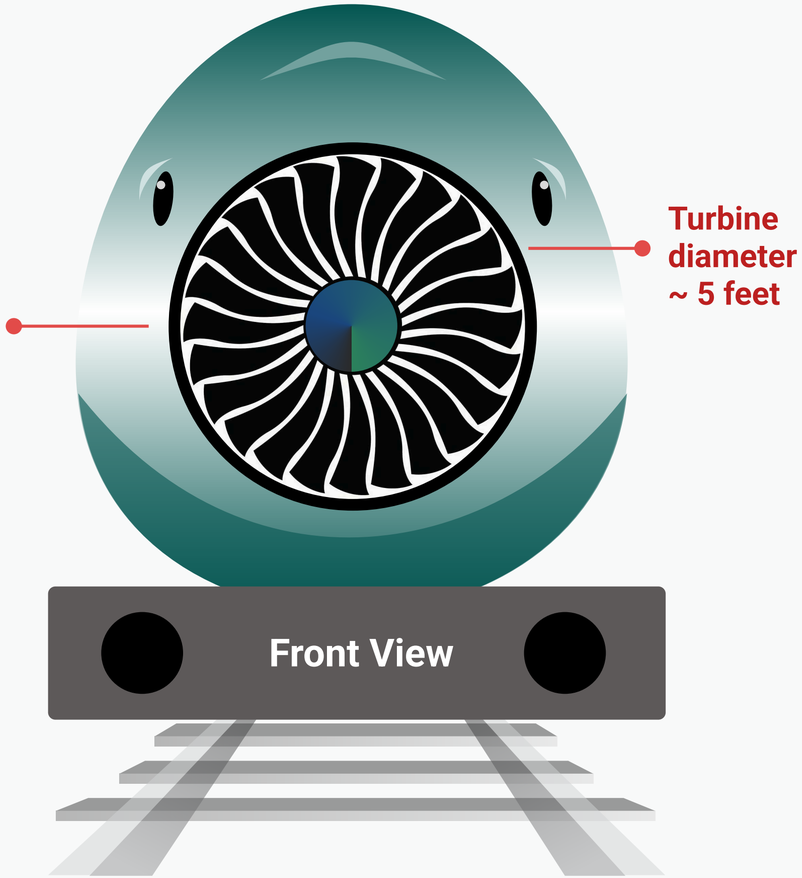
Vaayurath **turbine specifications.**

A safety mesh is placed in-front of the turbine to prevent accidents.



Turbine Capacity: 5 MW

At **100 km/h** wind speed, the turbine would rotate about **1,592 RPM.**



- **Volume of 24 blade**

  = Length (2.5 feet) × Width (1 feet) × Thickness (12 mm)
  = 2.5 × 1 × 0.039 ft
  = 0.0975 cubic feet (1 cubic foot = 0.0283168 cubic meters)

- **Weight of the blades (Polycarbonate)**

  Density of Polycarbonate : 1200 kg/m³
  = 0.002764 m³ × 1200 kg/m³ = 3.317 kg

  So, the mass of one fan blade is approximately 3.317 kg.
  = 3.317 kg x (48 fans) = 159.2 kg

- **Total weight of the ball bearings**

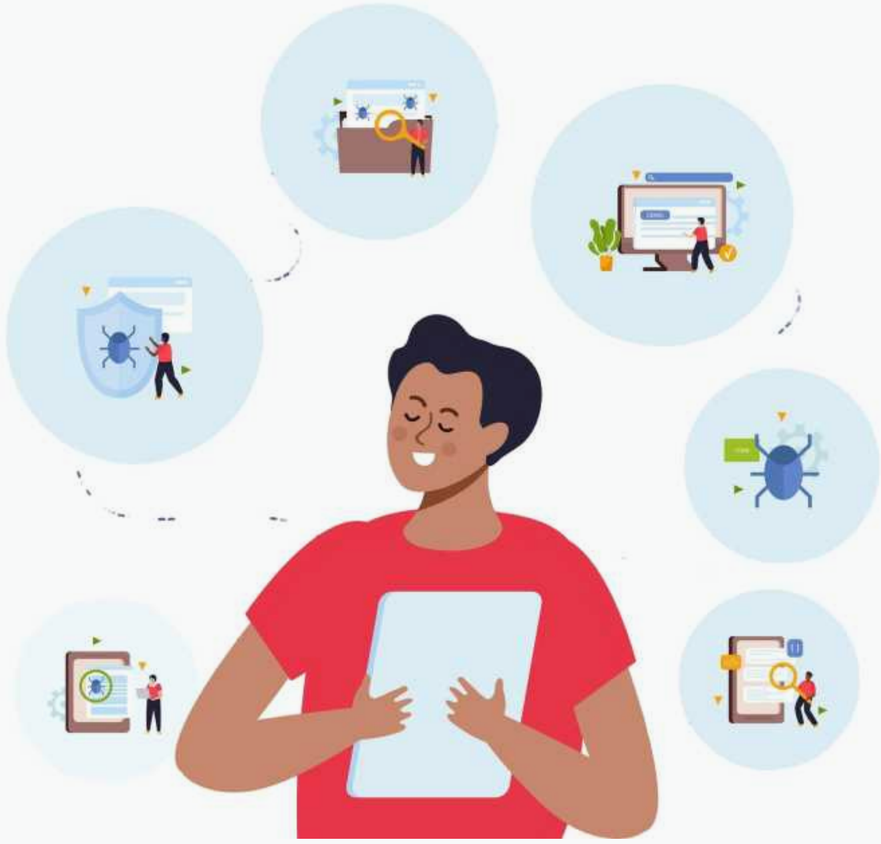
  Weight of one ball bearing = 2 units × 15 grams = 30 grams
  Weight of ball bearings = 24 blades × 30 grams = 0.72 kg

- **Total weight of the turbine = 160 kg**

  = 159.2 kg (blades) + 0.72 kg (ball bearings) = 159.92 kg
  = Approximately 160 kg.

Vaayurath’s

Top use cases & key questions



01. How much energy is consumed by the train to accelerate from 0 to 42.3 kmph?

Ans.

Approximately 5 kW of energy is consumed by the train to move from 0 to 42.3 kmph.

42.3 kmph is the average speed of Indian ordinary trains.

1 kilowatt = 1,000 watts
1 watt = 1 joule per second

Given

- **Train Engine + Vaayurath = Mass** (*m*) = 200 + 61 = 261 tons
- **Initial velocity,** v_i = 0 km/s
- **Final velocity,** v_f = 42.3 km/s

Convert the velocities from km/h to metre per second.

$V_i = \frac{0\ \text{km}}{\text{h}} \times \frac{1000\ \text{m}}{3600\ \text{s}} =$ **0 m/s**

$V_f = \frac{42.3\ \text{km}}{\text{h}} \times \frac{1000\ \text{m}}{3600\ \text{s}} =$ **11.75 m/s**

Let's calculate Kinetic Energy

$$\text{KE} = \frac{1}{2} \times m \times (v^2_f - v^2_i) = \frac{1}{2} \times 261{,}000 \times \left(\left(11.75\right)^2 - 0^2 \right)$$

$$\text{KE} = \frac{1}{2} \times 261{,}000 \times 138.06 =$$ **Approximately 1,80,16830 Joules (J)**

Let's convert this kinetic energy from joules to kilowatt-hour using the conversion factor 1 kWh = 1,000 w × 3,600 sec = 36,00,000

$$\textbf{Energy} = \frac{1{,}80{,}16830}{36{,}00{,}000} =$$ **Approximately 5.0 kWh**

02. How much energy will Vaayurath generate at 100 kmph?

Ans.

Vaayurath, as part of 22,669 trains, can power approx 1.56 crore homes with 200 units per month at 100 km/h.

Vaayurath's battery capacity is 3.9 Megawatts (MW)

1 MW = 1000 units
3.9 MW = 3.9 x 1000 = 3900 units

Let's calculate one Vaayurath wind energy output:

P = 0.5 x ρ x A x Cp x v^3 x Ng x Nb

= 0.5 x 1.225 x 1.82 x 0.8 x 21438.6 x 0.8 x 1.0

= **19,128.89 W = 19,128.89 / 1000 = 19 kW**

1 hour	24 hrs (1 day)	30 days (1 month)
19 kWh	**459 kWh**	**13,769 kWh**

Where in:

ρ	=	Air density in kg/m3	≈ 1.225 kg/m³ at sea level
A	=	Rotor Swept Area (m²)	= 5 feet (1 foot = 0.3048 meters)
		Diameter (d)	= 5 x 0.3048 m/foot = 1.524 meters
		Radius (R)	= 1.524 / 2 = 0.762 meters
		Swept Area formula (*fx*)	= π × R² = 3.14 × (0.762)²
			= 3.14 × 0.58 ≈ 1.82 square meters
Cp	=	Coefficient of performance	= 80% = 0.80
V	=	Wind velocity (m/s)	= 100 × 1000/3600 ≈ 27.78 m/s
Ng	=	Generator efficiency	= 80% = 0.80
Nb	=	Gear box bearing efficiency	= 100% = 1.00

03. Vaayurath vs Solar System comparison.

✅ Strength or Advantage

Aspect	Vaayurath	Solar System
Velocity	**100 km/h**	Not applicable
Power output	**19.13 kW**	19.13 kW
Energy generated (1 hour)	✅ **19.13 kWh**	4.77 kWh
Energy generated (1 day)	✅ **458.97 kWh**	114.48 kWh
Energy generated (1 month)	✅ **13,769.1 kWh**	3,434.4 kWh
Area required	**1.82 m² swept area (1 bogie space)**	✅ 130.9 m² (77 panels)
Time to charge 3.9 MW battery	**8.5 days (based on the battery capacity)**	8.5 days (5 peak sunlight hours per day)
Homes powered with 200 units (1 month)	✅ **68 homes**	17 homes
Number of homes powered per month by **22,669 Indian trains,** supplying 200 units each.	✅ **1.56 crore homes**	Energy for 1.56 crore homes is **312,717,008 kWh (1 month)** Required **: 7,000,000 panels** Land required **: 11,919,900 m²** (approx.)

Vaayurath, as part of 22,669 trains, can power approx 1.56 crore homes with 200 units per month at 100 km/h

Vaayurath,

SWOT Analysis.

Strengths

- Zero carbon emissions.
- Leverages existing railway infrastructure.
- 100% secure, scalable, portable, and reliable.
- 24/7 electricity generation.
- Prevents 99% of coal crises.
- Weather-independent.

Weaknesses

- Requires support and approvals from the Central and State Governments for implementation.
- Seeking investors, sponsors, and manufacturers of large battery systems.

Opportunities

- Generate electricity 24/7, 365 days a year
- Can create numerous job opportunities and contribute to economic progress
- Opportunity to leverage central and state government renewable energy production schemes

Threats

- Currently, no threats have been identified.

Vaayurath,

Cost Estimate.

Seeking investors, sponsors, and battery system manufacturers for collaboration.

Vaayurath Component	Cost Estimate
Polycarbonate Fan Blades (48 blades)	₹ 01 lakh
3.9 MW Synchronous Generator (2 units)	₹ 12 Crores
Wind Charge Controller (2 Units)	₹ 31 Crores
3.9 MW battery storage system	₹ 16 Crores
Train Coach with HVAC System (with a bogie)	₹ 04 Crores
Total (approximately)	**₹ 63 Crores**

Possibility of implementing Vaayurath by leveraging Indian railway infrastructure.

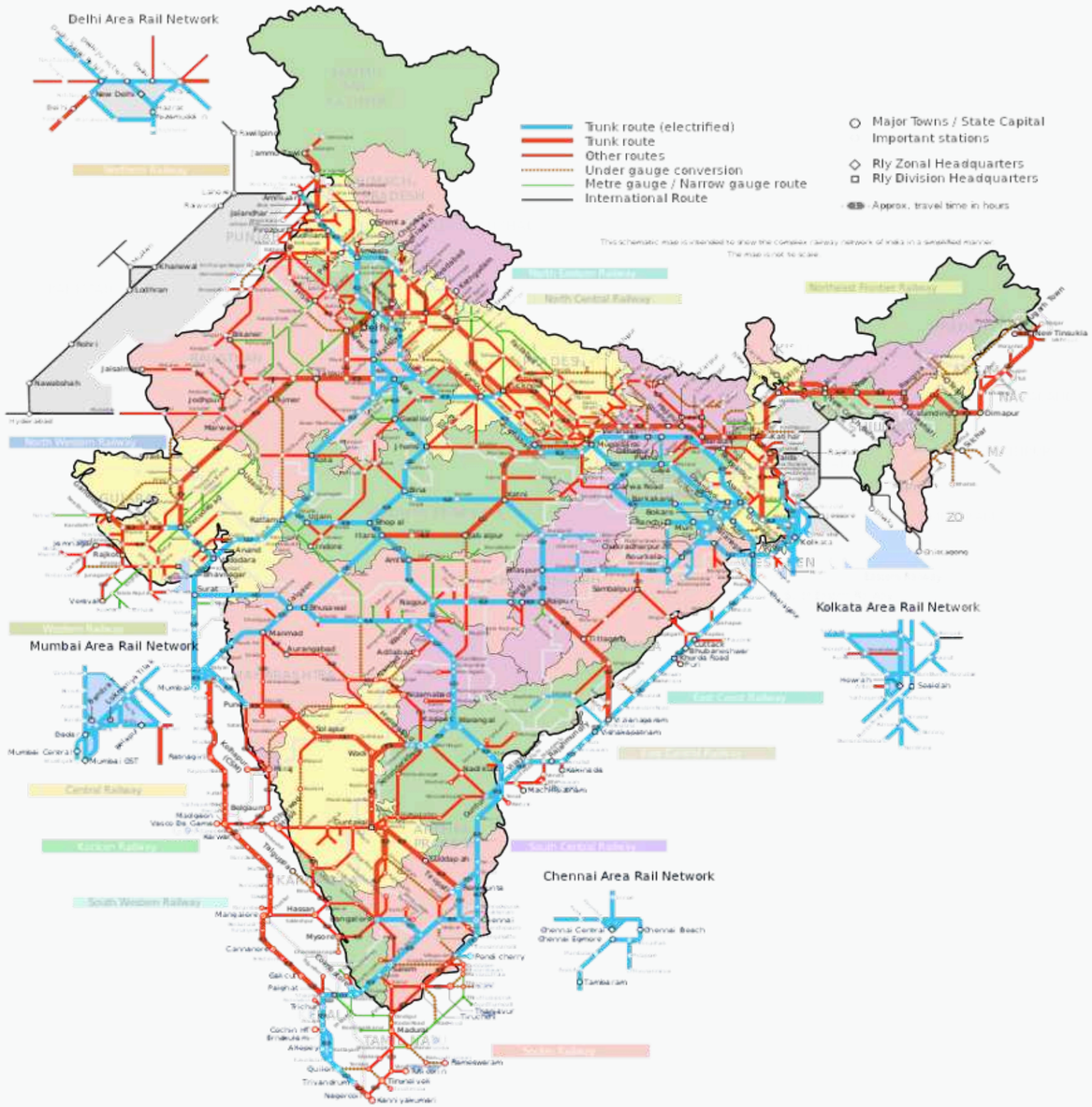
Total trains operating

22,669

Total railway stations

7,349

Therefore, Vaayurath, as part of 22,669 trains, can power approximately 1.56 crore homes with 200 units per month at 100 km/h.



Opportunity to implement Vaayurath by utilising existing central & state governments schemes.

Each state has its own set of policies focusing on promoting wind energy development through incentives, subsidies, land allocation.

Central Government Schemes

- The Ministry of New and Renewable Energy (MNRE)
- Prime Ministers Employment Generation Programme (PMEGP)
- Credit Guarantee Fund Trust for Micro & Small Enterprises (CGTMSE)
- Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME)
- National Clean Energy Fund (NCEF) for Wind Energy Projects
- Wind Power Policy under Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya)
- Central Financial Assistance (CFA) for Wind Power Projects

सत्यमेव जयते
Ministry of New and Renewable Energy
Government of India

PMEGP
Prime Minister's Employment Generation Programme

cgtmse

State Government Schemes

- Telangana Wind Energy Policy
- Gujarat Wind Energy Policy
- Rajasthan Wind Power Policy
- Maharashtra Wind Power Policy
- Karnataka Wind Power Policy
- Andhra Pradesh Wind Power Policy
- Uttarakhand Wind Energy Policy
- Himachal Pradesh Wind Energy Policy
- Kerala Wind Energy Policy
- Odisha Wind Power Policy
- West Bengal Wind Energy Policy
- Chhattisgarh Wind Energy Policy
- Punjab Wind Power Policy
- And so on.

My Inspiration

I was inspired by a small child playing with a **pinwheel** that sparked my idea.

Vaayurath's

Achievements

Invented & Founded
Vaayurath

Trademark Registered
6299231

India Granted Patent
555950

International PCT
IB2024/055273

Feb 12, 2024

Honoured with the esteemed Empowering India Award in the category of **Most Innovative SME of the Year** New Delhi.

Sept 5, 2024

Honoured with a memento at **UX India Largest Design Conference** Bangalore.

Sept 15, 2024

Current Opportunity

As a speaker at the esteemed **Rail Analysis Innovation & Excellence Summit 2025**, New Delhi.

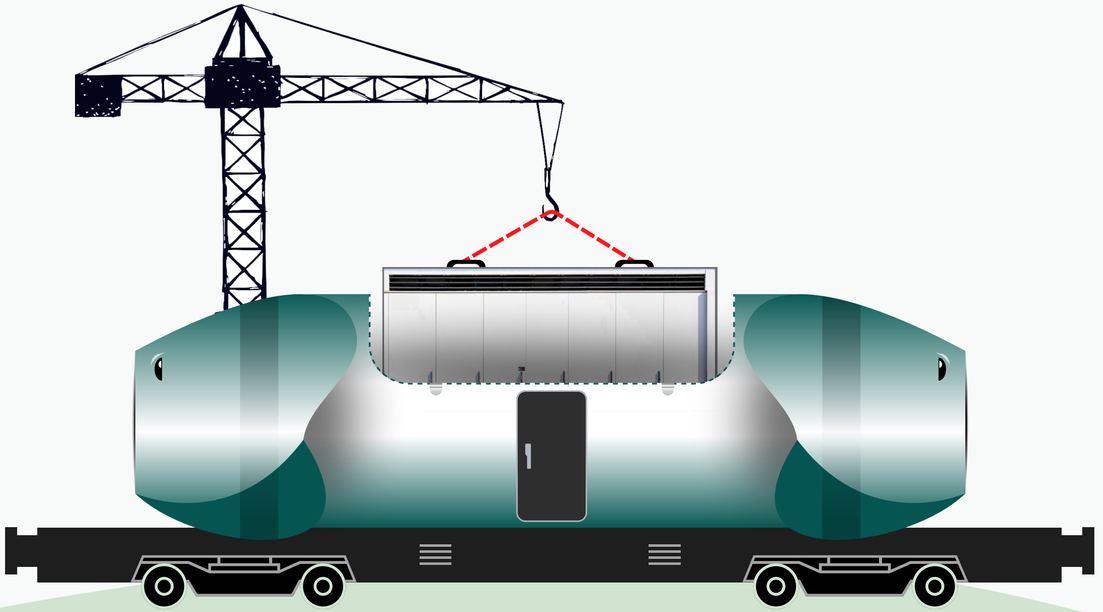
Jan 31, 2025

Let’s be a part of,

Vaayurath®

the future of sustainable wind energy

Thank you, Jai Hind.



Chanukya Sri Vinayak Katta

Inventor & Founder of Vaayurath

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